SCANNED

PERMIT FOR OPEN BURNING (OB) TREATMENT OF HAZARDOUS WASTE

National Aeronautics and Space Administration Goddard Space Flight Center

Wallops Flight Facility
Wallops Island, VA 23337-5099

EPA I.D. No. VA7800020888

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Permit
VA7800020888

SCANNED
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COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

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VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

PERMIT
FOR OPEN BURNING (OB) TREATMENT OF HAZARDOUS WASTES

National Aeronautics and Space Administration
Goddard Space Flight Center
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Wallops Island, VA 23337-5099
EPA I.D. No. 7800020888
VA7800020888 CDE

Pursuant to Chapter 14, Article 4, Title 10.1, Code of Virginia (1950), as amended; and regulations promulgated thereunder by the Virginia Department of Environmental Quality, a Permit is issued to the National Aeronautics and Space Administration, Goddard Space Flight Center, Wallops Flight Facility (hereinafter called the Permittee), for the open burning treatment of hazardous wastes in Wallops Island, Virginia in Accomack County, and with a geographic location of latitude 37° 56" 33" North and longitude 75° 75' 56" West.

The Permittee shall comply with all terms and conditions set forth in this Permit including Attachments AA through HH. If the Permit and the above attachments conflict, the wording of the Permit shall prevail. The Permittee shall also comply with all applicable regulations contained in the Virginia Hazardous Waste Management Regulations (VHWMR) as codified in Title 9 of the Virginia Administrative Code, Agency 20, Chapter 60 (9 VAC 20-60), and in 40 CFR 124, 260, 261, 262, 264, 265, 268, and 270 as adopted by reference in these regulations. The Commonwealth of Virginia has received authorization for these programs under Section 3006(b) of *the Resource Conservation and Recovery Act* (RCRA), 42 U.S.C. § 6926(b), to administer and enforce in lieu of the federal hazardous waste management program under RCRA. Applicable regulations are those which are in effect on the date of final administrative action on this Permit as well as any self implementing statutory provisions and related regulations

which are automatically applicable to the Permittee's hazardous waste management activities, notwithstanding the conditions of this Permit.

This Permit is based on the administrative record and the assumption that the information submitted by the Permittee and contained in the administrative record is complete and accurate. The Permittee's failure in the application, or during the permit issuance process, to fully disclose all relevant facts, or the Permittee's misrepresentation of any relevant facts at any time, shall be grounds for the termination or modification of this Permit pursuant to 9 VAC 20-60-124.5, 270.41, and 270.43 and 40 CFR 124.5, 270.41 and 270.43, and shall also be grounds for initiation of an enforcement action. The Permittee shall inform the Department of any deviations from Permit Conditions or changes from information provided in the application. In particular, the Permittee shall inform the Department of any proposed changes that might affect the ability of the Permittee to comply with applicable regulations and/or Permit Conditions, or which alter any of the conditions of the Permit in any way.

This Permit is effective as of 10/20/2005, and shall remain in effect until 10/20/2015 (ten years from effective date) unless revoked and reissued in accordance to 9 VAC 20-60-124.5, 270.41, and 270.43 and 40 CFR 124.5, 270.41 and 270.43, terminated in accordance with 9 VAC 20-60-270.43, or continued in accordance with 9 VAC 20-60-270.B.5.

Sept 20, 2005
Date Signed

Leslie A Romanchik
for Robert G. Burnley
Director

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DEFINITIONS

For the purposes of this Permit, the following definitions shall apply:

a. The term "**Permit**" shall mean the Permit issued by the Virginia Department of Environmental Quality, pursuant to Chapter 14, Article 4, Title 10.1, Code of Virginia (1950), as amended, and the Virginia Hazardous Waste Management Regulations (VHWMR) as codified in Title 9 of the *Virginia Administrative Code*, Agency 20, Chapter 60 (9 VAC 20-60).

b. The term "**Director**" shall mean the Director of the Virginia Department of Environmental Quality or his designated representative.

c. The term "**Department**" shall mean the Virginia Department of Environmental Quality (DEQ), (with the address as specified in Permit Condition I.I.2).

d. The terms "**facility**" or "**site**" shall mean all contiguous portions of the Wallops Flight Facility as identified in the physical description of the property (including structures, appurtenances, and improvements). This property description is as set forth in Attachment II.AA of this Permit.

e. The term "**permitted Open Burn (OB) area**" shall mean those portions of the facility used for open burning treatment of hazardous waste as described in Permit Attachment II.AA.

f. The term "**release**" shall mean any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of any hazardous waste or hazardous constituents.

g. The term **"Area of Concern"** shall mean an area at the facility or an off-site area, which is not at this time known to be a solid waste management unit, where hazardous waste and/or hazardous constituents are present or are suspected to be present as a result of a release from the facility.

h. The term **"Hazardous Constituent"** shall mean a constituent that caused the Administrator to list the hazardous waste in 40 CFR 261, subpart D or a constituent listed in Table 1 of 40 CFR 261.24.

i. The term **"Permittee"** shall mean the facility to which the Permit is issued.

j. The term **"Regulated Unit"** shall mean the unit for which a permit has been issued by DEQ or EPA.

k. The term **"EPA"** shall mean United States Environmental Protection Agency.

l. The term **"Solid Waste Management Unit"** shall mean any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released.

m. The term **"Days"** shall mean calendar days except as otherwise provided herein.

n. All definitions contained in 40 CFR Sections 124.2, 260.10, 270.2, 264.141, 264.1031, 264.1051, 264.1081, and 9 VAC 20-60 are hereby incorporated, in their entirety, by reference into this Permit. Any of the definitions used above, (a) through (n), shall supersede any definition of the same term given in 40 CFR Sections 124.2, 260.10, 270.2, 264.141, 264.1031, 264.1051, 264.1081, and 9 VAC 20-60. Where terms are not defined in the regulations or the Permit, the meaning associated with such terms shall be defined by a standard dictionary reference or the generally accepted scientific or industrial meaning of the term.

o. Throughout the Permit, all references to 40 C.F.R. Parts 261-266, 268, 270, 273, 279, are as adopted by reference in the *Virginia Hazardous Waste Management Regulations,* 9 VAC 20-60.

MODULE I

STANDARD CONDITIONS

MODULE I - STANDARD CONDITIONS

I.A. EFFECT OF PERMIT

The Permittee is authorized to manage hazardous waste in accordance with the conditions of this Permit and in accordance with the applicable provisions of Title 9 of the Virginia Administrative Code, Agency 20, Chapter 60 (9 VAC 20-60). Any management of hazardous waste by the Permittee in the facility which is not authorized by this Permit or 9 VAC 20-60, and for which a permit is required under Chapter 14, Article 4, Title 10.1, Code of Virginia (1950), as amended, is prohibited. Compliance with this Permit constitutes compliance, for the purposes of enforcement, with Chapter 14, Article 4, Title 10.1, Code of Virginia (1950), as amended. This Permit does not convey any property rights of any sort, or any exclusive privilege. Possession of a permit does not authorize any injury to persons or property or invasion of other private rights, or any infringement of Commonwealth or local laws or regulations. Compliance with terms of this Permit may not constitute a defense to any action brought under Chapter 14, Article 8 of Title 10.1, Code of Virginia (1950) as amended for any other law governing protection of the public or the environment.

I.B. PERMIT ACTIONS

I.B.1 This Permit may be modified, revoked and reissued, or terminated for cause as specified in 9 VAC 20-60-124.5, 270.30(f), 270.41, and 270.43, 40 CFR 124.5, 270.30(f), 270.41, and 270.43. The filing of a request by the Permittee for a permit modification, revocation and reissuance, or termination, or the notification of planned changes or anticipated noncompliance does not stay the applicability or enforceability of any Permit Condition.

I.B.2 Permit modifications at the request of the Permittee shall be accomplished as specified by 9 VAC 20-60-270.42.

I.B.3 This Permit may be renewed as specified in 9 VAC 20-60-270.10 and 40 CFR 270.10, and Permit Condition I.D.2. Review of any application for a permit renewal shall consider improvements in the state of control and measurement technology, as well as changes in applicable regulations.

I.C. SEVERABILITY

I.C.1 The provisions of this Permit are severable, and if any provision of this Permit or the application of any provision of this Permit to any

circumstance is held invalid, the application of such provision to other circumstances and the remainder of this Permit shall not be affected

thereby. Invalidation of any Commonwealth or Federal statutory or regulatory provision which forms the basis for any condition of this Permit does not affect the validity of any other Commonwealth or Federal statutory or regulatory basis for said condition.

I.C.2 In the event that a condition of this Permit is stayed for any reason, the Permittee shall continue to comply with the related applicable and relevant permit standards in 9 VAC 20-60-270.10(e) until final resolution of the stayed condition unless the Director determines compliance with the related applicable and relevant permit standards would be technologically incompatible with compliance with other conditions of the Permit which have not been stayed.

I.D. DUTIES AND REQUIREMENTS

I.D.1. Duty to Comply

The Permittee shall comply with all conditions of this Permit, except that the Permittee need not comply with the conditions of this Permit to the extent and for the duration such noncompliance is authorized by an emergency permit (9 VAC 20-60-270.61, and 40 CFR 270.61). Any permit noncompliance, except under the terms of an emergency permit, constitutes a violation of Title 10.1 Code of Virginia (1950), as amended and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

I.D.2. Duty to Reapply

If the Permittee wishes to continue an activity regulated by this Permit after the expiration date of this Permit, the Permittee shall apply for and obtain a new permit as specified below.

a. The Permittee shall submit a new application at least 180 days before the expiration date of the Permit, unless a later date has been granted by the Director.

b. Pursuant to 9 VAC 20-60-270.10(h) and 40 CFR 270.10(h), the Director shall not grant permission for an application to be submitted later than the expiration date of the existing permit.

I.D.3. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for the Permittee in an enforcement action to argue that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Permit.

I.D.4. Duty to Mitigate

In the event of noncompliance with the Permit, the Permittee shall take all reasonable steps to minimize releases to the environment, and shall carry out such measures as are reasonable to prevent significant adverse impacts on human health or the environment.

I.D.5. Proper Operation and Maintenance

The Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittee to achieve compliance with the conditions of this Permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of this Permit.

I.D.6. Duty to Provide Information

The Permittee shall furnish, to the Director within a reasonable time, any pertinent information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Permit, or to determine compliance with this Permit. The Permittee shall also furnish to the Director, upon request, copies of records required to be kept by this Permit.

I.D.7. Inspection and Entry

The Permittee shall allow the Director or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to:

a. Enter at reasonable times upon the Permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this Permit;

b. Have access to and copy, at reasonable times, any records that must be kept under conditions of this Permit;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Permit; and

d. Sample or monitor at reasonable times for the purposes of assuring permit compliance or as otherwise authorized by 9 VAC 20-60, any substances or parameters at any location.

I.D.8. Reporting Planned Changes

The Permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility. This notice shall include a description of all incidents of noncompliance reasonably expected to result from the proposed changes.

I.D.9. Anticipated Noncompliance

The Permittee shall give advance written notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

I.D.10. New and Modified Portions of Waste Management Unit

The Permittee shall not treat hazardous waste in any new or modified portion of the hazardous waste management unit, except as provided in 9 VAC 20-60-270.42 and 40 CFR 270.42, until the Permittee has submitted to the Director, by certified mail or hand delivery, a letter signed by the Permittee and a Virginia-registered professional engineer stating that the facility has been constructed or modified in compliance with the Permit; and:

a. The Director has inspected the modified or newly constructed facility and finds it is in compliance with the conditions of the Permit; or

b. Within 15 days of the date of submission of the letter required pursuant to Permit Condition I.D.10., if the Permittee has not received notice from the Director of his intent to inspect, prior inspection is waived and the Permittee may commence storage of hazardous waste.

I.D.11. Twenty-four Hour Reporting

The Permittee shall report any noncompliance which may endanger health or the environment to the Director. Information shall be provided orally within twenty-four (24) hours from the time the Permittee becomes aware of the circumstances. The information specified in "a" and "b" below

shall be included as information which shall be reported orally within 24 hours.

a. Information concerning the release of any hazardous waste that may cause an endangerment to public drinking water supply sources shall be reported.

b. Any information of a release or discharge of hazardous waste or of a fire or explosion at the facility, which could threaten the environment or human health outside the facility, shall be reported. The description of the occurrence and its cause shall include:

   i. Name, address, and telephone number of the owner or operator;

   ii. Name, address, and telephone number of the facility;

   iii. Date, time, and type of incident;

   iv. Names and quantities of material(s) involved;

   v. The extent of injuries, if any;

   vi. An assessment of actual or potential hazard to the environment and human health outside the facility, where this is applicable; and

   vii. Estimated quantity and disposition of recovered material that resulted from the incident.

c. A written submission shall also be provided to the Director within five (5) days of the time the Permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the periods of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. The Permittee need not comply with the 5-day written notice requirement only if the Director waives that requirement following verbal notification and the Permittee submits a written report within (15) days of the time the Permittee becomes aware of the circumstances.

I.D.12. Other Noncompliance

The Permittee shall report all other instances of noncompliance not otherwise reported pursuant to Permit Conditions I.D.11, I.D.13, and I.E.1 at the time monitoring reports are submitted. The reports shall contain the information listed in Permit Condition I.D.11.

I.D.13. Other Information

Whenever the Permittee becomes aware that he failed to submit any relevant facts in the permit application, or submitted incorrect information in a permit application or in any report to the Director, the Permittee shall promptly submit such facts or information to the Director.

I.E. MONITORING AND RECORDS

I.E.1. Monitoring shall be performed and results shall be reported at the intervals specified in the Permit.

I.E.2. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. The method used to obtain a representative sample of the waste to be analyzed must be the appropriate method specified in Appendix I of 40 CFR 261 or an equivalent method approved by the EPA. Laboratory methods must be those specified in *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (SW-846, 3rd ed., November, 1986, as updated), *Standard Methods of Wastewater Analysis* (16th ed., 1985, as updated), or an equivalent method approved by the EPA.

I.E.3. The Permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this Permit, all certifications required by 40 CFR 264.73(b)(9) and records of all data used to complete the application for this Permit, for a period of at least 3 years (or longer if specified elsewhere in this Permit) from the date of the sample, measurement, report, certification, or record. These retention periods may be extended by the request of the Director at any time and are automatically extended during the course of any unresolved enforcement actions regarding this facility.

I.E.4 Records of monitoring information shall include at a minimum:

a. The date, exact place, and time of sampling or measurements;

b. The individual(s) who performed the sampling or measurements;

c. The date(s) analyses were performed;

d. The individual(s) who performed the analyses;

e. The analytical techniques or methods used; and

f. The results of such analyses.

I.F. COMPLIANCE NOT CONSTITUTING DEFENSE

Compliance with the terms of this Permit does not constitute a defense to any action brought under Chapter 14, Article 8 of Title 10.1, Code of Virginia (1950), as amended, or any other Commonwealth law governing protection of the public or the environment.

I.G. TRANSFER OF PERMITS

This Permit is not transferable to any person, except after notice to the Director. The Director may require modification or revocation and reissuance pursuant to 9 VAC 20-60-124.5, 270.40, 270.41, 270.42, and 270.43, and 40 CFR 124.5, 270.40, 270.41, 270.42, and 270.43 to change the name of the Permittee and incorporate such other requirements as may be necessary. Before transferring ownership or operation of the facility during its operating life, the Permittee shall notify the new owner or operator in writing of the requirements of 9 VAC 20-60-264 and 9 VAC 20-60-270.

I.H. PERMIT EXPIRATION AND CONTINUATION

Pursuant to 9 VAC 20-270.51, this Permit will remain in force until the effective date of a new permit, if the Permittee has submitted a timely, complete application pursuant to Permit Condition I.D.2.a and through no fault of the Permittee, the Director has not issued a new permit with an effective date on or before the expiration date of this Permit. All conditions of the continued permit shall remain fully effective and enforceable.

I.I. REPORTS, NOTIFICATIONS, AND SUBMISSIONS TO THE DEPARTMENT

I.I.1. The Permittee shall submit biennial report to the Department, which covers facility activities during the previous calendar year. At a minimum this report will include:

a. The generator biennial report pursuant to 40 CFR 262.41; and

b. The hazardous waste management facility biennial report pursuant to 40 CFR 270.30(l)(9).

I.I.2. All reports, notifications or other submissions which are required by this Permit to be sent or given to the Director should be sent or be given to:

Director, Office of Waste Permitting
Department of Environmental Quality
P.O. Box 10009
Richmond, VA 23240-0009
Telephone Number: (804) 698-4190

Copies of all such correspondence should also be sent to:

Director, Tidewater Regional Office
Department of Environmental Quality
5636 Southern Blvd
Virginia Beach, VA 23462

Virginia Program Manager (3WC21)
Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

I.J. SIGNATORY REQUIREMENTS

All applications, reports, or information submitted to the Director shall be signed and certified as specified by 9 VAC 20-60-270.11.

I.K. DOCUMENTS TO BE MAINTAINED AT THE FACILITY SITE

Current copies of the following documents, as amended, revised, and modified, shall be maintained at the facility (or other location approved by the Director). These documents shall be maintained during the term of this Permit, including any reissued permit, unless a lesser time is specified in the Permit.

a. The Permit including all attachments, revisions and modifications;

b. The Part A and Part B Permit Applications;

c. The facility's operating record required by 40 CFR 264.15(b)(2) and 264.15(d);

d. Inspection schedules and logs required by 40 CFR 264.16 and this Permit;

e. Personnel training documents and records required by 40 CFR 264.16 and this Permit; and

f. Closure Plans as required by 40 CFR 264.112(a) and this Permit.

I.L. APPROVAL/DISAPPROVAL OF SUBMISSIONS

The VDEQ will review the plans, reports, schedules and other documents (hereinafter collectively referred to as "submission") submitted which require the Director or VDEQ approval. The VDEQ will notify the Permittee in writing of the VDEQ's approval, conditional approval or disapproval of each submission.

Each submission required by this Permit is, upon approval by the Director, incorporated into this Permit. Any noncompliance with such VDEQ-approved submission shall be deemed noncompliance with this Permit. A conditionally approved submission, including any terms of such conditional approval set forth in VDEQ's decision, shall constitute the VDEQ-approved submission and shall be incorporated into this Permit.

In the event of VDEQ's conditional approval of submission, the Director shall specify in writing any deficiencies in the submission and the terms upon which approval of the submission is conditioned. If the Permittee disputes any term upon which approval of the submission was conditioned, the Permittee may file an appeal with the Director within 30 days of the approval (as provided for in Rule 2A:2 of the Supreme Court of Virginia). In the event of VDEQ disapproval of a submission, the Director shall specify the deficiencies in writing. The Permittee shall modify the submission to correct/address the specified deficiencies within a reasonable time period established by the Director taking into account the tasks to be performed, and submit the revised submission to VDEQ for approval. If the revised submission is disapproved, the Director will notify the Permittee of the deficiencies in writing and specify a schedule for the Permittee to correct the deficiencies and resubmit the submission to VDEQ. The Permittee shall correct the deficiencies as directed by VDEQ, and forward the revised submission within the time period specified by VDEQ. In the event the Permittee disagrees with VDEQ's disapproval of the revised submission, the Permittee may file an appeal with the Director within 30 days of the disapproval (as provided for in Rule 2A:2 of the Supreme Court of Virginia).

MODULE II

GENERAL FACILITY CONDITIONS

MODULE II - GENERAL FACILITY CONDITIONS

II.A. WASTE ANALYSIS

II.A.1. General Waste Analysis

The Permittee shall follow the procedures described in the Waste Analysis Plan, Attachment II.BB. Waste analysis shall require, at a minimum, the maintenance of proper functioning instruments, use of approved sampling and analytical methods, verification of the validity of sampling and analytical procedures, and correct calculations. If the Permittee does not have the sufficient capability for analysis, then the Permittee shall inform the laboratory performing the analysis that the laboratory must operate under the waste analysis conditions placed on the Permittee.

II.B. SECURITY

The Permittee shall comply with the security provisions of 40 CFR 264.14. The security provisions shall follow the outline in Attachment II.DD.

II.C. GENERAL INSPECTION REQUIREMENTS

The Permittee shall follow the inspection schedule set out in Attachment II.CC. The Permittee shall remedy any deterioration or malfunction discovered by an inspection as required by 40 CFR 264.15 Records of inspections shall be kept as required by 40 CFR 264.15(d) and Permit Conditions II.H.2.c.v.

II.D. PERSONNEL TRAINING

The Permittee shall conduct personnel training as required by 40 CFR 264.16. This training program shall follow the Training Outline, Attachment II.EE. The Permittee shall maintain training documents and records as required by 40 CFR 264.16(d) and Permit Conditions II.H.2.a.xi and II.H.2.c.iii.

II.E. GENERAL REQUIREMENTS FOR IGNITABLE AND REACTIVE WASTE

The Permittee shall comply with the requirements of 40 CFR 264.17. The Permittee shall follow the procedures for the handling of ignitable and reactive waste as specified in the Module III.

II.F. PREPAREDNESS AND PREVENTION

II.F.1. Design and Operation of Facility

The Permittee shall maintain and operate the facility to minimize the possibility of a fire, explosion, or any unplanned sudden or nonsudden release of hazardous waste constituents to air, soil, groundwater, or surface water which could threaten human health or the environment.

II.F.2. Required Equipment

At a minimum, the Permittee shall equip the facility with the equipment set forth in Attachment II.FF, as required by 40 CFR 264.32.

II.F.3. Testing and Maintenance of Equipment

The Permittee shall test and maintain the equipment specified in Permit Condition II.F.2 and in Attachment II.FF as necessary to assure its proper operation in time of emergency (40 CFR 264.33).

II.F.4. Access to Communications or Alarm System

The Permittee shall maintain access to the communication or alarm system as required by 40 CFR 264.34.

II.F.5. Arrangements with Local Authorities

The Permittee shall maintain arrangements with State and local authorities as required by 40 CFR 264 Subpart C, and Attachment II.FF.6. If State and local officials refuse to enter into or renew existing preparedness and prevention arrangements with the Permittee, the Permittee shall document this refusal in the operating record pursuant to Permit Condition II.H.2.d.iv.

II.G. CONTINGENCY PLAN

II.G.1. Implementation of Plan

The Permittee shall immediately carry out the provisions of the Contingency Plan, Attachment II.FF, and follow the emergency procedures described by 40 CFR 264.56, whenever there is an imminent or actual fire, explosion, or release of hazardous waste or constituents which threaten or could threaten human health or the environment.

II.G.2. Copies of Plan

The Permittee shall comply with the requirements of 40 CFR 264.53.

II.G.3. Amendments to Plan

The Permittee shall review and immediately amend, if necessary, the Contingency Plan, as required by 40 CFR 264.54.

II.G.4. Emergency Coordinator

The Permittee shall comply with the requirements of 40 CFR 264.52(d) and 40 CFR 264.55.

II.G.5. Emergency Procedures

The Permittee shall comply with the requirements of 40 CFR 264.56 including the record keeping and reporting requirements specified in Permit Condition II.H.2.a.iv.

II.H. RECORD KEEPING AND REPORTING

II.H.1. Notification, Certification, and Recordkeeping Requirements

In addition to the record keeping and reporting requirements specified elsewhere in this Permit, the Permittee shall comply with all the applicable notification, certification, and record keeping requirements described in 40 CFR 264.73.

II.H.2. Operating Record

The Permittee shall maintain a written operating record at the facility, consisting of records kept for the lengths of time specified below. The record can be a compilation of various documents. The operating record shall include, but not be limited to, the information listed below.

a. The following records shall be maintained until closure is complete and certified:

   i. A current map showing the location of hazardous waste management units and non-regulated units within the facility;

   ii. A map showing all locations of past hazardous waste management units if different from present locations;

iii. Pursuant to 40 CFR 264.73, a description and the quantity of each hazardous waste received, and the method(s) and date(s) of its treatment, storage, or disposal at the facility;

iv. The time, date, and details of any incident that requires implementation of the Contingency Plan, including copies of all reports prepared pursuant to 40 CFR 264.56(j) and Permit Condition I.D.11.c or II.H.2.iv;

v. Records of spills and releases;

vi. Written reports and records of verbal notification to the Director and the Administrator to address releases, fires, and explosions;

vii. All reports of noncompliance pursuant to Permit Condition I.D.12;

viii. All submittals prepared pursuant to Permit Condition I.D.13;

ix. Records and results of waste analyses required by 40 CFR 264.73(b)(3), which shall include at a minimum:

A. The date(s), exact place, and times of sampling or measurements;

B. The name of the individual(s) who performed the sampling or measurements;

C. The date(s) analyses were performed, demonstrating that EPA SW-846 holding times were satisfied;

D. The name(s) of the individual(s) who performed the analyses;

E. The analytical techniques or method used;

F. The analytical results;

G. The QA/QC summary; and

H. The type(s) and model number(s) of the equipment used for analysis.

x. All waste determinations, waste profiles, and waste feed composition determinations made pursuant to the Waste Analysis Plan, Attachment II.BB.

xi. Training records of current facility personnel;

xii. Certifications pursuant to 40 CFR 264.73 (Waste Minimization Plan);

xiii. The notice and certification required by a generator under 40 CFR 264.73 and 268.7 (Land Disposal Restrictions); and

xiv. Records of facility constructions pursuant to Permit Condition I.D.10.

b. The following records shall be maintained for a minimum of 5 years. This time period may be extended by the Department in the event of enforcement action or notification by the Department that an investigation is ongoing.

i. Facility operation and maintenance records and reports prepared pursuant to this Permit; and

ii. Progress reports and any required notifications prepared pursuant to this Permit.

c. The following records shall be maintained for a minimum of 3 years. This time period may be extended by the Department in the event of enforcement action or notification by the Department that an investigation is ongoing.

i. Generator biennial reports submitted in compliance with 40 CFR 262.41;

ii. Facility biennial reports submitted in compliance with 40 CFR 264.75;

iii. Training records of former facility personnel;

iv. Records of all monitoring information pursuant to Permit Condition I.E.3; and

v. Records of all inspections, pursuant to 40 CFR 264.15, which shall include at a minimum:

A. The date and time of the inspection;

B. The name of the person performing the inspection;

C. A notation of the observations made; and

D. The date and nature of any repairs or remedial actions.

d. Current copies of the following documents as amended, revised, and modified shall be maintained at the facility until closure is complete and certified:

i. Waste Analysis Plan;

ii. Personnel Training Plan;

iii. Contingency Plan;

iv. Documentation of arrangements made with local authorities pursuant to 40 CFR 264;

v. Closure Plan; and

vi. Documentation pertaining to the storage of ignitable and reactive wastes required pursuant to 40 CFR 264.17.

II.I. CLOSURE

II.I.1. Performance Standard

The Permittee shall close the permitted Open Burn (OB) area as required by 40 CFR 264.111 and 264.178, and in accordance with the Closure Plan, Attachment II.GG.

II.I.2. Amendments to Closure Plan

The Permittee shall amend the Closure Plan in accordance with 40 CFR 264.112(c) whenever necessary.

II.I.3. Notification of Closure

The Permittee shall notify the Director at least 45 days prior to the date he expects to begin closure as required by 40 CFR 264.112(d).

II.I.4. Time Allowed for Closure

After receiving the final volume of hazardous waste, the Permittee shall treat or remove from the permitted areas all hazardous waste and shall complete closure activities in accordance with the schedules specified in the Closure Plan, Attachment II.GG and 40 CFR 264.113.

II.I.5. Disposal or Decontamination of Equipment

The Permittee shall decontaminate and/or dispose of all facility equipment as required by 40 CFR 264.114 and the Closure Plan, Attachment II.GG.

II.I.6. Certification of Closure

The Permittee shall certify that the permitted Open Burn (OB) area has been closed in accordance with the specifications in the Closure Plan, Attachment II.GG, as required by 40 CFR 264.115.

LIST OF ATTACHMENTS

The following Attachments are incorporated, in their entirety, by reference into this Permit. These incorporated attachments are enforceable conditions of this Permit. Some of the documents contain excerpts from the Permittee's Hazardous Waste Permit Application. The Department has, as deemed necessary, modified specific language excerpted from the Permit application. Additional modifications are prescribed in the Permit Conditions (Modules I through IV), and thereby supersede the language of the attachments. Facility operations shall be in accordance with the contents of the Attachments and this Permit.

Attachment AA	Description of the Hazardous Waste Management Facility
Attachment BB	Waste Analysis Plan
Attachment CC	Inspection Schedule
Attachment DD	Security Provisions and Procedures to Prevent Hazards
Attachment EE	Personnel Training
Attachment FF	Contingency Plan
Attachment GG	Closure Plan
Attachment HH	Plans and Specifications for Open Burn Units

ATTACHMENT II.AA

FACILITY DESCRIPTION

ATTACHMENT II.AA-FACILITY DESCRIPTION

II.AA.1. General Description

WFF is owned and operated by the National Aeronautics and Space Administration. It is located in Virginia on the Atlantic Coast of the Delmarva Peninsula approximately 64 kilometers (40 miles) southeast of Salisbury, Maryland, and 113 kilometers (70 miles) north of the Chesapeake Bay Bridge Tunnel. Chincoteague Island is approximately 8 kilometers (5 miles) east of the Main Base. Figure II.AA-1 shows the relationship of the Wallops Flight Facility to major eastern cities.

The Main Base basic facilities were constructed in 1941 through 1958 by the Government as a Navy base for flight operations and for Naval Ordnance testing. In 1959, the Navy closed the base and the National Aeronautics and Space Administration acquired the Main Base and purchased the Wallops Mainland site. Since 1959, NASA has demolished obsolete buildings, renovated other buildings for adaptability to their missions, and built new facilities.

In 1945, a launch site was constructed on Wallops Island on land acquired by the National Advisory Committee for Aeronautics. Historically, research at Wallops was concentrated on obtaining aerodynamic data at transonic and low supersonic speeds, as part of the effort to penetrate the sound barrier of flight. Today, Wallops is used primarily to obtain scientific data about the atmosphere and the space environment, conduct aeronautical research, and perform space and terrestrial applications experiments.

WFF is a complex of three separate land areas known as the Main Base, Wallops Island, and Wallops Mainland. WFF is a facility of the Goddard Space Flight Center located in Greenbelt, Maryland.

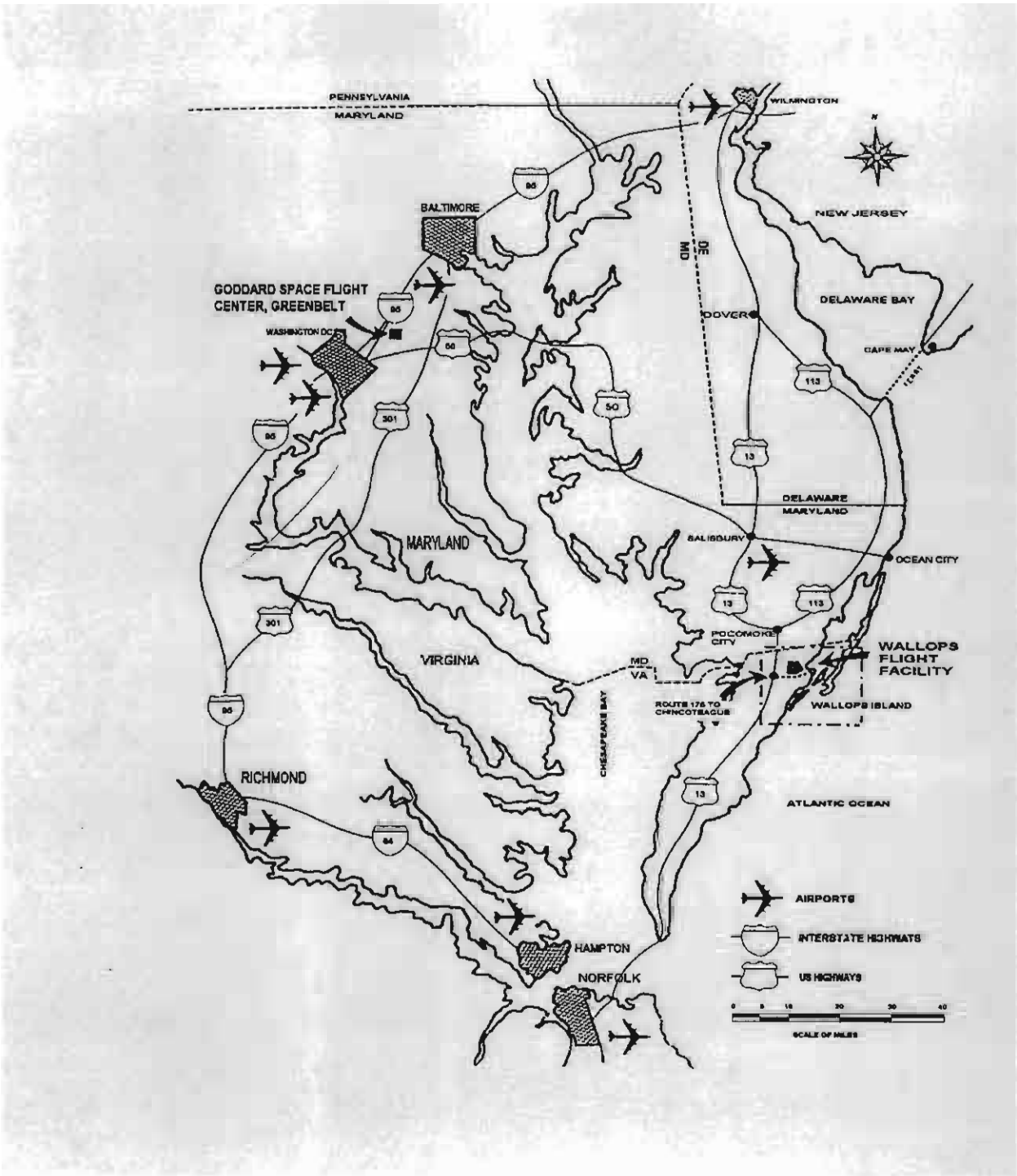


Figure II.AA-1 Site Location Map

The Main Base is a land area of 902 hectares (2,230 acres), bordered on the east by 6 kilometers (4 miles) of marshland, which separates it from Chincoteague Island. This area contains Wallops Headquarters, Administrative Offices, some tracking facilities, a range control center, rocket and fuel storage depots, rocket vehicle inspection facilities, several support shops, an approved FAA Airport, military family housing units, and bachelor's quarters.

Wallops Island and Wallops Mainland jointly comprise a land area of 1740 hectares (4,300 acres), and are located approximately 11 kilometers (7 miles) southeast of the Main Base. Wallops Island is connected to Wallops Mainland by a causeway and bridge that cross 3 kilometers (2 miles) of salt marsh, which is interlaced with small creeks and is bisected by the Intracoastal waterway. Wallops Island is approximately 11 kilometers (7 miles) long and 0.8 kilometers (0.5 miles) in width at its widest point. Wallops Island borders the Atlantic Ocean on the east, and the Chincoteague inlet on the north. Wallops Island was joined with Assawoman Island to the south when the inlet between them was closed by a storm in 1986. The inlet was temporarily reopened in 1987 but has since filled in and remains closed today.

Wallops Island contains the OB area, launch sites, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, U. S. Navy facilities, tracking facilities, and other related service support facilities. In 2003, an Unmanned Aerial Vehicle (UAV) runway was built on the access road just north of the OB area. Wallops Mainland provides a site for long-range radar, communications, and optical tracking installations. The relative locations and area boundaries of these three land areas of the Wallops Flight Facility and the OB area are illustrated on Figure II.AA-2.

The OB area located on the shoulder of the dike road at the southwestern corner of Wallops Island, consists of three subunits (ground embedded cylinders) and one open burning pad assembly. One subunit, subunit 1, is 0.6 meters (1.9 feet) in diameter, stands 0.8 meters (2.6 feet) above the ground surface, and is embedded 2.3 meters (7.5 feet) below the ground. One cylinder, Subunit 2, is 0.4 meters (1.4 feet) in diameter, stands 1.1 meters (3.5 feet) above the ground surface, and is embedded 2.2 meters (7.1 feet) below the ground surface. Sub-unit 3 is identical to Subunit 1 and is scheduled to be removed and to undergo "closure" upon installation of Subunit 4 in 2012. Subunit 4 is 0.7 meters (2.4 feet) in diameter, stands 1.10 meters (3.6 feet) above the ground surface, and is embedded 3.1 meters (10.2) feet below the ground surface. The subunits are covered when not in use to prevent entry and accumulation of precipitation. The subunits also have concrete bases to prevent contact between constituents, subsurface soils, and groundwater.

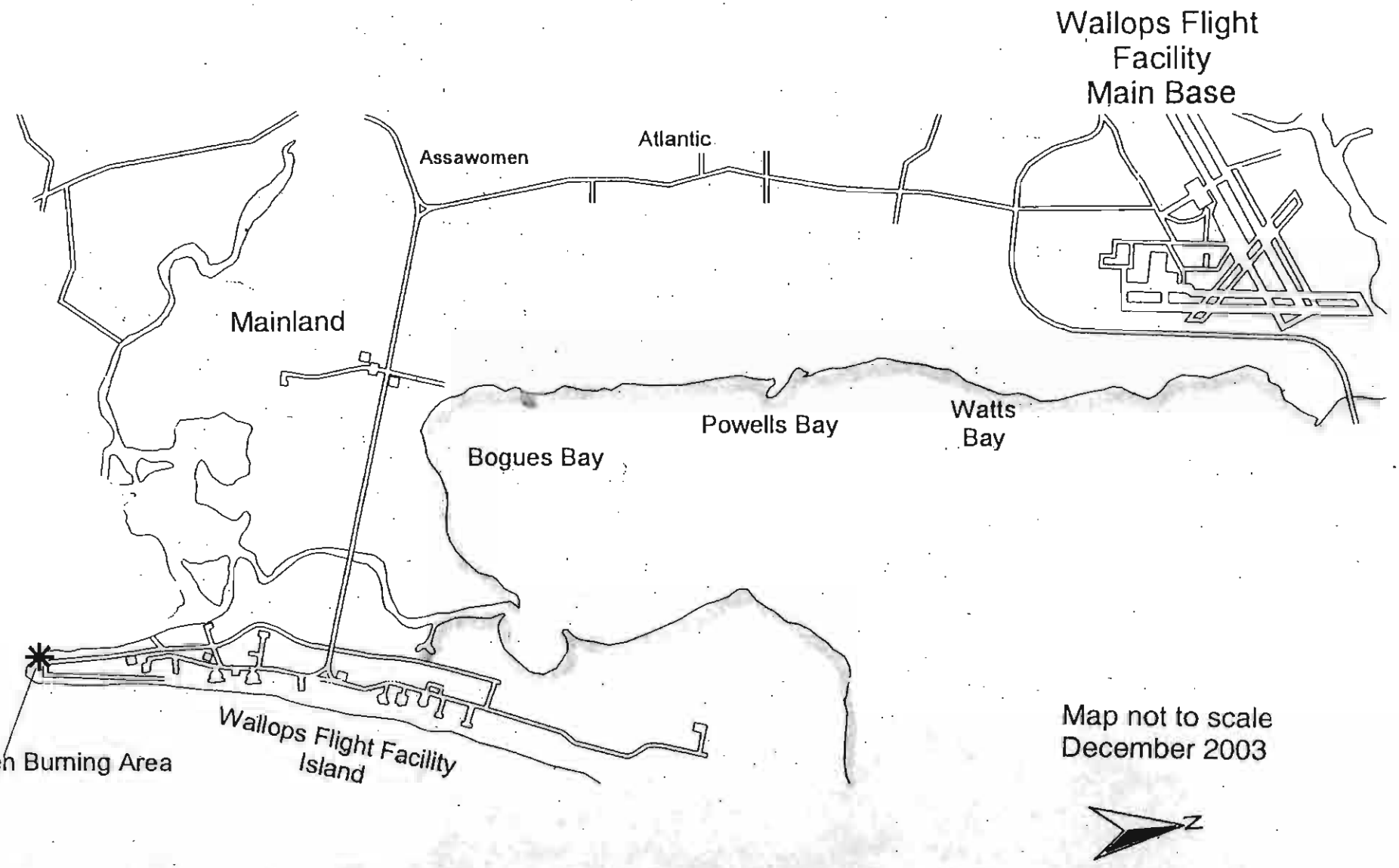
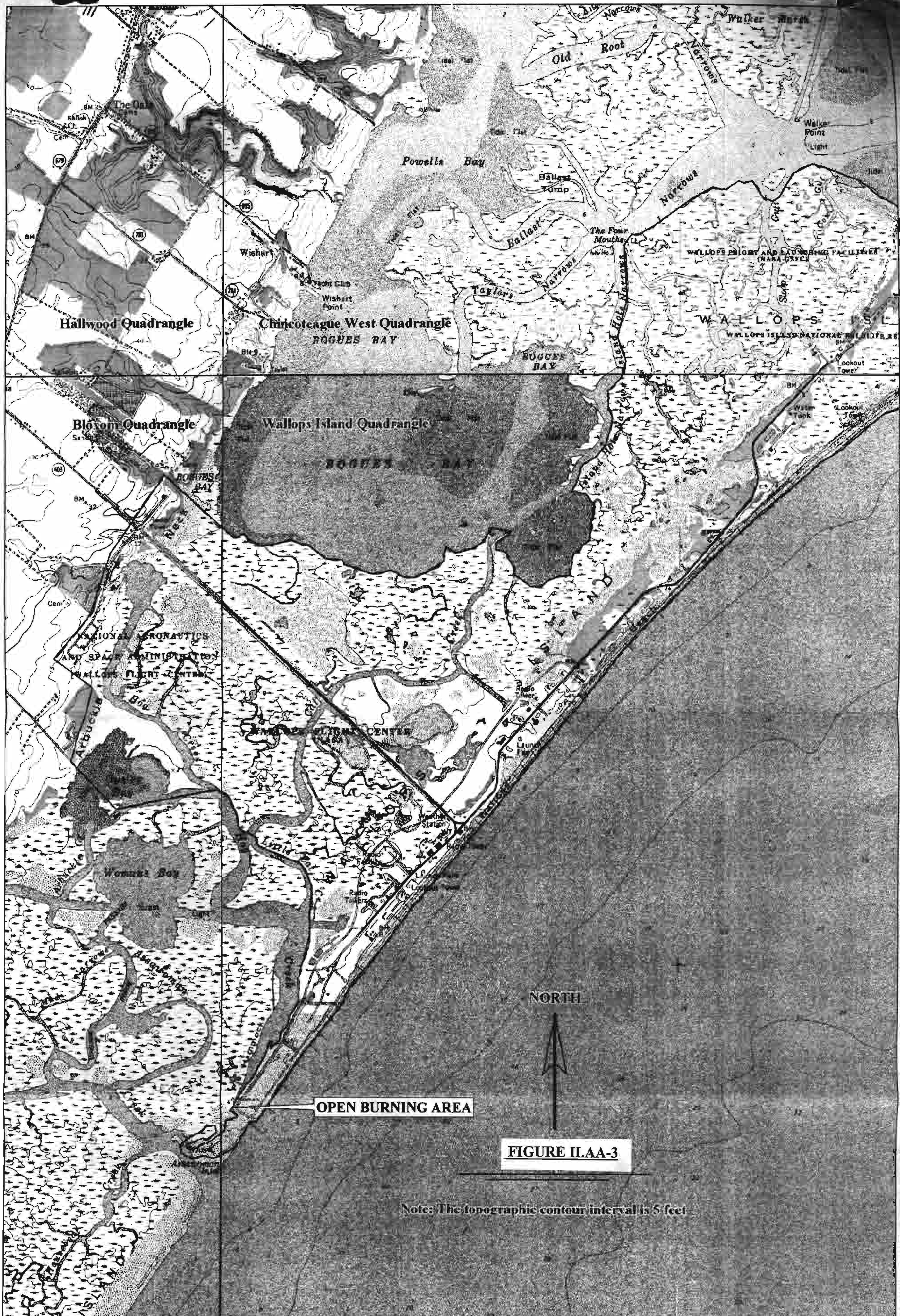


FIGURE II.AA-2 Location of Open Burning Area



Copyright © 2000 DeLorme. TopoTools Advanced Print Kit. Scale: 1 : 28,125 Zoom Level: 13-0 Datum: WGS84

2000 ft

MAR 01 2004

The open burning pad assembly is a 4.6 meters (15 feet) square by 46 centimeters (18 inches) thick concrete pad with a steel plate in the center for motor head attachment. Four cable tie downs are used to stabilize the motors.

Any rocket motor treated at the OB area, follows guidelines and measures, which have been approved by the WFF Safety Office. These procedures are included in Attachment II-CC. Simply stated, rocket motor and igniter are placed inverted into a cylinder or attached to the pad motor head assembly. The igniter is set off by battery hook-up behind a protective barrier. The distance between the barrier and burning area is specified in a ground safety plan prepared for each type rocket motor. Burned motors and igniters are inspected for visible signs of untreated material. If untreated material is present in the motor, then the motor is reignited or the material removed and reignited on the burn pad.

Occasionally, propellant is removed from a motor(s) when modifications are required. Propellant (not in a motor casing), ash, residue, or ejected material, are placed on the burn pad in a burn pan, a squib igniter is fabricated, and the material is ignited. Any unburnable material is containerized, sampled for characterization, if necessary, and any hazardous waste is disposed of through WFF's hazardous waste disposal contractor.

II.AA.2. Topographic Map

The topographic map, (Figure II.AA-3) developed by the United States Geological Survey, is a 7.5 minute series topographic quadrangle of Wallops Island. The contour interval is 1.5 meters (5 feet) with a scale of 2.54 centimeters equals 8,572.5 meters (1 inch:28,125 feet). An additional topographical map was prepared on May 27, 2003, at a scale of 2.54 centimeters equals 61 meters (1 inch equals 200 feet) and a contour interval of 0.25 meters (Figure II.AA-4). Figure II.AA-4 shows the OB area and a distance of 305 meters (1000 feet) around it. The map also includes map date, 100-year floodplain area, surface waters, map orientation, legal boundaries, monitoring wells, structures, and hazardous waste management units within the 1305-meter (1000-foot) surrounding area. Figure II.AA-4(b), shows the location of the new OB Subunit 4 in relation to the original OB Subunits, 1, 2, and 3. Subunit 4 is scheduled to be installed in 2012 and Subunit 3 is scheduled to be removed and undergo closure in 2012.

Access control (Figure II.DD-1), buildings (Figure II.AA-7), sanitary sewers (Figures IV.JJ-1 thru IV.JJ-8), Fire Department, Building X-15 (Figure II.AA-7), flood control (Figure II.AA-6), and solid waste

management units (Figures IV.JJ-1 thru IV.JJ-8) are shown on separate maps. There are no storm sewers, process sewers, or runoff control systems on Wallops Island or the Mainland. Surrounding land uses are described in the following paragraphs.

The entire OB area is located within NASA property boundaries. All of Wallops Island is located within the 100-year and 500-year floodplain. Refer to Figure II.AA-5 for the 100-year and 500-year floodplain maps for the Wallops Island. Maps delineating the floodplain were developed in 1984 by the Federal Emergency Management Agency.

Land uses in the vicinity of WFF and the OB area vary. Sparsely populated agricultural lands, marshes, and woodlands surround Wallops Island. The exception is the commercial seafood center and resort town of Chincoteague, Virginia. Chincoteague Island is located approximately 8.0 kilometers (5.0 miles) north of the OB area.

The Main Base, Mainland, and Wallops Island are zoned industrial by Accomack County, with one exception. The County has designated the land between Wallops Island and the Mainland as marshland.

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The Main Base, Mainland, and Wallops Island are zoned industrial by Accomack County, with one exception. The County has designated the land between Wallops Island and the Mainland as marshland.

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The document indicated below is located in the paper file cabinet.

2 Map(s) - Oversized
____ Colored Spreadsheet(s)
____ Blueprint(s)
____ Diagram(s)
____ Pictures (s)
____ CD(s)

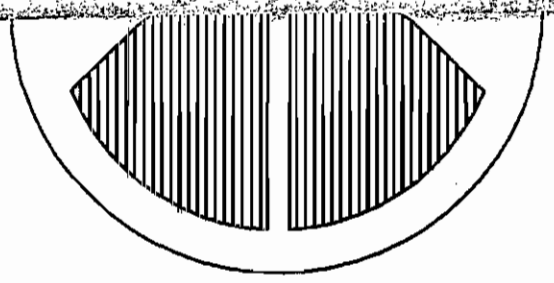

FIGURE AA-4

MAP COMPILE
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THIS SURVEY IS COMPILED FROM AN
CONDUCTED IN 1994, A CURRENT FI
WALLOPS ISLAND QUADRANGLE, PH
BURN PAD WERE LOCATED BY AN A
CERTIFIED SURVEY TECHNICIAN 0301-13

THE AREA DEPICTED BY THIS MAP LIES
SHOWN ON FEMA FLOOD INSURANCE RA

FIGURE II.AA-4

FIGURE AA-4

FIGURE AA-4

Figure II.AA-4(b), Open Burn Subunits 1, 2, 3, and 4, and Burn Pad
(Subunit 3 is scheduled for removal 2012, while
Subunit 4 is scheduled for installation in 2012.)

ENCLOSURE 1

OB Area Permit App page A-11 also Attachment 7 Appendix A page B-3

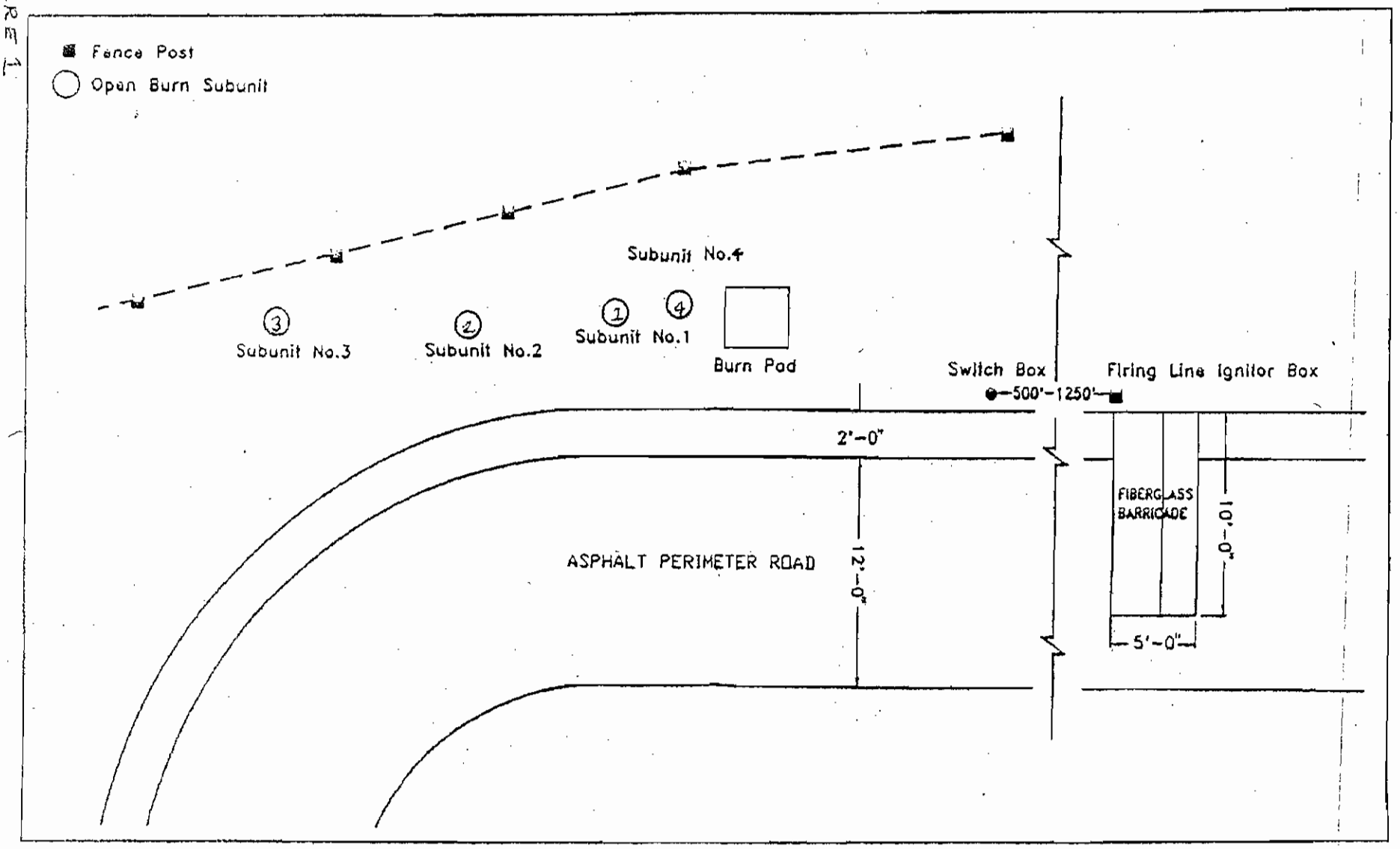
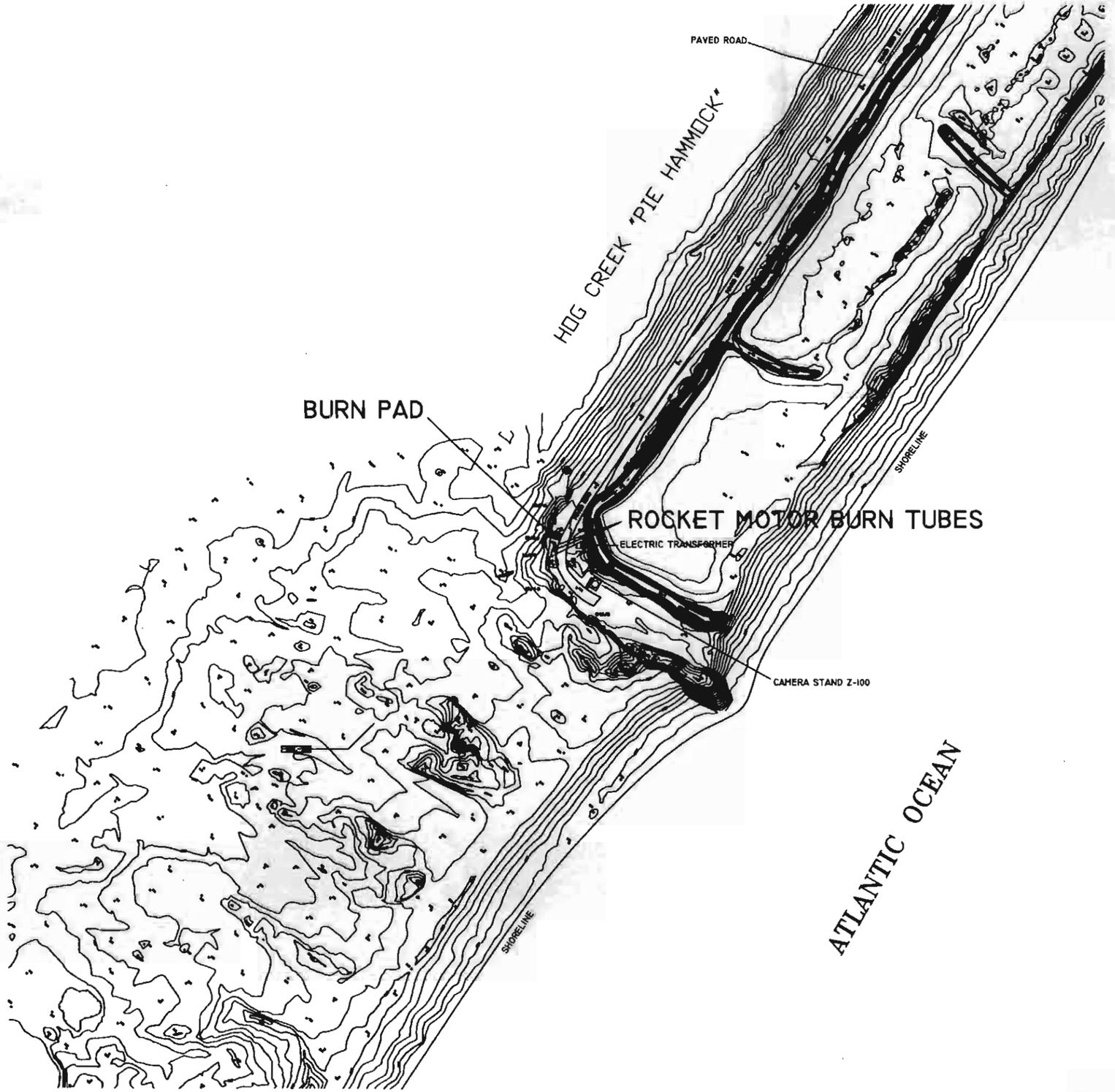


Figure A-3
Open Burning Area Subunits 1, 2, 3, 4 and Burn Pad
Date: November 16, 2011



THE AREA CONTAINED WITHIN THE LIMITS OF THIS MAP LIES ENTIRELY WITHIN THE 100-YEAR FLOOD BOUNDARY AS SHOWN ON THE FEMA FLOOD INSURANCE RATE MAP 510001 0100 C, DATED APRIL 2, 1992. BY DEFAULT THIS AREA IS ALSO INCLUDED WITHIN THE 500-YEAR FLOOD BOUNDARY AS SHOWN ON THE AFOREMENTIONED FEMA MAP.

THIS SURVEY IS COMPILED FROM AN AERIAL SURVEY OF THE WALLOPS FLIGHT FACILITY CONDUCTED IN 1994, A CURRENT FIELD SURVEY, AND INFORMATION DIGITIZED FROM THE USGS WALLOPS ISLAND QUADRANGLE, PHOTOINSPECTED 1989

GRAPHIC SCALE

200 0 200 400

(IN FEET)

1 inch = 200 ft.

REVISED 5/20/2005 TO INCLUDE 500-YEAR FLOOD PLAIN NOTE

DATE: DECEMBER 30, 2003 **FIGURE II.AA-5**

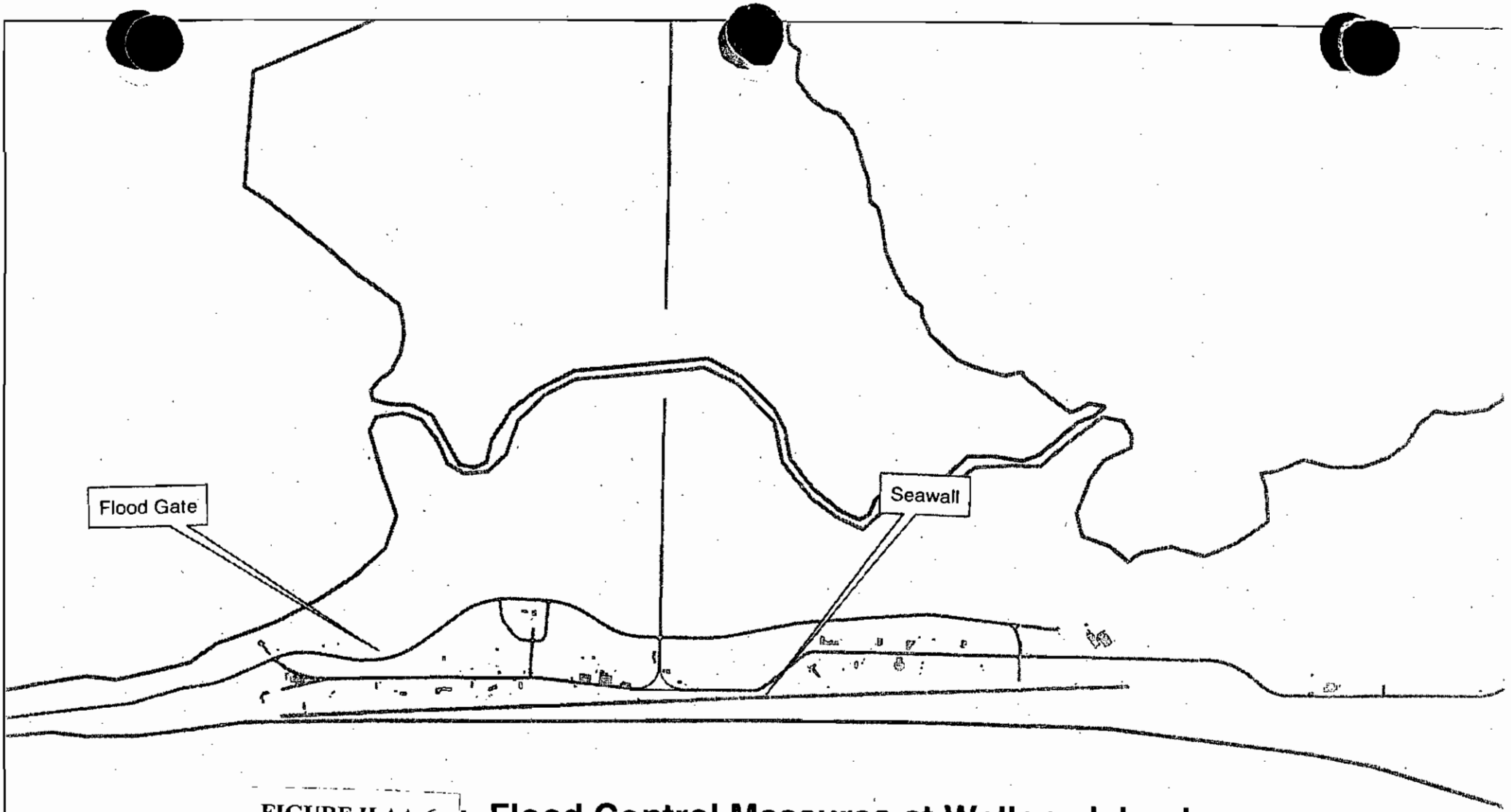


FIGURE II.AA-6: Flood Control Measures at Wallops Island

NASA Wallops Flight Facility

December 16, 2003

Area permitted by EPA ID # VA7800020888

National Aeronautics and Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337

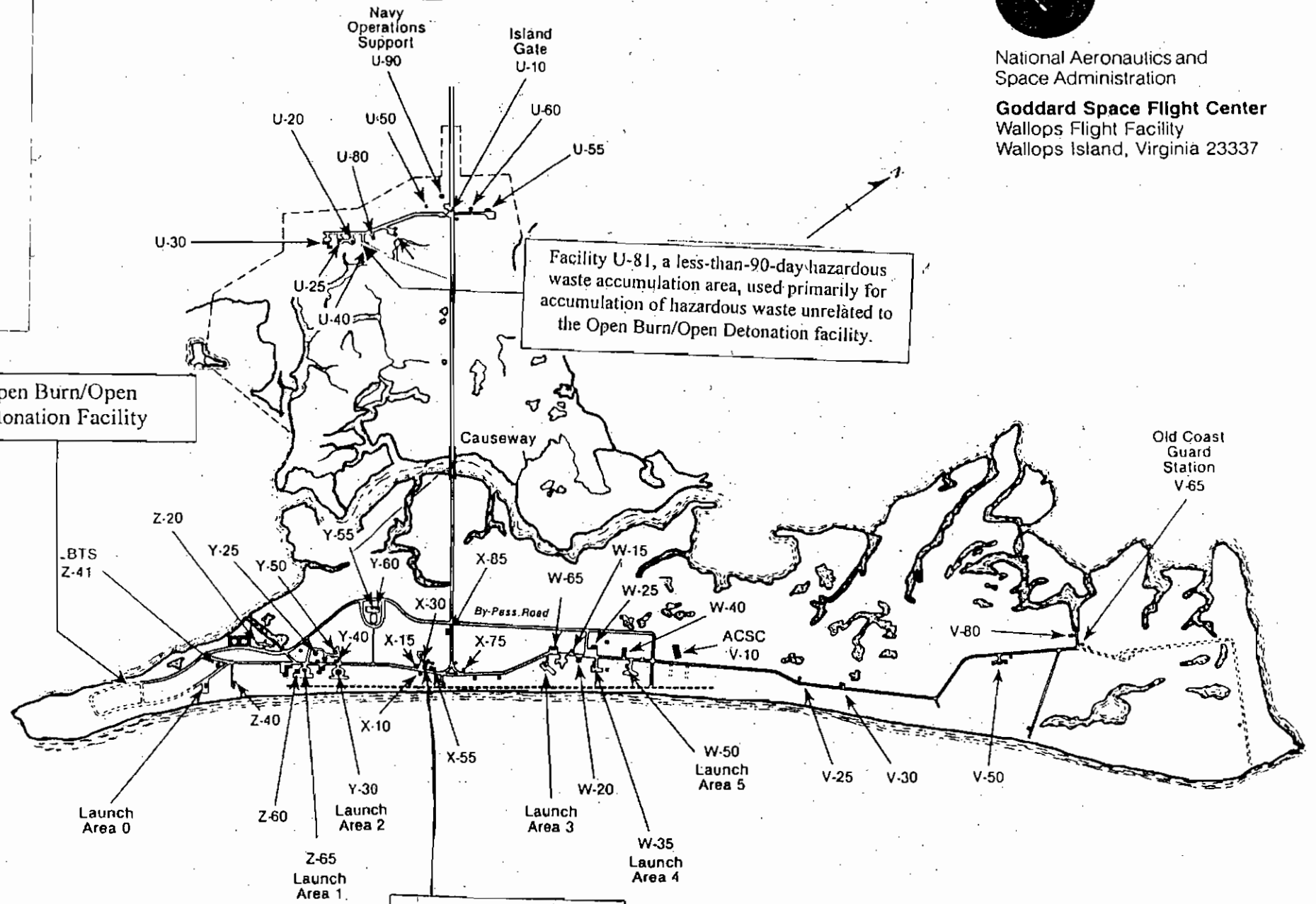


FIGURE II.AA-7

NASA WI-1533 (2 REV. 3-95)

ATTACHMENT II.BB

WASTE ANALYSIS PLAN

ATTACHMENT II.BB-WASTE ANALYSIS PLAN

II.BB.1 Waste Analysis Plan

The Open Burning Area Waste Analysis Plan is used to gather information that will aid in:

- The safe treatment of propellants and igniters;
- Characterizing any residue remaining after OB treatment
- Characterization of soil, and
- Subsequent handling, storing and disposing of residues.

The Open Burning Area Waste Analysis Plan, included in Exhibit II.BB-1, contains Material Safety Data Sheets for the rocket motors to be open burned at WFF.

II.BB.1.1 Additional Requirements for Waste Generated Offsite

Rocket motor propellants and igniters designated for thermal treatment may originate from storage buildings on the WFF Main Base or Wallops Island. Manifests and shipping documents will be inspected and reviewed to ensure that the materials received match the identity of the waste designated for thermal treatment. Rocket motor propellants and igniters are delivered directly to the OB area for burning. They are delivered to the OB area when scheduled for open burning. Rocket motor propellants and igniters are not stored at the OB area.

II.BB.1.2 Additional Requirements for Ignitable, Reactive, or Incompatible Wastes

The waste propellants and igniters to be treated by OB are of similar composition and are compatible. The residue remaining after OB will be considered reactive until proven otherwise. The requirements for handling this material are stated in Attachment II.DD - Procedures to Prevent Hazards.

EXHIBIT II.BB-1

OPEN BURNING AREA
WASTE ANALYSIS PLAN

OPEN BURNING AREA
WASTE ANALYSIS PLAN

NASA GODDARD SPACE FLIGHT CENTER
WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA 23337

EPA ID# VA7800020888

DECEMBER 2003

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APPENDIX C CERTIFICATES OF ANALYSES

1.0 INTRODUCTION

This Waste Analysis Plan is required as part of the Resource Conservation and Recovery Act (RCRA) Part B Permit for Thermal Treatment of rocket motor propellants and igniters at the National Aeronautics and Space Administration Goddard Space Flight Center's Wallops Flight Facility (NASA GSFC's WFF) located at Wallops Island, Virginia. At Wallops Island, NASA uses Open Burning (OB) as the preferred method of treatment for rocket propellants and igniters because of the highly reactive nature of these materials. This method is considered the safest treatment method and is conducted in a manner to minimize impacts to the environment. In addition to addressing the waste analysis requirements, specified under 40 Code of Federal Regulations (CFR) Parts 264 and 270, this document addresses the specific requirements of the Subpart X regulations for "Miscellaneous Units".

1.1 Facility Description

The OB area located on the shoulder of the dike road at the southwestern corner of Wallops Island, consists of three subunits (ground embedded cylinders) and one open burning pad assembly. One subunit, subunit 1, is 0.6 meters (1.9 feet) in diameter, stands 0.8 meters (2.6 feet) above the ground surface, and is embedded 2.3 meters (7.5 feet) below the ground. One cylinder, Subunit 2, is 0.4 meters (1.4 feet) in diameter, stands 1.1 meters (3.5 feet) above the ground surface, and is embedded 2.2 meters (7.1 feet) below the ground surface. Sub-unit 3 is identical to Subunit 1 and is scheduled to be removed and to undergo "closure" upon installation of Subunit 4 in 2012. Subunit 4 is 0.7 meters (2.4 feet) in diameter, stands 1.10 meters (3.6 feet) above the ground surface, and is embedded 3.1 meters (10.2) feet below the ground surface.The subunits are covered when not in use to prevent entry and accumulation of precipitation. They also have concrete bases to prevent contact between constituents and subsurface soils. Figure D-2, D-3, and D-7 (Appendix A) are subunit assembly drawings and burn pad assembly drawings, respectively. The OB pad assembly is 4.6 meters (15 feet) square by 46 centimeters (18 inches) thick concrete pad with a steel plate in the center for motor head attachment. Four cable tie downs are used to stabilize the motors.

1.2 Process Description

The rocket motor and igniter are placed inverted into a cylinder or attached to the pad motor head assembly. The igniter is set off by battery hook-up behind a protective barrier. The distance between the barrier and burn area is specified in a ground safety plan prepared for each type of rocket motor. Burned motors and igniters are inspected for visible signs of untreated material. If untreated material is present in the motor, then the motor is re-ignited or the material removed and re-ignited on the burn pad.

1.3 Quantity of Waste

The maximum amount of propellant to be disposed of per year is 68 metric tones (75 tons). To date, the maximum amount of propellant burned in a year has been 20 metric tones (22 tons). Operationally up to eight small motors, i.e. Super Arcas, or 4 medium size motors, e.g.,. Taurus or Black Brant, could be burned in one day.

Permit Modification 5/08/2012

2.0 WASTE DETERMINATION

2.1 Solid Waste Determination

To minimize waste and decrease pollution, many alternative uses are investigated for each rocket motor, before being classified as a solid waste or characterized as a hazardous waste. All rocket motors at WFF are tracked by owners name and organization. Rocket motors are kept in storage until they are needed for launch.

Prior to launching a sounding rocket, the rocket motor is inspected by contract personnel to determine if they meet contract performance standards. Rocket motors that do meet these performance standards are classified as flight worthy and are stored or used as part of a launch. Stored, flight worthy, rocket motors are also evaluated to determine if an overstock condition exists. The contractor may request permission from NASA to search for other users for overstock motors as described in the next paragraph. Rocket motors that do not meet contract performance standards may still be used on missions where minor flight performance is not an issue. Rocket motors designated for this type of mission, may also be returned to storage or used for a launch.

Another alternative for rocket motors, which do not meet performance standards, would be to request permission from NASA to remove them from contract inventory and to search for other users. NASA may deny this request because they have a current or future use for these rocket motors and thereby tracked in inventory as owner, NASA. These rocket motors will still be managed by the contractor and stored at the same location, but designated differently. Yearly, the contractor will request from NASA permission to search for other rocket motor users.

If this request is granted, the contractor will search for a new user until all prospects have been exhausted. If a user is found, the rocket motors will be transferred and shipped to the new user. When a user cannot be found for a rocket motor, the contractor will notify NASA and the Environmental Office. At this point, NASA will determine if they would like to test the rocket motor to evaluate it for other uses, return it to NASA inventory, or classify it as a solid waste. Rocket motors classified as a solid waste will immediately be characterized as a hazardous waste, based on generator knowledge, dated, and scheduled for OB in less than 90 days.

Any time a rocket motor is inspected for launch, records are kept of the inspections including external inspections. Records are also kept of annual inventories of all rocket motors and successful attempts to locate other facilities which could use excess rocket motors.

2.2 Hazardous Waste Determination

The rocket motors and igniters are considered hazardous waste because they meet the characteristic of reactivity. In 40 CFR 261.23 (a) (6&7) defines reactivity as follows:

> It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
>
> It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR173.53 or a Class B explosive as defined in 49 CFR 173.88.

Rocket motors treated at the OB area are reactive because they are Class 1.1 (formerly designated Class A) through 1.3 (formerly designated Class B) explosives.

3.0 WASTE CHARACTERIZATION

The general chemical composition of typical propellants and igniters that are thermally treated at the OB area is given in Table 1. Each type of rocket motor and igniter varies in the type and quantity of reactive constituents. The percent composition of the chemicals is proprietary/classified information and, therefore, not provided in most cases by the manufacturer.

Reactant formulations, which may be present in the various items treated by OB, are summarized in Tables 2 and 3. Typical rocket motors and igniters thermally treated at this facility and the amount of propellant in each rocket motor are summarized in Table 4.

Chemical analysis need not be performed because the wastes remain chemically unchanged from their formulation as a useful product. The material safety data sheets (MSDS) describing these formulations are included in Appendix B. In addition, as stated in the Draft Final Open Burning! Open Detonation Permitting Guidelines, February 2002, "Reactivity tests are dangerous to conduct and are not available commercially or at most Department of Defense (Do D) installations. In addition, it is generally dangerous, infeasible, or impractical to disassemble munition items to sample or test their energetic composition. Therefore, a facility may use generator knowledge to determine whether a waste is appropriate for OB/OD treatment. If generator knowledge is used, the generator should demonstrate that the waste is explosive through means other than the use of test data. Documentation may consist of material safety data sheets (MSDS), chemical formulations, manufacturer specifications, or DoD documents that attest to the explosive nature of the' material." Therefore, hazard characteristics analyses will not be performed to avoid the dangers associated with the handling of reactants.

Qualifications of those personnel shipping waste, accepting waste, and treating waste are presented in Attachment II.EE - Personnel Training.

Based on the information in Tables 1, 2, 3, 4, MSDS sheets, and inventory logs, the waste accepted for thermal treatment will be considered hazardous prior to treatment because of its reactivity characteristic. This information will be reviewed prior to treatment. If there is a question as to the suitability of a particular motor or igniter for OB, additional data will be gathered to resolve the issue. The rocket motor or igniter will be visually inspected prior to treatment to ensure that it can be safely and effectively treated. Those inspection procedures are found in Attachment II.CC – Inspection Schedule.

Table 1: Rocket Propellant and Igniter Constituents

Name	Chemical Formula	Hazardous Waste ID Number
Nitrocellulose	$C_{12}H_{16}(ONO_2)_4O_6$	D003
Nitroglycerin	$C_3H_5N_3O_9$	D003
Nitroguanidine	$CH_4N_4O_2$	D003
Ammonium Perchlorate	NH_4ClO_4	D003
(PPG) Polypropylene glycol	$HO(C_3H_6O)_nH$	Unlisted
(TEA) Triethanol amine	$(HOCH_2CH_2)_3N$	Unlisted
Poly 1,4-butylene glycol	$HOCH_2CH_2CH_2CH_2OH$	Unlisted
(TDI) Toluene di isocyanate	$CH_3C_6H_3(NCO)_2$	Unlisted
Carbon Black	C	Unlisted
(FeAA) Iron acetylacetate	$C_{15}H_{21}O_6Fe$	Unlisted
Sulfur	S	Unlisted
(DOZ) Dioctyl azelate	$(CH_2)_7[COOCH_2CH(C_2H_5)C_4H_9]_2$	Unlisted
(NDPA) n-phenyl-beta-napthylamine	$C_{10}H_7NHC_6H_5$	Unlisted
(PS) Polysulfide	$[-CH_2S_2S_2-]_n$	Unlisted
(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	$C_9H_{18}N_3OP$	Unlisted
(Parabar 441) 2,6-di-tert-butyl-p-cresol	$[C(CH_3)_3]_2CH_3C_6H_2OH$	Unlisted
(TA) Triacetin	$C_3H_5(OCOCH_3)_3$	Unlisted
(2-NDPA) 2-nitrodiphenyl amine	$C_6H_5NHC_6H_4NO_2$	Unlisted
(DPA) di-n-propyl adipate	$(C_6H_5)_2NH$	Unlisted
Pb (lead) salicylate	$Pb(OOCC_6H_4OH)_2.H_2O$	Unlisted
Candelilla wax (main constituent)	$C_{13}H_{64}$	Unlisted
Monobasic copper salicylate	$Cu(OOCC_6H_4ON)_2.H_2O$	Unlisted
(PU) Polyurethane	$R_1NHCOOR_2$	Unlisted
Aluminum Al	$C_8H_8O_8N_8$	D003
(HMX) "Her majesty's explosive", cyclotetra-methylenetetranitramine		D003
Resorcinol	$C_6H_4(OH)_2$	Unlisted
(PVC) Polyvinylchloride	$(-H_2CCHCl-)_x$	Unlisted
(DOA) Dioctyladipate	$[CH_2CH_2COOH_2CH(C_2H_5)C_4H_9]_2$	Unlisted
(DEP) Diethyl phthalate	$C_6H_4(CO_2C_2H_5)_2$	Unlisted
(DMP) Dimethylaminomethyl- substituted phenols	$C_6H_4OHCH_2N(CH_3)_2$	Unlisted
Graphite	C	Unlisted
Magnesium oxide	MgO	Unlisted
Nylon	$(C_6H_{11}NO)_N$	Unlisted
Zirconium carbide	ZrC	Unlisted

Table 1: Rocket Propellant and Igniter Constituents (continued)

Name	Chemical Formula	Hazardous Waste ID Number
(HX-752) Propylene imine product of isophalic acid	$CH_2HCNHCH_2$	Unlisted
(Flexzone/DTBH) Phenylene diamine/ hydroquinone	$C_6H_4(NH_2)_2$	Unlisted
Phosphorus	P	Unlisted
(PBCT) Polybutadiene carboxy terminated	$(C_4H_6)_{100}\,C_2H_2O_4$	Unlisted
Pb (lead) 2-ethyl hexoate	$PbC_5H_{11}COOC_2H_4$	Unlisted
Ferric (iron) oxide	Fe_2O_3	Unlisted
Copper chromate	$CuCrO_4\ 2CuO\ 2H_2O$	Unlisted
Potassium perchlorate	$KClO_4$	D003
(DOS) Dioctylsebacate	$(C_4H_8COOC_8H_{17})_2$	Unlisted
Octylene oxide	Mixed $CH_3\,(CH_2)_5\,CHCH_2O$ & $CH_3\,(CH_2)_4\,CHCH(CH_3)O$	Unlisted
(ERL 2795) Epoxy resin	$-OCH_2CHOCH_2$	Unlisted
Chromium 2-ethyl hexoate	$CrC_5H_{11}COOC_2H_4$	Unlisted
Lecithin	$C_8H_{17}O_5NRR'$	Unlisted
Substituted Ferrocene	$(C_5H_5)_2\,Fe$	Unlisted
(LBR) Lead beta-resorcylate	$C_{14}H_{10}O_8Pb$	Unlisted
(PBAA) Polybutadiene acrylic acid	$C_{70}H_{104}O_4$*	Unlisted
Circo Oil	$C_{15}H_{32}$	Unlisted
(PMAPO) bis 1-(2 methyl) aziridinyl phosphine oxide	$C_{12}H_{17}N_2OP$	Unlisted
(PBHT) Polybutadiene hydroxy terminated	$C_{73}H_{110}O_6$*	Unlisted
(DDI) Desmodour diiocyanate	$C_{38}H_{72}N_2O_2$	Unlisted
Hycar 1300 Synthetic elastomers	$C_{70}H_{100}N_{3.5}O_{1.5}$*	Unlisted
Polyester resin	$(C_7H_{12}O_2)_x$	Unlisted
Cobalt Octoate	$C_4H_9CH(C_2H_5)COOH$	Unlisted
Cumene Hydrogen Peroxide	$C_6H_5C\,(CH_3)_2\,OOH$	Unlisted
Copper Oxide	Cu_2O	Unlisted
Zinc Stearate	$Zn\,(C_{18}H_{35}O_2)_2$	Unlisted

* - Formula approximations for polymers

Table 2: Chemical Composition of Rocket Motors to be Thermally Treated

Rocket Motor	Propellant Composition	Action
2.75" FFAR	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	(DPA) di-n-propyl adipate	Plasticizer
	Pb (lead) salicylate	Burn rate modifier
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Candelilla wax	Processing aid
	Monobasic copper salicylate	Burn rate modifier
Aries	(AP) Ammonium perchlorate	Oxidizer
	(PU) Polyurethane	A class of binder materials
	(Al) Aluminum	Metal fuel
Antares X259 IIA	(AP) Ammonium perchlorate	Oxidizer
	(HMX) "Her majesty's explosive", cyclotetra-methylenetetranitramine	Oxidizer
	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(Al) Aluminum	Metal fuel
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Resorcinol	Plasticizer
Apache	(AP) Ammonium perchlorate	Oxidizer
TPG-3016D:	(PU) Polyurethane	A class of binder material
	(Al) Aluminum	Metal fuel
Arcas	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
	(PVC) Polyvinylchloride	Binder
	(DOA) Dioctyladipate	Plasticizer
Black Brant III	(AP) Ammonium perchlorate	Oxidizer
CARDE A24RX5:	(PU) Polyurethane	Binder
	(Al) Aluminum	Metal fuel
Black Brant VC	(AP) Ammonium perchlorate	Oxidizer

Table 2: Chemical Composition of Rocket Motors to be Thermally Treated (continued)

Rocket Motor	Propellant Composition	Action
ANP-2872 JM mod 1:	(PPG) Polypropylene glycol	Binder
	(TEA) Triethanol amine	Stabilizer
	Poly 1,4-butylene glycol	Binder
	(TDI) Toluene diisocyanate	Curative
	(Al) Aluminum	Metal fuel
	Carbon black	Burn rate modifier
	(FeAA) Iron acetylacetate	Cure catalyst
ANP-2872 JM mod 1 (con't):	(S) Sulfur	Catalyst
	(DOZ) Dioctyl azelate	Plasticizer
	(NDPA) n-phenyl-beta-napthylamine	Stabilizer
Cajun	T22:	
	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
Castor	TP-H-8038A:	
	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
Honest John	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
HYDAC	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
	Circo light oil	Plasticizer
	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	(PMAPO) bis 1-(2-methyl) aziridinyl phenyl phosphine oxide	Curative
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid

Table 2: Chemical Composition of Rocket Motors to be Thermally Treated (continued)

Rocket Motor	Propellant Composition	Action
Javelin III	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
	Circo light oil	Plasticizer
	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	(PMAPO) bis 1-(2-methyl) aziridinyl phenyl phosphine oxide	Curative
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid
Lance	GCR-221:	
	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
M37A1 Spin Rocket	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(DEP) Diethyl phthalate	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
M37A1 Spin Rocket (con't)	(LBR) Lead beta-resorcylate	Burn rate modifier
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
	Candelilla wax	Processing aid
M57A1	(AP) Ammonium perchlorate	Oxidizer
	(HMX) "Her majesty's explosive," cyclotetra-methylenetetranitramine	
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(NC) Nitrocellulose	Binder / oxidizer
	(Al) Aluminum	Metal fuel
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Resorcinol	Plasticizer
Malemute	(PBHT) Polybutadiene hydroxy terminated	Binder
	(DDI) Desmodour diisocyanate	Curative
	(HX-752) Propylene imine product of isophthalic acid	Bonding agent
	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
Mk 70 Terrier	See: Terrier below	

Table 2: Chemical Composition of Rocket Motors to be Thermally Treated (continued)

Rocket Motor	Propellant Composition	Action
Nihka	(PBHT) Polybutadiene hydroxy terminated	Binder
	(AP) Ammonium perchlorate	Oxidizer
	(Al) Aluminum	Metal fuel
Nike	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer/oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	*(DMP) Dimethylaminomethyl- substituted phenols	Curing agent
	*Pb (lead) stearate	Stabilizer
	*Graphite	Stabilizer
Orion	(AP) Ammonium perchlorate	Oxidizer
	(PU) Polyurethane	Class of binder materials
	(Ngu) Nitroguanidine	Oxidizer
Sargeant	(AP) Ammonium perchlorate	Oxidizer
	(S) Sulfur	Catalyst
	(LP-33) Polysulfide	Binder
	*(MgO) Magnesium oxide	Burn rate modifier
	(GMF)	Curative
	Nylon	Binder
Sidewinder	(AP) Ammonium perchlorate	Oxidizer
	(RDX) "Royal daughter's explosive", cyclotrimethyl- enetrinitramine	Oxidizer
	(PBHT) Polybutadiene hydroxy terminated	Binder
	(DOA) Dioctyladipate	Plasticizer
	(DDI) Desmodour diisocyanate	Curative
	*(ZrC) Zirconium carbide	
	(HX-752) Propylene imine product of isophthalic acid	Bonding agent
	(Flexzone/DTBH) Phenylene diamine/hydroquinone	Bonding agent
Signal Flare	Phosphorus	Metal fuel
25" Spherical Motor	TP-L-3050:(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
Star 6B	TP-H-3237A:	
	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
	(PBCT) Polybutadiene carboxy terminated	Binder
Super Arcas	(AP) Ammonium perchlorate	Oxidizer

Rocket Motor	Propellant Composition	Action
	(PVC) Polyvinylchloride	Binder
Super Loki	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
	(Al) Aluminum	Metal fuel
Talos	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Pb (lead) 2-ethyl hexoate	Burn rate modifier
Taurus	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
Terrier	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Pb (lead) 2-ethyl hexoate	Burn rate modifier
Tomahawk	(PBCT) Polybutadiene carboxy terminated	Binder
	(AP) Ammonium perchlorate	Oxidizer
	(Al) Aluminum	Metal fuel
	Ferric (iron) oxide	Burn rate modifier
Ute I	(AP) Ammonium perchlorate	Oxidizer
RPI-PAP-8:	(PS) Polysulfide	Binder
VAM-20	Potassium Perchlorate	Oxidizer
	Polyester Resin	Binder
	Styrene	Binder
	Carbon Black	Catalyst
	Cobolt Octoate	catalyst
	Cumene Hydrogen Peroxide	Burn rate modifier
Viper	(AP) Ammonium perchlorate	Oxidizer
	*Hycar 1300, TM for various types of synthetic elastomers	
	(Al) Aluminum	Metal fuel
	Copper chromite	Burn rate modifier
	*(KClO4) Potassium perchlorate	Oxidizer
	(DOS) Dicotylsebacate	Plasticizer
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid
	Octylene oxide	
	Epon 812	Processing aid
	(ERL 2795) Epoxy resin	Binder

Table 2: Chemical Composition of Rocket Motors to be Thermally Treated (continued)

Rocket Motor	Propellant Composition	Action
Zap	(AP) Ammonium perchlorate	Oxidizer
	(PBCT) Polybutadiene carboxy terminated	Binder
	(Al) Aluminum	Metal fuel
	Chromium 2-ethyl hexoate	Burn rate modifier
	(ERL 0510) Epoxy resin	Binder
	Lecithin	
	Ferric (iron) oxide	Burn rate modifier
	Substituted ferrocene	Burn rate modifier
	Dibutyl carbitol formal	Plasticizer
Zuni	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer/oxidizer
	(Al) Aluminum	Metal fuel
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Candelilla wax	Processing aid
	(DPA) Di-n-propyl adipate	Plasticizer
	Monobasic copper salicylate	Burn rate modifier

* The full name and actions of these were derived from Hawley's Condensed Chemical Dictionary. Information on chemical constituents was developed by John Hopkins University, Applied Physics Laboratory in Laurel, Maryland.

Table 3: Chemical Composition of Igniters to be Thermally Treated

Ignitor	Propellant Composition	Action
Antares	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	Aluminum	Metal fuel
	Ammonium Perchlorate	Oxidizer
	Boron Potassium nitrate	Oxidizer
Caster	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	Ammonium Perchlorate	Oxidizer
	Iron oxide	Burn rate modifier
	(DOS) Dicotylsebacate	Plasticizer
Altair	Same as Antares	
Orion	Polysulfide	Binder
	Quinone Dioxime	Curative
	Diphenly-Guanidine	Curative
	Sulfur	Catalyst
	Magnesium Oxide	Burn rate modifier
	Di(Butoxyethoxyet) Formal	Curative
	Iron Oxide	Burn rate modifier
	Ammonium Perchlorate	Oxidizer
	Boron Potassium nitrate	Oxidizer
Tomahawk	Same as Orion	
Malemute	T	
Black Brant III	Magnesium powder	Oxidizer
	Potassium Nitrate	Oxidizer
	Acaroid Resin	Binder
	Zinc Stearate	Stabilizer
Lance	T	
UTE	T	
Super Loki	Aluminum	Metal Fuel
	Cupric Oxide	Catalyst
Arcas	Boron Potassium Nitrate (Pellets)	Oxidizer
Javeline III	Aluminum	Metal Fuel
	Cupric Oxide	Catalyst
Aerojet Jr.	Potassium Perchlorate	Oxidizer
	Aluminum	Metal Fuel
	Vegetable Oil	Binder
15" Spherical	Ammonium Perchlorate	Oxidizer
	Aluminum	Metal Fuel
	Iron Oxide	Burn rate modifier
	(PBAA) Polybutidiene Acylic Acid	Binder
	Epoxy	Binder

T – Thermal Ignitor

Table 4: Rocket Motors to be Thermally Treated at WFF OB Unit

Motor	Propellant (lbs.)	Length (in.)	Diameter (in.)
2.75" FFAR	5.9	48.0	2.75
Aries	10,370	158	143
Antares X259 IIA	2,834	113	30.5
Apache	131	107.5	7
Arcas	40.12	26	4.25
Black Brant III	447	147	10.2
Black Brant VC	2,198	210	17.2
Black Brant V	2,198	223	17.2
Cajun	118.5	107.7	7
Castor	8,202.3	243.6	31.0
Honest John	2,050	197.4	23
HYDAC	415.7	144	9
Javelin III	258	104	9
Lance	2,800	20.5	1.8
M37A1 Spin Rocket	2	13.5	3.75
M57A1	3,665.2	85.25	38
Malemute	1,115	114	17.25
Mk 70 Terrier	same as Terrier	157	18
Nihka	756	76	17.2
Nike	750	145.2	16.5
Orion	604	105.5	14.0
Sargeant	5,900	414	70
Sidewinder	60	75.5	5
Signal Flare	<1	1.875	1.25
25" Spherical Motor	5	25.0	25.0
Star 6B	13.45	17	6.5
Super Arcas	40	76	4.5
Super Loki	38	78.1	4
Talos	2,803	134.5	30.875
Taurus	1,663	166.125	23
Terrier	1,202	157	18
Tomahawk	387	142	9
Ute I	550	77	16.5
VAM-20	260	74.5	12
Viper	148.8	107	6.5
Zap	33.5	176.5	5
Zuni	50	176.5	5

* Shaded rocket motors are not in current inventory.

4.0 ADDITIONAL REQUIREMENTS

4.1 Additional Requirements for Waste Generated Off Site

Rocket motor propellants and igniters designated for thermal treatment may originate from storage buildings on the WFF Main Base or Wallops Island. Manifests and shipping documents will be inspected and reviewed to ensure that the materials received match the identity of the waste designated for thermal treatment. Rocket propellants and igniters are delivered directly to the OB area for burning. They are delivered to the OB area when scheduled for open burning. Rocket propellants and igniters are not stored at the OB area.

4.2 Additional Requirements for Ignitable, Reactive or Incompatible Wastes

The waste propellants/igniters to be treated by OB at WFF are of similar composition and are compatible. The residue remaining after OB will be considered reactive unless chemical analysis proves otherwise. The requirements for handling this material are stated in Attachment II.DD – Procedures to Prevent Hazards.

4.3 Land Disposal Requirements

Generator knowledge and MSDS are used to classify the rocket motors as reactive hazardous waste. Reactive hazardous wastes are a restricted waste banned from land disposal until they have been treated effectively. Open Burning is designed to effectively treat hazardous waste. The treatment standard, as described in 40 CFR 268.40 for DO03, Explosives Subcategory, nonwastewaters, is deactivation and meeting 40 CFR 268.48 universal treatment standards. All underlying constituents must be analyzed to make certain that the waste meets LDRs. At least once per year, the residue will be analyzed in accordance with 40 CFR 268.48 for underlying hazardous constituents of concern. If the waste is not reactive, it must still pass for all underlying constituents before land disposal. If universal treatment standards can not be met for underlying hazardous constituents, the residue will be disposed as a hazardous waste off site and LDR Notification will accompany each hazardous waste manifest.

5.0 TREATMENT EFFECTIVENESS

Rocket motors are designed for complete combustion of all products. Typically, after OB treatment is complete, no materials remain in the motor or are expelled from the motor. The OB area will be visually examined after each use to verify that no materials were ejected. If materials are expelled they will be collected for further OB treatment. The OB/OD Contingency Plan found in Attachment II.FF details these procedures. Rocket motor casings and igniters will be inspected for visible signs of untreated material. The primary constituents of the residue (if present) after thermal treatment will be trace amounts of reactant material and, in some cases, propellant sealant. The residue will be removed and re-ignited on the bum pad. The process will be repeated until thermal treatment is complete.

5.1 Suitability of Rocket Motors and Igniters for Open Burning

Open burning is designed to be used as a treatment option for those waste energetics that would result in a subsonic chemical transformation process (no detonation) and is consistent with the materials open burned at WFF.

5.2 Analysis of Post Treatment Wastes

OB treatment is typically complete so that no materials remain in the motor or are expelled from the motor. The OB area will be visually examined after each use to verify that no materials were ejected. If materials are expelled they will be collected for further OB treatment. Rocket motor casings and igniters will be inspected for visible signs of untreated material. The primary constituents of the residue (if present) after thermal treatment will be trace amounts of reactant material and, in some cases, propellant sealant. The residue will be removed and re-ignited on the burn pad. The process will be repeated until thermal treatment is complete. Any unburnable material is to be containerized, sampled for characterization, if necessary, in accordance with 40 CFR 261 and the OB Area Waste Analysis plan, and disposed of through WFF's hazardous waste disposal contractor. The container will be stored at Building U-81, less-than-90-day-accumulation area for less than 90 days.

5.2.1 Parameters

Open Burn post treatment residues may have hazardous waste characteristics or characteristics of concern that should be identified. Table 5 identifies target constituents and methods for post treatment waste analysis. Only the individual metal Toxic Characteristic Leaching Procedure (TCLP) analysis will be performed as warranted by the propellant constituents. Dioxins, furans and perchlorates will be analyzed on those rocket motors with a perchlorate based fuel. Dioxins and furans are potential emission products associated with the treatment of chlorinated propellants.

Table 5: Post Treatment Test Procedures

Parameter	Method Number	Mass
TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver)	SW-846 1311/6010B/7000A	1000 grams
Energetics (to determine total energetic concentration relative to 12% explosive criterion)	SW-846 8330/8332/8321/8095	100-500 grams
Dioxins/Furans (applicable for chlorinated wastes)	SW-846 1311 and 8830 or 8270	100-500 grams
Perchlorates	EPA 314	100-500 grams

Source: Draft Final Open Burning/ Open Detonation Permitting Guidelines, February 2002.

5.2.2 Sampling Methods

Residue samples will be collected based on standard SW-846 sampling methods, but sparkless sampling equipment should be used.

5.2.3 Frequency of Analysis

When residues or ash remain after OB operations, post treatment analyses will be conducted at least annually on each different type of rocket motor residue or ash.

APPENDIX A

MAPS AND DRAWINGS

Figure D-1, OB Area, Showing Installation of Subunit 4 in 2012
Subunit 3 Scheduled for Removal in 2012

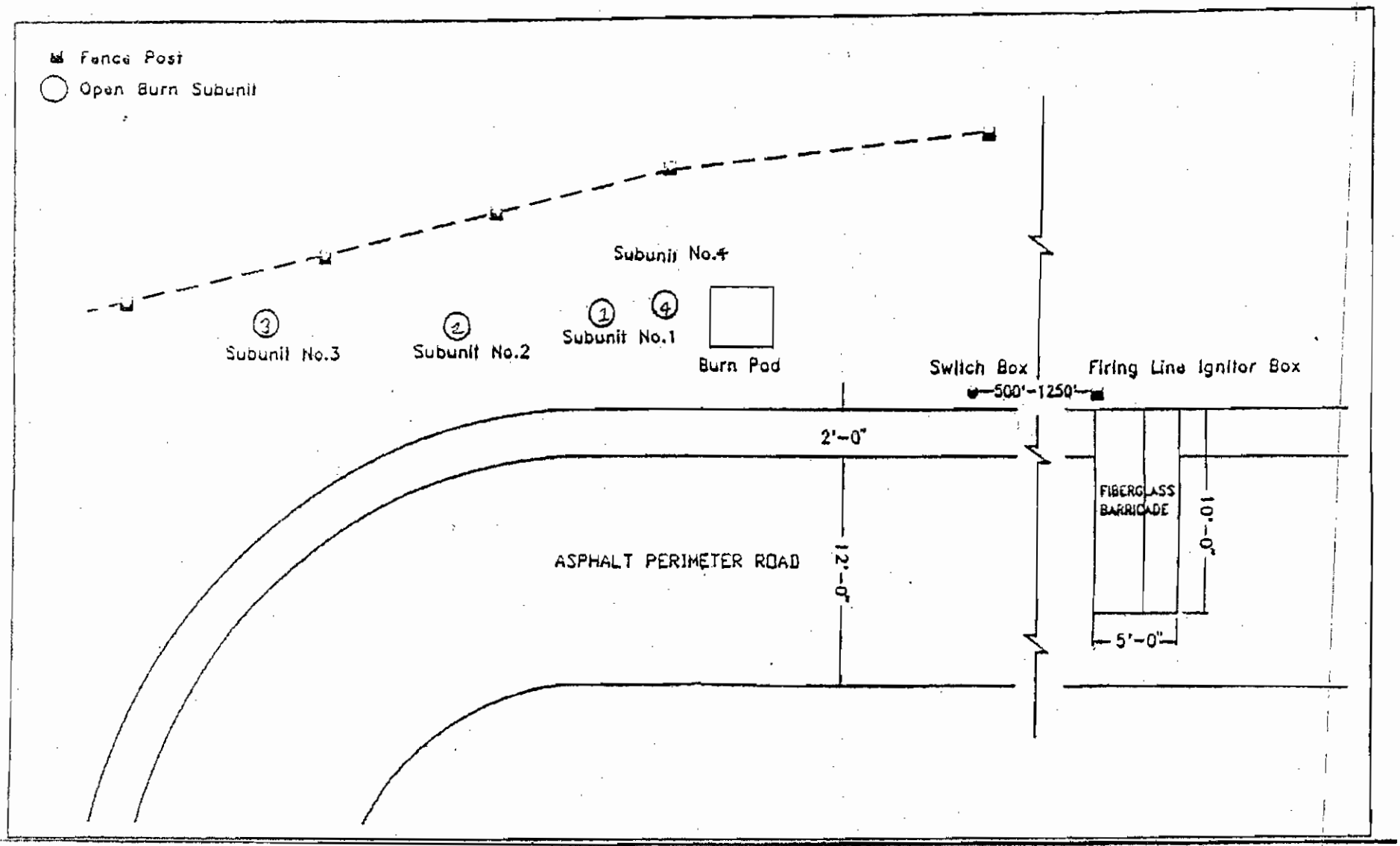
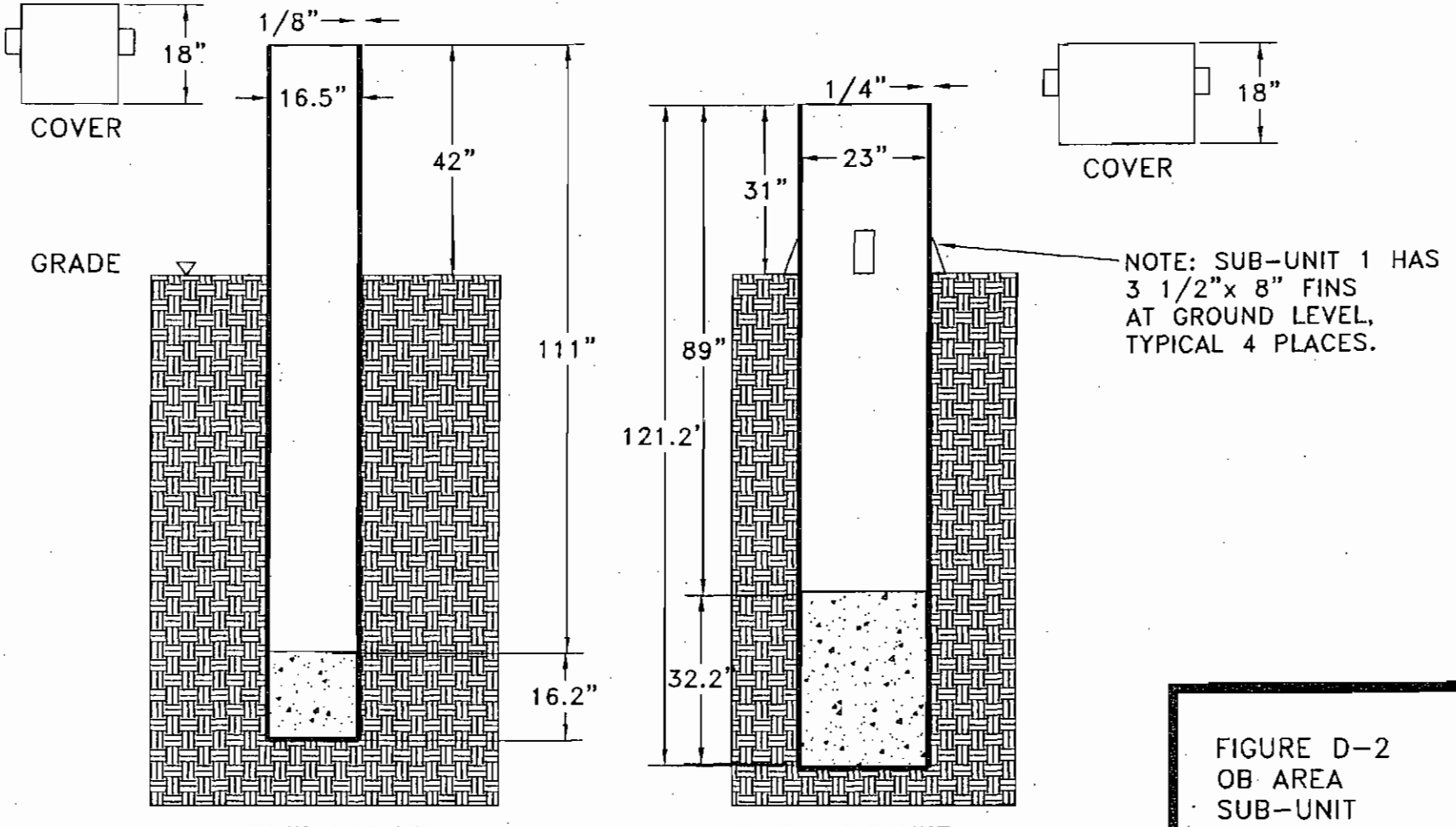


Figure D-1 OB Area

Exhibit E BD-1 Appendix A

Also OB Permit Application
Page D-3



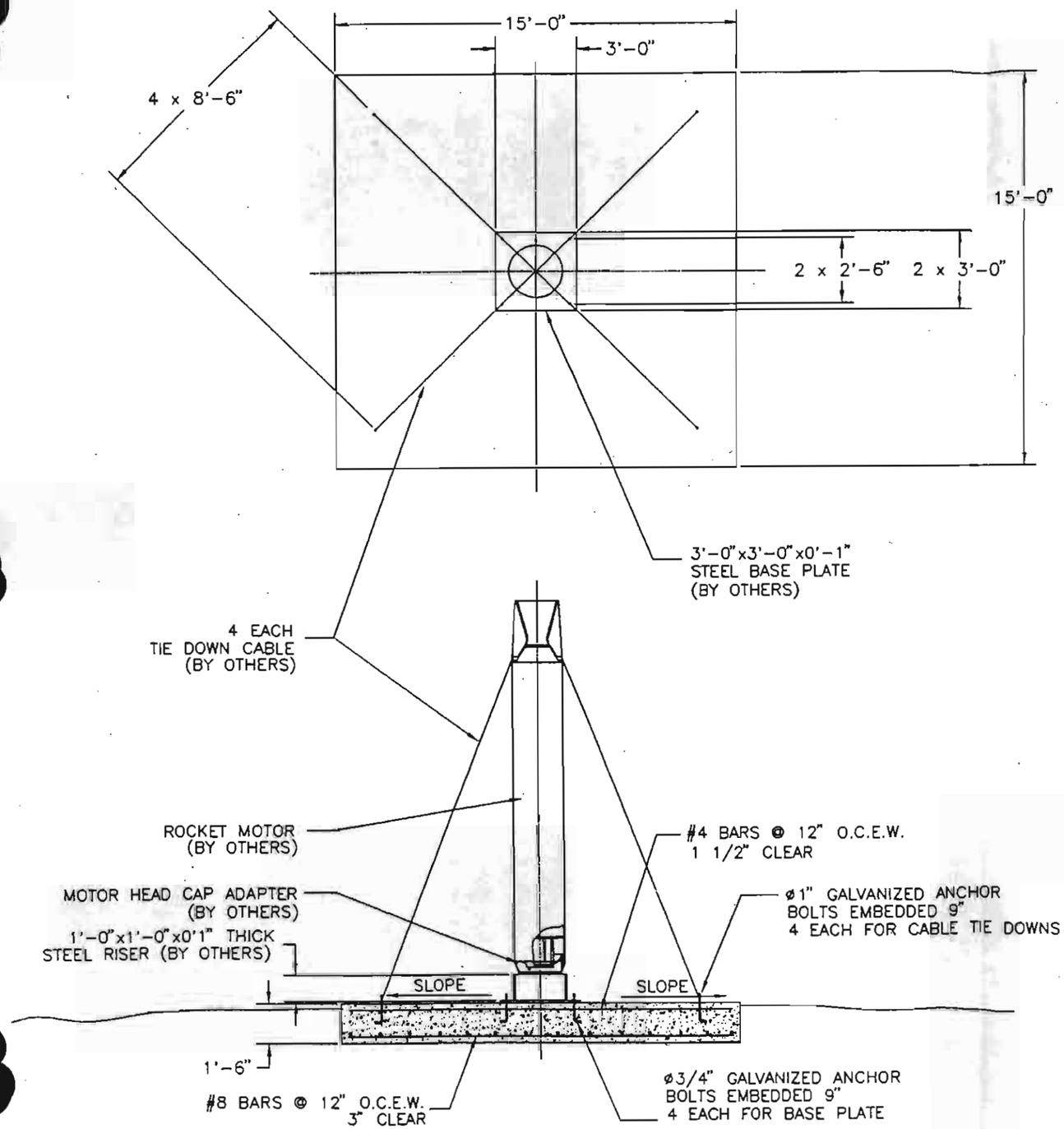
NIKE ROCKET
MOTOR CASING
SUB-UNIT 2

TARUS ROCKET
MOTOR CASING
SUB-UNIT 1 & 3

FIGURE D-2
OB AREA
SUB-UNIT
AS-BUILT DRAWINGS

12/23/03

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. REMOVE BURRS AND BREAK SHARP EDGES .005 - .010 MAX.
2. INTERPRET DWG. PER ANSI Y 14.5 1988



3-6-97	A	ADDED LOADING INFO. SIZED REBAR	T.F.W.

STRUCTURAL DESIGN DATA

FOUNDATION DESIGN LOADS

ROCKET MOTOR WEIGHT	3937 LBS.
ACTUAL THRUST	112,000 LBS.
FACTOR OF SAFETY (FOUNDATION)	2

DESIGN LOADS APPLIED AT ORIGIN OF ADAPTOR ANCHOR BOLT CIRCLE
ANCHOR BOLTS, ADAPTOR, AND TIE-DOWN CABLES BY OTHERS

STRUCTURAL CONCRETE NOTES

1. ALL CAST-IN-PLACE CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI.
2. ALL CONCRETE SHALL HAVE AN APPROVED AIR-ENTRAINING ADMIXTURE.
3. ALL REINFORCING BARS SHALL BE NEW BILLET STEEL CONFORMING TO THE STANDARDS OF ASTM A615, GRADE 60.
4. ALL CONCTETE REINFORCEMENT SHALL BE DETAILED, FABRICATED, LABELED, SUPPORTED, AND SPACED IN FORMS AND SECURED IN PLACE IN ACCORDANCE WITH THE PROCEDURES AND REQUIREMENTS OUTLINED IN THE LATEST EDITION OF THE "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE", ACI 318 AND THE "MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES", ACI 315.
5. MAXIMUM SLUMP SHALL BE 4", MINIMUM CEMENT CONTENT SHALL BE 6 SACKS.
6. MINIMUM CONCRETE COVER SHALL BE 3" FOR CONCRETE CAST AGAINST THE EARTH AND 1 1/2" FOR CONCRETE EXPOSED TO WEATHER.
7. MAXIMUM SIZE FOR COARSE AGGREGATE SHALL BE 3/4".
8. PROVIDE 1/16" PER 12" DRAINAGE SLOPE FROM CENTER OF PAD TO OUSIDE EDGES.

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Figure D-3

NEXT ASSEMBLY	UNIT OF PROJECT: TEST_PAD	SCALE: 1/30	MATERIAL	HEAT TREAT	DR. GARI GURRIER DES. ROB MADDOX CHK. G. BARFIELD QL. APP.
TOLERANCE ON DIMENSIONS UNLESS SHOWN OTHERWISE: X.X ±.010, X.XX ±.005, X.XXX ±.000 / ANGULAR ±			NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER WALLOPS FLIGHT FACILITY WALLOPS ISLAND, VIRGINIA 23337		

1-16-96

Attachment II.BB – Waste Analysis Plan
Appendix A, Maps and Drawings

Figure D-7, OB Area, Subunit 4 Side View – Installation in 2012
Note: Subunit 3 Scheduled for Removal in 2012

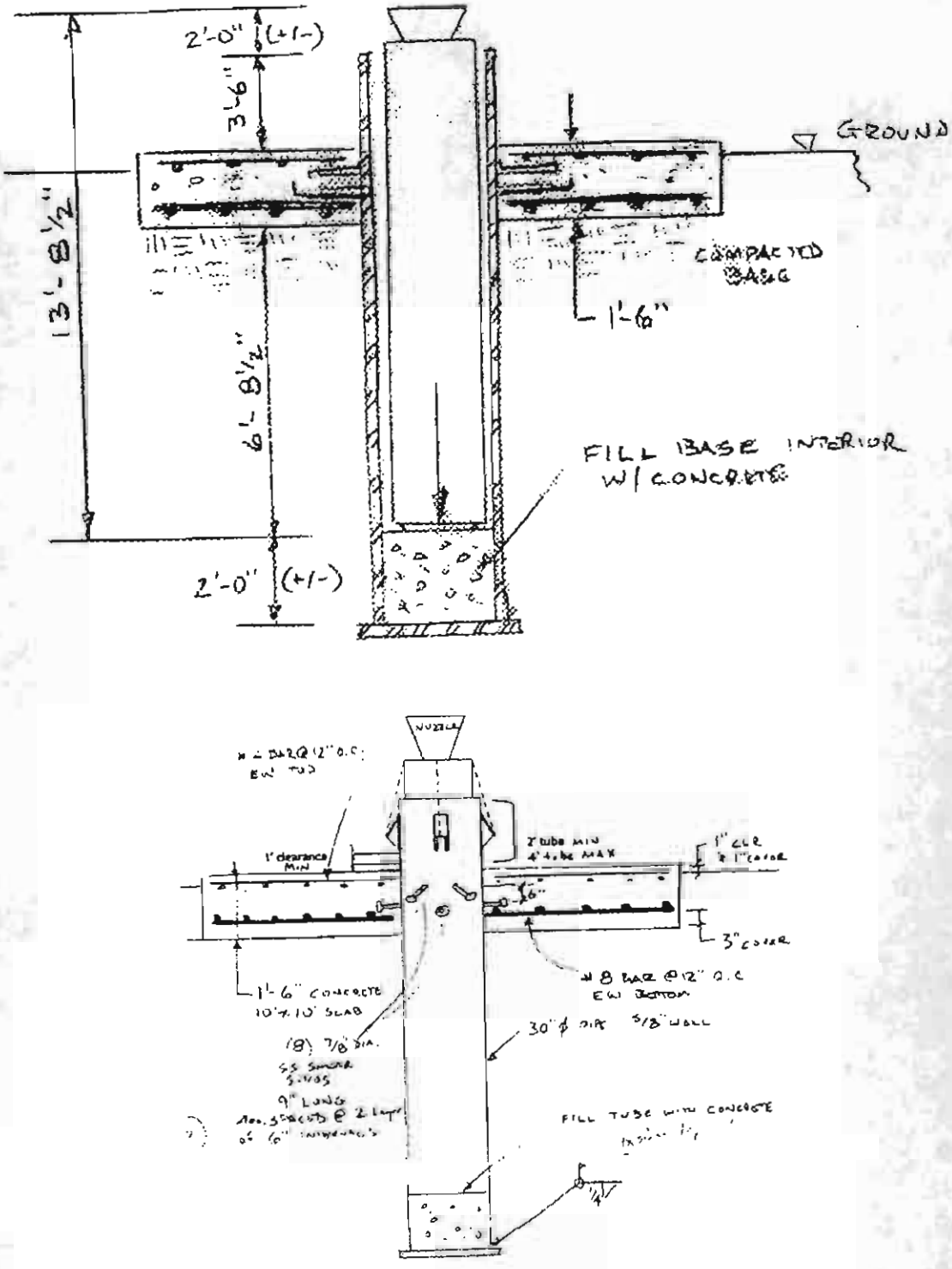

Figure D-7
Open Burning Area Subunit 4
October 2011

Exhibit F BB-L Appendix A

Also OB permit Application Attachment 7, Appendix A, page D-6

Also OB permit applica page D-16

APPENDIX B

MATERIAL SAFETY DATA SHEETS

BLACK BRANT MOTOR

(Black Brant Motor)

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List) 26KS20000-BBV Motor with Nozzle	Use Sounding Rocket
Section I	
Manufacturer's Name Bristol Aerospace Ltd.	Emergency Telephone Number 204-344-5545
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-5545
	Date Prepared March 20, 1995
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Asbestos (See Note 1)	N/A	2.00ml	N/A	<1.20
Phenyl B-Naphthylamine (PBNA) (See Note 2)	N/A	N/A	N/A	<0.20
Black Brant Propellant Class 1.3C UN0186	N/A	N/A	N/A	85 to 90

Note 1: Asbestos is encapsulated within the motor and is not released during storage or operation. Interior of fired motors will contain surface asbestos which may exceed the percent specified and could be released by uncontrolled cutting, grinding, wire brushing, etc.

Note 2: PBNA is a constituent of the solid propellant. It is not released from the motor during storage and is completely consumed during operation.

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A
Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water	Appearance and Odour
Insoluble - Propellant contains Ammonium Perchlorate which is soluble in water.	Cylindrical - no odour.

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
N/A Propellant has auto ignition temperature of 275°C (528°F)		N/A	N/A

Extinguishing Media
None; self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires, move personnel from area.

Unusual Fire and Explosion Hazards
If initiated, material burns rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability			Conditions to Avoid
	Unstable		Avoid any possible sources of ignition. Observe temperature limits of product.
	Stable	X	

Incompatibility (Materials to Avoid)
Strong acids and bases.

Hazardous Decomposition or Byproducts
HCL, Al_2O_3, CO, CO_2, H_2.

Hazardous Polymerization			Conditions to Avoid
	May Occur		
	Will Not Occur	X	

Section VI - Health Hazard Data

Route(s) of Entry:	Inhalation? No	Skin? No	Ingestion? No

Health Hazards (Acute and Chronic)
N/A

Carcinogenicity: U	NTP? N/A	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure	Medical Conditions Generally Aggravated by Exposure
If material burns, injuries to personnel may be serious and will involve burns, lacerations, shock and possible inhalation of fumes.	None known.

Emergency and First Aid Procedures
If material burns, trained personnel should treat victims.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
- Eliminate all ignition sources. - Structural fire fighters protective clothing does not provide adequate protection, if material burns. - Inspection required before use.	- Dispose of material in accordance with local legislation.
Precautions to be Taken in Handling and Storing Keep material away from impact, friction and high temperatures. Use precautions against electrostatic build up.	**Other Precautions**

Section VIII - Control Measures

Respiratory Protection (Specify Type)
If dust or fumes exist, use NIOSH approved respirators for dust or organic fumes.

Ventilation	Local Exhaust	Special
- Under normal conditions ventilation is not required. - If material burns structural fire fighter's self-contained breathing apparatus will provide reasonably adequate protection against toxic gases produced.	Not Required	Not Required
	Mechanical (General) Not Required	Other Not Required

Protection Gloves	Eye Protection
Latex or vinyl.	Safety Glasses

Other Protective Clothing or Equipment	Work/Hygiene Practices
Structural fire fighter's protective clothing will not provide adequate protection, against flames from an ignited motor.	- Minimize exposure to interior propellant. - Wash hands after exposure to material.

BLACK BRANT IGNITER

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List)	USE
1. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04862-3	1. Black Brant VC Rocket Motor High Altitude Igniter
2. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04850-1	2. Black Brant Igniter Kit 600-04005-1, Black Brant High Altitude Igniter
3. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-00339-1	3. Black Brant Igniter Assy 600-00335-1, Black Brant High Altitude Igniter

Section I

Manufacturer's Name	Emergency Telephone Number
Bristol Aerospace Limited	204-344-3201
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-3211
	Date Prepared August 20, 2001
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
1) Boron Potassium Nitrate Pellets (BPN) 380 gms total weight 1.3L explosive UN 0359			Manufacturer suggests TLV of 10 mg/m^3.	
2) Asbestos Insulator		2f/cc asbestos	Insulator encapsulated in ablative sealant material	

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A

Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water
Assembly is watertight. If seal broken BPN is water soluble.

Appearance and Odour
Fully assembled and sealed - no odour.

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
Igniter has auto ignition temperature of 221°C (430°F)	N/A	N/A	N/A

Extinguishing Media
None self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires involving this material. If quantities are small and safety is not compromised an attempt to limit fire spread can be made.

Unusual Fire and Explosion Hazards
If initiated, material will burn rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability	Unstable		Conditions to Avoid Fire, flame and other ignition sources.
	Stable	X	

Incompatibility (Materials to Avoid)
BPN pellets are incompatible with strong oxidizers, or active fuels.

Hazardous Decomposition or Byproducts
Boric Oxide, Potassium Oxide, Nitrogen in the form of hot particles and gases.

Hazardous Polymerization	May Occur		Conditions to Avoid N/A
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry: N/A	Inhalation? N/A	Skin? N/A	Ingestion? N/A

Health Hazards (Acute and Chronic)
Sealed unit does not pose a health hazard. If opened dust from BPN pellets may irritate eyes, respiratory system.

Carcinogenicity: No	NTP? No	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure
BPN Dust - irritation of eyes, nose, coughing, sneezing, nausea.

Medical Conditions Generally Aggravated by Exposure
None known.

Emergency and First Aid Procedures
1) For irritation - remove to fresh air. Flush affected area with soap and water.

2) For burns - treat for burn, shock, lacerations and possible inhalation of combustion products.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
Eliminate all ignition sources, carefully clean-up spilled material. Place in conductive container.	Burn under approved controlled conditions.
Precautions to be Taken in Handling and Storing	**Other Precautions**
Store in approved magazine for 1.3 explosive in shipping container at ambient temperature and humidity.	N/R

Section VIII - Control Measures

Respiratory Protection (Specify Type)
In the event of a spill use NIOSH approved dust type respirator for dust exposure.

Ventilation	Local Exhaust	Special
N/R - sealed unit		N/R
	Mechanical (General)	Other
		N/R
Protection Gloves		**Eye Protection**
N/R		Safety glasses.
Other Protective Clothing or Equipment	**Work/Hygiene Practices**	
Flame resistant clothing	If dust present (spill) wash clothing, hands, face.	

12A Dart

Material Safety Data Sheet

May be used to comply with
OSHA's Hazard Communication Standard
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S.Department of Labor

Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No.1218-0072

Identity (As Used on Label and List)	Note: Blank spaces are not permitted. If any item is not applicable or no information is available the space must be marked to indicate that.
PWN-12A Robinsphere Dart (P/N 466-10)	

Section I

Manufacture's Name OSC Space Data Division	Emergency Telephone Number (602) 228-5772
Address (Number, Street, City, State, and ZIP Code) Meteorological Data Systems	Telephone Number for Information (602) 814-6800
1303 West 21st Street Tempe, Arizona 85282	Date Prepared April 27, 1992
	Signature of Preparer (optional)

Section II - Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Boron Potassium Nitrate, $BKNO_3$, 2A Powder	U	5 mg/m^3	N/A	N/A
Cis-2-Butene (590-18-1)	N/A	N/A	N/A	N/A
Igniter Delay (S-326), Pyrotechnic Delay Train	N/A	N/A	N/A	N/A

Note: These assemblies are hermetically sealed within the wooden shipping containers.

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H$_2$O = 1)	N/A
Vapor Pressure (mm Hg)	N/A	Melting point	N/A
Vapor Density (Air = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water
N/A

Appearance and Odor
N/A

Section IV - Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
N/A	N/A	N/A	N/A

Extinguishing Media: Water spray, Fog or Foam. CO_2, Dry Chemical

Special Fire Fighting Procedures: Remove all personnel from danger area. Reduce vapors with fog or fine water spray. Decomposition byproducts are toxic. Avoid the fumes. Fight fires only from a safe distance. Should units become engulfed in flames, use self-contained breathing apparatus and light fragment shield protection. DOD 45.26M, Chapter 10. On-site fire brigades must comply with OSHA 29 CFR 1910.156

Unusual Fire and Explosion Hazards: Once initiated, the Ignition Delay will explosively eject the 5 pound nose cone. Flammable gas may form mixtures with air an auto-ignite.

Published by THE BUREAU OF NATIONAL AFFAIRS, INC., Washington, D.C.20037

Section V - Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable	X	Elevated temperatures and pressures. High impact.

Incompatibility (Materials to Avoid) NONE
Use normal storage in ordnance magazine.

Hazardous Decomposition of Byproducts
Oxides of Nitrogen, Carbon, Lead Vapors, CO/CO_2

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
	N/A	N/A	N/A

Health Hazards (Acute and Chronic)
N/A

Carcinogenicity	NTP?	IARC Monographs?	OSHA Regulated?
	N/A	N/A	N/A

Signs and Symptoms of Exposure
N/A

Medical Conditions
Generally Aggravated by Exposure

Emergency and First Aid Procedures
N/A

Section VII - Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled
Evacuate all personnel to a safe distance. Contact ordnance disposal personnel.

Waste Disposal Method
As determined by the local ordnance disposal personnel.

Precautions to Be Taken in Handling and Storing
These assemblies must be handled by personnel trained in ordnance device handling.

Other Precautions
Keep fire and flame away, handle each unit separately, do not collect in mass

Section VII - Control Measures

Respiratory Protection (Specify Type)
N/A

Ventilation	Local Exhaust N/A	Special N/A
	Mechanical (General) N/A	Other N/A

Protective Gloves N/A	Eye Protection Safety glasses are recommended.

Other Protective Clothing or Equipment
Use full electrostatic control program.

Work/Hygienic Practices
Use normal hygiene practice, after handling these devices, wash hands prior to eating , drinking or smoking

USGPO 1986-491-529/45775

IMPROVED ORION ROCKET MOTOR

JHCS Custom Query Form

DOD Compontent: A

Tri-Service Coordination: N

NSN: 1337-00-484-855

Nomenclature: ROCKET MOTOR, M112

DODIC: V229

Inhabited Building Distance:

DOD Hazard Class/Division/Subdivision: 1 3

Compatibility Group: C

Label (First Label): 3

Label (Second Label):

UN Number: 0186

Label (Third Label):

Proper Shipping Name: ROCKET MOTORS

Technical Name:

DOT Explosive Registration Number: 8811544

High Explosive Wt-lbs: 0.00000

HighExplosiveWt-kgs: 0.000000

Net Propellant Wt-lbs: 650.0000

Net Propellant WT-kgs: 294.83511

Net Explosive Wt-lbs: 650.0000

Net Explosive Wt-kgs: 294.83511

Net Explosive QD Wt-lbs: 650.0000

Net Explosive QD Wt-kgs: 294.83511

Maximum Credible Event Wt-lbs:

Maximum Credible Event Wt-kgs:

PN/Dwg1:

PN/Dwg2:

PN/Dwg3:

Remarks:

Date Changed: 9310

Last Action: C

Elements Chgd: OPQ

Record 101 of 490

MATERIAL SAFETY DATA SHEET MSDS D0059 Page 1 of 4

Latest Revision: May 29, 1990 Superseding: August 6, 1985

Thiokol Corporation
P.O. Box 707
Brigham City, UT 84302-0707

Emergency Phone No. (801) 863-8545
Product Information (801) 863-3325

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms:
TP-H1194 Malemute Propellant

II. PHYSICAL DATA

A. Appearance and Odor: Gray, rubbery, solid propellant with an aromatic odor.

B. Volatiles: None.

III. TYPICAL COMPOSITION

Hazardous Ingredients	Percent	TWA (PEL)	STEL (PEL)	TLV
Hydroxyl terminated polybutadiene polymer	*	NE	NE	NE
Dimeryl diisocyanate	*	NE	NE	0.005 ppm
Difunctional aziridine (HX-752)	*	NE	NE	NE
Aluminum powder**	*	5 mg/m^3	NE	5 mg/m^3
CAS No. 7429-90-5	EPA section 313 toxic chemical (1989)			
Ammonium perchlorate**	*	NE	NE	NE

* Percentages are confidential.
** Exposure potential is limited by physical form of material.
NE: Not established.

IV. HEALTH HAZARD DATA

A. Threshold Limit Value (TLV): Not known for cured material. As an uncured mixture, this material has a TLV of 0.005 ppm, due to the presence of dimeryl diisocyanate.

B. Effects of Overexposure

Inhalation: The diisocyanate contained in this mixture in the uncured state may cause serious lung damage and death if inhaled in large volume. HX-752 may also irritate the upper respiratory tract. There is evidence that HX-752 may be carcinogenic. Once cured, this material poses no known inhalation risk until it is burned.

Eyes: Diisocyanate in the uncured material will cause serious injury to the eyes if directly exposed.

Skin: Causes skin irritation in uncured state.

Ingestion: Highly toxic in uncured form. See Inhalation. Cured hazard is not known.

Existing conditions which may be aggravated: Uncured isocyanates may trigger severe reactions in people with asthma or other respiratory ailments.

V. EMERGENCY FIRST AID PROCEDURES

A. Inhalation: Contact physician. Give oxygen or artificial respiration if needed. For thermal burns contact physician.

B. Eyes: Flush immediately with water for at least 15 minutes. Contact physician.

C. Skin: Wash with soap and water. Contact physician.

D. Ingestion: Contact physician.

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: Not applicable.

B. Explosion Limits: Not applicable.

C. Extinguishing Media: Do not attempt to fight burning propellant. Water, CO_2 or foam may be used to restrict the spread of fire.

D. Special Fire Fighting Procedures: Propellant and igniter materials contain oxidizer and fuel. Do not fight fires involving this material. If ignited, thrust created while burning may give this propellant uncontrollable ballistic properties. Fire fighting should be limited to preventing the spread of fire.

E. Explosion Hazards: Static discharge, impact, friction and pinch points between hard surfaces can initiate propellant fires. Overpressures associated with rapidly burning propellant can be explosive-like, creating fireballs and shock waves.

VII. REACTIVITY DATA

A. Stability: Unstable.
Conditions to Avoid: Temperatures above 250°F, shock, impact, friction and static charge buildup.

B. Incompatibility (materials to avoid): Water-soaked propellant may evolve Hydrogen gas.

C. Hazardous Decomposition Products: CO, CO_2, HCl and NO_x.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

Protective Measures

A. Ventilation: General recommended for cured material. With uncured material, provide sufficient mechanical (general and/or exhaust) ventilation to keep vapors below the TLV.

B. Respiratory Protection: None required for cured propellant. For uncured propellant, a NIOSH/MSHA approved air purifying respirator is advised in the absence of proper environmental control. Engineering and/or administrative controls may be implemented to reduce exposure.

C. Protective Gloves: Wear nonporous gloves such as natural rubber or neoprene for handling.

D. Eye Protection: Chemical monogoggles in compliance with OSHA regulations are advised.

E. Other Protective Equipment: Flame resistant clothing is advised.

F. Other Precautions: Propellant should be controlled and handled only by personnel properly trained to handle pyrotechnic materials.

IX. HANDLING AND STORAGE PRECAUTIONS

Handling and Storage Precautions: Protect propellant from ignition sources, static charge buildup, mechanical shock, friction and temperatures above 250°F. Motor should only be fired when the environmental history is known, and aging and temperature limits set by design and aging studies have not been exceeded.

X. ENVIRONMENTAL PROTECTION

A. Precautions if Container is Damaged or Materials Spilled: Propellant must be protected from sources of ignition (see Section VI). If ignited, unpredictable ballistic properties should be anticipated, releasing pressure and spreading flaming, burning material over a wide area, and producing toxic decomposition fumes. Contact appropriate authorities.

B. Waste Disposal Method: This material is highly reactive and flammable. Dispose of in accordance with federal, state and local regulations.

For industrial use only. To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

MALEMUTE IGNITER

MATERIAL SAFETY DATA SHEET MSDS D0087

Latest Revision: January 31, 1986 Page 1 of 4

MORTON THIOKOL, INC.
PO BOX 524
Brigham City, UT 84302 Emergency Phone No. (801) 863-8545
Product Information (801) 863-3325

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms:
C-4 1st Stage Igniter
Malemute Igniter

II. PHYSICAL DATA

A. Appearance: Metal cased igniter.

B. Volatiles: None.

III. TYPICAL COMPOSITION

A. Hazardous Ingredients	Percent	PEL	TLV
TP-H1137 Propellant:			
Hydroxyl terminated polybutadiene resin	*	NE	NE
Iron oxide**	*	NE	NE
Isophorone diisocyanate**	*	NE	0.01ppm(skin)
Difunctional Aziridine (HX752)	*	NE	NE
Powdered aluminum**	*	NE	10mg/m^3
Ammonium perchlorate**	*	NE	NE
Igniter granules (UIX 156-02):			
Boron**	*	NE	NE
Potassium Nitrate**	*	NE	NE
Insulation:			
Asbestos-filled Rubber**	*	2 fibers/cc (Asbestos 2 fibers/cc)	2 fibers/cc

*Company Proprietary
**Exposure potential is limited by physical form of material. Once cured, the isocyanate and aziridine are completely reacted.
NE Not Established

IV. HEALTH HAZARD DATA

A. Threshold Limit Value: None established. The TLVs listed above are for individual components in the uncured state. Exposure to the finished product is not known to be hazardous. Decomposition products are considered toxic.

B. Effects of Overexposure:

Inhalation: For burned out igniter, chronic respiratory conditions may result from asbestos fiber exposure. Decomposition products are known to cause breathing difficulty and respiratory damage.

Eyes: Not known. Decomposition products are irritating.

Skin: Not known

Skin Absorption. Not known

Ingestion: Not known.

V. EMERGENCY AND FIRST AID PROCEDURES

A. Inhalation (of decomposition products): Contact physician. Give oxygen or artificial respiration if needed.
B. Eyes: Contact physician.
C. Skin: Wash with soap and water. Contact physician.
D. Skin Absorption: Not applicable.
E. Ingestion: Contact physician.

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: Not applicable.

B. Explosion Limits: Not applicable.

C. Extinguishing Media: Do not attempt to extinguish.

D. Special Fire Fighting Procedures: This igniter contains DOT Class A explosives, oxidizers, and fuel. Fire fighting should be limited to evacuating an area proportional to the amount of propellant which may burn and preventing the spread of fire beyond the isolated area.

E. Explosion Hazards: Static discharge, impact, friction and pinch points between hard surfaces may initiate a conflagration or detonation. Overpressures associated with rapidly burning propellant can be explosive-like, creating fireballs and shock waves.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Temperatures above 250°F, shock, impact, friction, and static charge buildup.

B. Incompatibility (Materials to Avoid): Water soaked propellant may evolve explosive hydrogen gas.

C. Hazardous Decomposition Products: CO, CO_2, HCl, NO_x, unidentified organics.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

Ventilation: None required.

Respiratory Protection: For a fired motor, provide sufficient mechanical (general and/or local exhaust) ventilation to maintain asbestos exposure below TLV. If potential exists for exceeding the TLV of asbestos, a NIOSH/MSHA approved air purifying respirator is advised.

Protective Gloves: Impervious gloves are recommended.

Eye Protection: Safety glasses with side shields.

Other Protective Equipment: Clothing combinations which may create static discharges must be avoided. Flame resistant clothing is advised. If propellant is removed it should be contained in conductive containers.

IX. HANDLING AND STORAGE PRECAUTIONS

Buildings and transporting equipment must be protected from lightning and other forms of static discharge. Protect igniter from ignition sources, static charge buildup, mechanical shock or friction and temperatures above 250°F. Igniter should only be fired when the environmental history is known and aging and temperature limits set by design and aging studies have not been exceeded.

Other Precautions: Explosives contained in this igniter are federally controlled. Igniter should be controlled and handled only by personnel properly trained and authorized to handle explosive materials. This igniter must be stored according to the specifications referenced in the contract through which it was manufactured.

Note: This document pertains to the C-4 igniter as shipped from Morton Thiokol Wasatch Operations.

X. ENVIRONMENTAL PROTECTION

A. Precautions if Container is Damaged or Spilled: Igniter must be protected from sources of ignition (See Section VI). Contact appropriate authorities.

B. Waste Disposal Method: This igniter contains explosives. Fired motor residues may include asbestos-containing dust and char. Dispose of in accordance with federal, state, and local regulations.

For industrial use only. To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

MK 12 TERRIER

MATERIAL SAFETY DATA SHEET (MSDS)

Serial No. 3280
(Assigned by Code 04)

Identity (As Used on Label)	Trade Name(s)/Synonyms
Cast Double Base Propellant	MARK 12 TERRIER
Section I	
Manufacturer Naval Ordnance Station Indian Head, MD 20640-5000	Emergency Telephone Number (301)-743-4438 Telephone Number for information (301)-743-4484
Date Prepared 7/22/91	

Section II – Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED	% (optional)
Casting Powder				60 - 70
Casting Solvent				30 - 40

Section III – Physical/Chemical Characteristics

Impact Sensitivity (cm)		Specific Gravity (H2O)=1	
Friction Sensitivity (psig)		Heat of Explosion	
ESD Sensitivity (joules)		Evaporation Rate (Butyl Acetate=1)	

Solubility in Water: Non-Soluble

Appearance and Odor: Red or Black Grain, Sweet Odor

Section IV – Fire and Explosion Hazard Data

Flash Point (Method Used)		Autoignition Temperature	

Extinguishing Media: Water

Special Fire Fighting Procedures: Use extreme caution in fire-fighting situations. Self-contained breathing apparatus must be used.

Unusual Fire and Explosion Hazards: This material is a Class 1, Division 3 Explosive. This material gives off toxic fumes when burning.

NDW-NAVORDSTA 5100/11 (10/89) *Note: Blank Spaces are not permitted. If any item is nto applicable, or no information is available, the space must be marked to indicate that.*

ak Rocket Motor, 1.3C, UN0186, PGII EX 8803651 NALC V298 NSN: 9937-LL-990-0145
NASA Modified Rocket Motor Mk12

NAVORDSTA
MATERIAL SAFETY DATA SHEET

CHEMICAL NAME N/A
SYNONYMS: N/A
FORMULA: N/A
TRADE NAME AND SYNONYMS: ABI ABI 1362 ABI 1481 CASTING POWDERS
DATE OF PREPARATION/CHANGE: 12/22/87

REGULAR TELEPHONE NO. (301) 743-4484
EMERGENCY TELEPHONE NO. (301) 743-4430
CHEMICAL FAMILY Double Base Propellant
MOLECULAR WEIGHT N/A

I. PHYSICAL DATA

	References		References
BOILING POINT: @ 760 mm Hg. N/A		FREEZING POINT: N/A	
SPECIFIC GRAVITY (H2O = 1) 1.6-1.69 typical		VAPOR PRESSURE @ °C Negligible	
VAPOR DENSITY (AIR = 1) N/A		SOLUBILITY IN WATER, % BY WT @ °C Negligible	
PERCENT VOLATILES BY VOLUME Negligible		EVAPORATION RATE (BUTYL ACETATE = 1) N/A	
APPEARANCE AND ODOR Small Granular Solids			

II. HAZARDOUS INGREDIENTS

Material	%	PEL or TLV (UNITS)	References
* Nitrocellulose	65.36 - 84.40	- Not established	
* Nitroglycerine	10.80 - 19.00	- 0.2 ppm	
* 2-Nitrodiphenylamine	0.80 - 2.20	- Not established	
* Lead Salicylate	2.00 - 3.30	- 50 ug/m3	
* Lead Beta Resorcylate	0.00 - 3.30	- 50 ug/m3	
Lead 2-Ethyl Hexoate	0.00 - 2.60	- 50 ug/m3	
Aluminum Powder	0.00 - 9.46	- 10 mg/m3	
* Carbon Black	0.00 - 0.37	- 3.5 mg/m3	
Graphite (Glaze)	0.04	- 3.5 mg/m3	

III. FIRE AND EXPLOSION HAZARD DATA

References

FLASH POINT (TEST METHOD) N/A
AUTOIGNITION TEMPERATURE 145°C
FLAMMABLE LIMITS IN AIR, % BY VOLUME LOWER N/A UPPER N/A

EXTINGUISHING MEDIA: Self oxidizing, Deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in a very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

NAVORDSTA 8000/2 (6/86) TEST

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

Prepared by: S. Cottrell
Date Prepared: 2/4/88

Approved by: P. Buckley
Date:

IV. HEALTH HAZARD DATA

		References
THRESHOLD LIMIT VALUE or PERMISSIBLE EXPOSURE LIMIT	Not established	See Section II
EFFECTS OF OVEREXPOSURE		
EMERGENCY AND FIRST AID PROCEDURES	EYES: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. If flushing water does not relieve irritation, seek medical attention. SKIN: Wash with soap and running water. INHALATION: Remove to fresh air. If symptoms listed above develop, seek medical attention	

V. REACTIVITY DATA

STABILITY				References
UNSTABLE	STABLE	CONDITIONS TO AVOID	Avoid open flame, sparks and heat.	Sax
	X			
INCOMPATIBILITY (MATERIALS TO AVOID)	Acid and bases (Organic and inorganic)			N/A
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of Nitrogen and Carbon			SAX
HAZARDOUS POLYMERIZATION				
MAY OCCUR	WILL NOT OCCUR	CONDITIONS TO AVOID	NONE	N/A
	X			

VI. SPILL OR LEAK PROCEDURES

		References
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction, impact and electrostatic discharge.	
WASTE DISPOSAL METHOD	Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.	

VII. SPECIAL PROTECTION INFORMATION

			References
RESPIRATORY PROTECTION (SPECIFY TYPE)	Selection of type respirator shall be lead exposure specified in accordance W/OPNAVINST 5100.23B, Cha.21, Par. 21004 (d)(2)		
VENTILATION	LOCAL EXHAUST: MECHANICAL (GENERAL)	SPECIAL: OTHER: Adequate Ventilation	
PROTECTIVE GLOVES	Cotton or leather	EYE PROTECTION: Safety glasses	
OTHER PROTECTIVE EQUIPMENT	Flame retardant coveralls and conductive shoes		

VIII. SPECIAL PRECAUTIONS

		References
PRECAUTIONARY LABELING	Nitrocellulose (flammable solid) Nitroglycerine (skin) Lead Salicylate, Lead Beta Resorcylate, Lead 2-Ethyl Hexoate Aluminum powder	
OTHER HANDLING AND STORAGE CONDITIONS	Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21°C (70°F) at 50% Humidity.	

IX. LABEL

DATE:
PAGE: 3 of 3

TRADE NAME:
Chemical Name or Common Name

DOUBLE BASE PROPELLANT

ABL 705, ABL 917, ABL 1362, ABL 1491, ABL 2434

DANGER!

EXTREMELY FLAMMABLE. SEVERE
FIRE AND EXPLOSIVE HAZARD.

KEEP AWAY FROM HEAT, SPARKS AND FLAME. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. AVOID BREATHING DUST AND VAPORS. DO NOT STORE IN DIRECT SUNLIGHT.

WHEN HANDLING WEAR SAFETY GLASSES, GLOVES AND PROTECTIVE CLOTHING. USE WITH ADEQUATE VENTILATION AND EMPLOY RESPIRATORY PROTECTION WHEN EXPOSED TO DUST AND VAPORS. WASH THOROUGHLY AFTER HANDLING.

EFFECTS OF OVEREXPOSURE:
CONTACT CAN CAUSE IRRITATION TO THE EYES AND SKIN. INHALATION OF DUST OR VAPORS CAN CAUSE IRRITATION TO MUCOUS MEMBRANES, DRYNESS OF MOUTH AND THROAT, HEADACHE, NAUSEA AND DIZZINESS.

FIRST AID PROCEDURES:

EYES:
IMMEDIATELY FLUSH WITH WATER. IF FLUSHING WITH WATER DOES NOT RELIEVE IRRITATION SEEK MEDICAL ATTENTION.

SKIN:
WASH WITH SOAP AND WARM WATER. REMOVE CONTAMINATED CLOTHING. IF IRRITATION DEVELOPS SEEK MEDICAL ATTENTION.

INHALATION:
REMOVE PERSON FROM CONTAMINATED AIR. IF SYMPTOMS LISTED ABOVE DEVELOP SEEK MEDICAL ATTENTION.

INGESTION:
SEEK MEDICAL ATTENTION.

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

MARK 70 TERRIER ROCKET MOTOR

MATERIAL SAFETY DATA SHEET NO: 3074***

THIOKOL CORPORATION
Tactical Operations
Huntsville Division
Huntsville, AL 35815-1506
Telephone: ~~205~~ 256/882-8000
Date Revised: July 27, 1989

5201

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms: MK 70 Propellant
B. Propellant Formulation: TPH 8238

II. PHYSICAL DATA

A. Appearance: Rubbery/solid/grey propellant.

III. HAZARDOUS INGREDIENTS

MATERIAL (Note 1)	CAS # (Note 2)	RTECS (Note 3)	PEL (Note 4)	TLV (Note 5)
Aluminum Powder	7429905	BD0330000	None	5 mg/m3
Ammonium Perchlorate	779089	SC7520000	None	None
Isophorone Diisocynate	4098719	NQ9370000	.005ppm (skin)	.005ppm (skin)
Dioctyl Adipate (Note 6)	103231	AU9700000	None	None
Hydroxyl Terminated Polybutadiene	6910295	None	None	None

NOTES:
1. The physical form of solid propellant limits exposure to the individual ingredients
2. Chemical Abstract Service Number
3. Registry of Toxic Effects of Chemical Substances
4. Permissible Exposure Limit - published by OSHA
5. Threshold Limit Value - published by ACGIH.
6. Suspected Animal Carcinogen - IARC

IV. HEALTH HAZARD DATA

A. Threshold Limit Value: See Section III.
B. Effects of Overexposure:
   1. Inhalation: Decomposition products could cause breathing difficulty and respiratory damage.
   2. Eyes: Decomposition products are extremely irritating.
   3. Skin: No known hazard.
   4. Skin Absorption: No known hazard.

C. Primary Route of Entry: Inhalation

V. EMERGENCY AND FIRST AID PROCEDURES

A. Inhalation: If decomposition products are inhaled, remove victim to fresh air. Obtain immediate medical attention.
B. Eyes: If irritated, flush with large quantities of water for at least 15 minutes, obtain immediate medical attention.
C. Skin: If burned, obtain immediate medical attention.
D. Ingestion: Obtain immediate medical attention.

VI. FIRE AND EXPLOSION HAZARD

A. Flash Point: Not Applicable
B. Explosive Limits: Not Applicable
C. Extinguishing Media: DO NOT ATTEMPT TO FIGHT FIRE INVOLVING AFTER PROPELLANT HAS BURNED OUT, water, CO2, or foam may be used to restrict the spread of fire.
D. Special Fire Fighting Procedures: DO NOT ATTEMPT TO FIGHT FIRE INVOLVING PROPELLANT. Propellant contains both oxidizer and fuel and cannot readily be extinguished. Fire fighting should be limited to preventing the spread of other fires.
D. Explosion Hazards: Static discharge, impact, friction, or pinch points between hard surfaces can initiate propellant fires and should be avoided.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Temperatures above 200 degrees F. Avoid shock, impact, friction, and static charge buildup.
B. Incompatibility (Materials to Avoid): Strong acids, alkalies.
C. Hazardous Decomposition Products: CO_2, CO, HCl, Al_2O_3, H_2, N_2
D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

A. Protective Measures: For handling a loaded rocket motor, wear cotton or other static-free clothing.
B. Handling and Storage Precautions: Protect propellant from static charge buildup, mechanical shock, impact, friction or temperatures over 200 degrees F. (See Section VII)
C. Other Precautions: This propellant is a DOT Class B Explosive and a Military Class 1.3 explosion hazard.
Access to propellant should be limited to personnel trained in the handling of pyrotechnic and explosive devices.

IX. ENVIRONMENTAL PROTECTION

A. Precautions if Component is Damaged: Damaged motor propellant must be protected from sources of ignition. (See Section VI.) Damaged propellant may be more susceptible to ignition.
B. Proper DOT Classification: EXPLOSIVE B
C. Waste Disposal Method: Dispose of in accordance with federal, state and local regulations.

FOR INDUSTRIAL USE ONLY. To the best of our knowledge, the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESSED OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

Prepared by: Wayne Throneberry
Wayne Throneberry,
Engineer

Date: 7/28/89

Approved by: E. J. Krupka
E. J. Krupka
Manager, Safety

Date: 8/1/89

MK 23 MOD 3 JATO

JHCS LINKS	JHCS MAIN MENU	JHCS DATA ELEMENTS	ESMAM	SENSITIVITY GROUPS
	JHCS CUSTOM QUERY	COMPATIBILITY GROUPS	USATCES	LOG OUT

Record 1 of 1	JHCS Data Item Detail

NSN:	1340-01-231-3984	DODIC:	J145

Nomenclature:	JET THRUST UNIT MK 23 MOD 3 SHIPPING CONDITION
Proper Shipping Name:	ROCKET MOTORS
Technical Name:	
DOT Registration (EX #):	8708594
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PG II

Inhabited Building Distance:		Shipping Label 1:	EXPLOSIVE 1.3C
DOD Hazard Class/Division/Subdivision:	1.3	Shipping Label 2:	
Compatibility Group:	C	Shipping Label 3:	
UN Number:	0186	Part/Dwg1	1255AS200
DOD Component:	NAVY	Part/Dwg2	
TRI-Service Coordination:	YES	Part/Dwg3	

WEIGHT	POUNDS	KILOGRAMS	TYPE OF WEIGHT
High Explosive Weight (HEW)	0.330750	0.150026	Class 1.1 Material
Net Propellant Weight (NPW)	110.00000	49.895176	Class 1.3 Material
Net Explosive Weight (NEW)	110.33100	50.045200	Transportation Qty
Net Explosive QD Weight (NEWQD)	110.33100	50.045315	Storage Quantity

Record 1 of 1

New Query

PROPELLANT

MSDS Propellant, Space Data Corp, 386-10

SPACE DATA -- SDC 386-10 - ROCKET MOTOR FUEL
MATERIAL SAFETY DATA SHEET
NSN: 134000F016457
Manufacturer's CAGE: 27555
Part No. Indicator: A
Part Number/Trade Name: SDC 386-10

General Information

Item Name: ROCKET MOTOR FUEL
Company's Name: SPACE DATA CORPORATION
Company's Street: 3380 SOUTH PRICE ROAD
Company's City: CHANDLER
Company's State: AZ
Company's Zip Code: 85248
Company's Emerg Ph #: (602) 899-6000
Company's Info Ph #: (602) 899-6000
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Date MSDS Prepared: 29MAR90
Safety Data Review Date: 12JUN91
MSDS Preparer's Name: BOB FISHER
Preparer's Company: SPACE DATA CORPORATION
Preparer's St Or P. O. Box: 3380 SOUTH PRICE ROAD
Preparer's City: CHANDLER
Preparer's State: AZ
Preparer's Zip Code: 85248
MSDS Serial Number: BKGPH
Net Propellant Weight-Ammo: 590 LBS

Ingredients/Identity Information

Proprietary: NO
Ingredient: POLY BUTADIENACRYLIC ACID COPOLYMER
Ingredient Sequence Number: 01
Percent: 12.40%
NIOSH (RTECS) Number: 1006308PA

Proprietary: NO
Ingredient: EPOXY
Ingredient Sequence Number: 02
Percent: 0.20%
NIOSH (RTECS) Number: 1000515EP

Proprietary: NO
Ingredient: FERRIC OCTOATE, IRON (3+) OCTANOATE
Ingredient Sequence Number: 03
Percent: 0.10%
NIOSH (RTECS) Number: 1006309FO
CAS Number: 3130-28-7

Proprietary: NO
Ingredient: MAPO, REGULAR
Ingredient Sequence Number: 04
Percent: 0.35%
NIOSH (RTECS) Number: 1006310MR

Proprietary: NO
Ingredient: AMMONIUM PERCHLORATE
Ingredient Sequence Number: 05
Percent: 68%
NIOSH (RTECS) Number: SC7520000
CAS Number: 7790-98-9

Proprietary: NO
Ingredient: ZL-496 (POLYURETHANE LAQUER)
Ingredient Sequence Number: 06
Percent: 3.09%
NIOSH (RTECS) Number: 1006311PL

Proprietary: NO
Ingredient: ALUMINUM (SARA III)
Ingredient Sequence Number: 07
Percent: 16%
NIOSH (RTECS) Number: BD0330000
CAS Number: 7429-90-5
OSHA PEL: 15MG/M3 DUST/5 FUME
ACGIH TLV: 10MG/M3 DUST; 9192

Physical/Chemical Characteristics

Fire and Explosion Hazard Data

Extinguishing Media: WATER
Special Fire Fighting Proc: TREAT FIRE AS CLASS I, DIVISION 3 FIRE HAZARD. CLASS B ROCKET MOTORS, HANDLE AS CLASS 1.3, MASS FIRE HAZARD.
Unusual Fire And Expl Hazrds: AUTOIGNITION TEMP: 275F.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): SPARK & FLAME
Hazardous Decomp Products: H2O/HYDROGEN CHLORIDE/CO/CO2/MAGNESIUM OXIDE/ALUMINUM OXIDE/SULFUR DIOXIDE/HYDROGEN SULFIDE/NITROGEN OXIDE/SULFUR OXIDE
Hazardous Poly Occur: NO

Health Hazard Data

Route Of Entry - Inhalation: NO
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: NO
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: PROPELLANT IS NOT LIKELY TO BE RELEASED FROM MOTOR. KEEP SPARK & FLAME PRODUCING ITEMS AWAY FROM PROPELLANT.
Waste Disposal Method: DISPOSE OF IN ACCORDANCE W/LOCAL, STATE, & FEDERAL REGULATIONS.
Precautions-Handling/Storing: HANDLE & STORE AS CLASS I DIVISION 3 ITEM. MOTOR SHOULD BE ELECTRICALLY GROUNDED WHEN NOT IN ITS SHIPPING CONTAINER.
Other Precautions: PROPELLANT IS NOT LIKELY TO BE RELEASED FROM MOTOR. KEEP SPARK & FLAME PRODUCING ITEMS AWAY FROM PROPELLANT.

Control Measures

Transportation Data

Disposal Data

Label Data

Label Required: YES
Label Status: G
Common Name: SDC 386-10
Special Hazard Precautions: N/K N/K
Label Name: SPACE DATA CORPORATION
Label Street: 3380 SOUTH PRICE ROAD
Label City: CHANDLER
Label State: AZ
Label Zip Code: 85248
Label Emergency Number: (602) 899-6000

UNIVERSAL PROPULSION INC -- 11740301, ROCKET MOTOR MK 119 ASSEMBLY

==========

MSDS Safety Information

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FSC: 1377
NIIN: 00-244-1578
MSDS Date: 06/25/1992
MSDS Num: BPTXG
Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
MFN: 01
Responsible Party
Cage: 51998
Name: UNIVERSAL PROPULSION CO INC
Address: 25401 NORTH CENTRAL AVE
City: PHOENIX AZ 85027-7837
Info Phone Number: 602-869-8067
Emergency Phone Number: 602-869-8067;602-234-6663
Preparer's Name: N. WHITE
Published: Y

==========

Contractor Summary

==========

Cage: 51998
Name: UNIVERSAL PROPULSION CO
Address: 25401 N CENTRAL AVENUE
City: PHOENIX AZ 85027-7899
Phone: 602-516-3340

==========

Item Description Information

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Item Manager: NCB
Item Name: ROCKET MOTOR
Unit of Issue: EA
UI Container Qty: E

==========

Ingredients

==========

Name: COMPOSITE PROPELLANT-MIXTURE OF INGREDIENTS 2-10
% Wt: 2.53LBS

Name: CARBOXYL TERMINATED POLYBUTADIENE
% Wt: <10

Cas: 10099-74-8
RTECS #: OG2100000
Name: LEAD (II) NITRATE (1:2) (SARA III)
% Wt: 53.58
ACGIH TLV: 0.15 MG/M3 (PB)
EPA Rpt Qty: 100 LBS
DOT Rpt Qty: 100 LBS

Cas: 7778-74-7
RTECS #: SC9700000
Name: PERCHLORIC ACID, POTASSIUM SALT (1:1); (POTASSIUM PERCHLORATE)
% Wt: 15-20

Cas: 7429-90-5
RTECS #: BD0330000
Name: ALUMINUM (SARA III)
% Wt: 15-20
OSHA PEL: 15MG/M3 DUST;5 FUME
ACGIH TLV: 10MG/M3 DUST;5 FUME

Name: BORON POTASSIUM NITRATE; (IGNITION MATERIAL)
% Wt: 2 GM

Name: IGNITION PELLET
% Wt: 11

Name: PERCUSSION PRIMER ((1) PVU-1/A)
% Wt: 0.05 GM

Cas: 7439-92-1
RTECS #: OF7525000
Name: LEAD (SARA III). %: 36% BY WT OF EXPLOSIVES
% Wt: SEE ING
OSHA PEL: 0.05 MG/M3
ACGIH TLV: 0.15 MG/M3; DUST
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB

Cas: 7439-92-1
RTECS #: OF7525000
Name: LEAD; (LEAD COMPOUNDS). %: 57% BY WT OF EXPLOSIVES.
% Wt: SEE ING
OSHA PEL: 0.05 MG/M3
ACGIH TLV: 0.15 MG/M3, DUST
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB

Health Hazards Data

LD50 LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry Inds - Inhalation: YES
Skin: NO
Ingestion: NO
Carcinogenicity Inds - NTP: NO
IARC: YES
OSHA: NO
Effects of Exposure: NOTE: LEAD 7439-92-1 APPEARS ON THE NAVY LISTING OF OCCUPATIONAL REPRODUCTIVE HAZARDS. SEEK CONSULTATION FROM APPROPRIATE HEALTH PROFESSIONALS CONCERNING LATEST HAZARD LIST INFORMATION AND SAFE HANDLI NG AND EXPOSURE RECOMMENDATIONS (FP N).
Explanation Of Carcinogenicity: LEAD & LEAD COMPOUNDS: GROUP 2B (IARC).
Signs And Symptions Of Overexposure: SEE HEALTH HAZARDS.
Medical Cond Aggravated By Exposure: AVOID INHALATION OF PRODUCTS OF COMBUSTION.
First Aid: INGESTION: CALL MD IMMEDIATELY. INHALATION: REMOVE FROM EXPOSURE. SUPPORT BREATHING (GIVE ARTIFICIAL RESPIRATION/OXYGEN) (FP N). SKIN: FLUSH WITH COPIOUS AMOUNTS OF WATER (FP N). EYES: FLUSH WITH WATE R FOR AT LEAST 15 MINUTES (FP N).

Handling and Disposal

Spill Release Procedures: AN UNDAMAGED UNIT MAY BE PICKED UP AND RETURNED TO ORIGINAL CONTAINER.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Methods: IF UNIT IS DAMAGED OR NEEDS TO BE DISPOSED OF FOR ANY REASON,IT SHOULD BE DISPOSED OF BY PERSONNEL QUALIFIED TO DISP OF EXPLO AT AN APPRVD DISP SITE UNDER APPRVD CNDTNS. DISPOSE OF IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS (FP N).
Handling And Storage Precautions: HANDLE & STORE AS CLASS 1.3 COMPATIBILITY GROUP C EXPLOSIVE I/A/W DOD 4145.26M, FEDERAL, STATE & LOCAL LAWS. DO NOT EXPOSE TO HEAT OR OPEN FLAME.
Other Precautions: DO NOT EXPOSE TO ELECTRICAL DISCHARGE OF ANY SORT. DO NOT DROP OR ROUGH HANDLE.

Fire and Explosion Hazard Information

Extinguishing Media: USE MEDIA SUITABLE FOR SURROUNDING FIRE CONDITIONS (FP N). NONE ARE EFFECTIVE FOR LARGE FIRES.
Fire Fighting Procedures: WEAR NIOSH/MSHA APPROVED SCBA & FULL PROT EQUIP (FP N). DO NOT FIGHT FIRE. EVACUATE AREA UNTIL ROCKET MOTOR(S) BURN(S) OUT. ROCKET MOTOR(S) WILL BE PROPULSIVE.
Unusual Fire/Explosion Hazard: CLASSED AS DOT ROCKET MOTOR CLASS B EXPLOSIVE. NEW=2.56 LBS.

Control Measures

Respiratory Protection: NONE. WEAR NIOSH/MSHA APPROVED RESPIRATOR APPRORIATE FOR EXPOSURE OF CONCERN (FP N).
Ventilation: GENERAL VENTILATION SUFFICIENT TO KEEP AIRBORNE CONCENTRATIONS BELOW EXPOSURE LIMITS (FP N).
Protective Gloves: IMPERVIOUS GLOVES (FP N).
Eye Protection: CHEMICAL WORKERS GOGGLES (FP N).
Other Protective Equipment: FLAME RESISTANT CLOTHING RECOMMENDED.
Work Hygienic Practices: NORMAL PRACTICES.
Supplemental Safety and Health: SPECIFIC GRAVITY: (H*2O=1) (PROPELLANT).

Physical/Chemical Properties

Spec Gravity: 2.77(SUPP DATA)
Appearance and Odor: METAL PART.. NO ODOR.

Reactivity Data

Stability Indicator: YES
Hazardous Decomposition Products: LEAD OXIDES.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: NOT RELEVANT.

Toxicological Information

Ecological Information

MSDS Transport Information

Regulatory Information

Other Information

Transportation Information

Responsible Party Cage: 51998
Trans ID NO: 60269
Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
MSDS Prepared Date: 06/25/1992
Review Date: 01/27/1993
MFN: 1
Multiple KIT Number: 0
Review IND: Y
Unit Of Issue: EA
Container QTY: E

Detail DOT Information

DOT PSN SC
DOT Proper Shipping Name: ROCKET MOTORS
Hazard Class: 1.3C
UN ID Num: UN0186
DOT Packaging Group: II
Label: EXPLOSIVE 1.3C
Special Provision: 109
Packaging Exception: NONE
Non Bulk Pack: 62
Bulk Pack: NONE
Max Qty Pass: FORBIDDEN
Max Qty Cargo: 220 KG
Vessel Stow Req: B

Detail IMO Information

IMO PSN Code: NDJ
IMO Proper Shipping Name: ROCKET MOTORS
IMDG Page Number: 1295
UN Number: 0186
UN Hazard Class: 1.3 C
IMO Packaging Group: -
Subsidiary Risk Label: -
EMS Number: 1-03
MED First Aid Guide NUM: *

Detail IATA Information

IATA PSN Code: VUX
IATA UN ID Num: 0186
IATA Proper Shipping Name: ROCKET MOTORS +
IATA UN Class: 1.3C
IATA Label: EXPLOSIVE
Packing Note Passenger: FORB
Max Quant Pass: FORB
Max Quant Cargo: 220 KG
Packaging Note Cargo: 130

Detail AFI Information

AFI PSN Code: VUX
AFI Proper Shipping Name: ROCKET MOTORS
AFI Hazard Class: 1.3C
AFI UN ID NUM: UN0186
AFI Packing Group: II
Special Provisions: P4, 109
Back Pack Reference: A5.73

HAZCOM Label

Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
Cage: 51998
Company Name: UNIVERSAL PROPULSION CO
Street: 25401 N CENTRAL AVENUE
City: PHOENIX AZ
Zipcode: 85027-7899
Health Emergency Phone: 602-869-8067;602-234-6663
Label Required IND: Y
Date Of Label Review: 08/24/1992
Status Code: C
abel Date: 08/24/1992

Origination Code: G
Chronic Hazard IND: Y
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: CAUTION
Respiratory Protection IND: YES
Health Hazard: None
Contact Hazard: None
Fire Hazard: Slight
Reactivity Hazard: Slight
Hazard And Precautions: HANDLE & STORE AS CLASS 1.3 COMPATABILITY GROUP C. EXPLOSIVE IN ACCORDANCE WITH DOD 4145.26M. DO NOT EXPOSE TO ELECTRICAL DISCHARGE OF ANY SORT. DO NOT DROP OF ROUGH HANDLE. ACUTE: NONE UNDER NORMAL H ANDLING. CHRONIC: NONE. CONTAINS LEAD WHICH IS A SUSPECT HUMAN CARCINOGEN.

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NIHEA IGNITOR

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List)	USE
1. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04862-3	1. Black Brant VC Rocket Motor High Altitude Igniter
2. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04850-1	2. Black Brant Igniter Kit 600-04005-1, Black Brant High Altitude Igniter
3. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-00339-1	3. Black Brant Igniter Assy 600-00335-1, Black Brant High Altitude Igniter

Section I

Manufacturer's Name	Emergency Telephone Number
Bristol Aerospace Limited	204-344-3201
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-3211
	Date Prepared August 20, 2001
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
1) Boron Potassium Nitrate Pellets (BPN) 380 gms total weight 1.3L explosive UN 0359			Manufacturer suggests TLV of 10 mg/m^3.	
2) Asbestos Insulator		2f/cc asbestos	Insulator encapsulated in ablative sealant material	

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A

Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A
Solubility in Water Assembly is watertight. If seal broken BPN is water soluble.		Appearance and Odour Fully assembled and sealed - no odour.	

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used) Igniter has auto ignition temperature of 221°C (430°F)	Flammable Limits N/A	LEL N/A	UEL N/A

Extinguishing Media
None self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires involving this material. If quantities are small and safety is not compromised an attempt to limit fire spread can be made.

Unusual Fire and Explosion Hazards
If initiated, material will burn rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability	Unstable		Conditions to Avoid Fire, flame and other ignition sources.
	Stable	X	

Incompatibility (Materials to Avoid)
BPN pellets are incompatible with strong oxidizers, or active fuels.

Hazardous Decomposition or Byproducts
Boric Oxide, Potassium Oxide, Nitrogen in the form of hot particles and gases.

Hazardous Polymerization	May Occur		Conditions to Avoid N/A
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry: N/A	Inhalation? N/A	Skin? N/A	Ingestion? N/A

Health Hazards (Acute and Chronic)
Sealed unit does not pose a health hazard. If opened dust from BPN pellets may irritate eyes, respiratory system.

Carcinogenicity: No	NTP? No	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure BPN Dust - irritation of eyes, nose, coughing, sneezing, nausea.	Medical Conditions Generally Aggravated by Exposure None known.

Emergency and First Aid Procedures
1) For irritation - remove to fresh air. Flush affected area with soap and water.

2) For burns - treat for burn, shock, lacerations and possible inhalation of combustion products.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
Eliminate all ignition sources, carefully clean-up spilled material. Place in conductive container.	Burn under approved controlled conditions.
Precautions to be Taken in Handling and Storing	**Other Precautions**
Store in approved magazine for 1.3 explosive in shipping container at ambient temperature and humidity.	N/R

Section VIII - Control Measures

Respiratory Protection (Specify Type)
In the event of a spill use NIOSH approved dust type respirator for dust exposure.

Ventilation	Local Exhaust	Special
N/R - sealed unit		N/R
	Mechanical (General)	Other N/R
Protection Gloves		**Eye Protection**
N/R		Safety glasses.
Other Protective Clothing or Equipment	**Work/Hygiene Practices**	
Flame resistant clothing	If dust present (spill) wash clothing, hands, face.	

JHCS Database

DODIC:	V160
NSN:	1337-00-032-2462
Nomenclature:	ROCKET MOTOR, M5 M1M-14A
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8806858
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PGII

Inhabited Building Distance:		**Label (First Label):**	3
DOD Hazard Class/Division/Subdivision:	1.3	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0186	**Part/Dwg Number 1:**	8025075
DOD Component/ TRI-Service Coordination:	IY	**Part/Dwg Number 2:**	
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	755.00000	342.46234
Net Explosive Weight: (Transportation Qty)	755.00000	342.46234
Net Explosive QD Weight: (Storage Quantity)	755.00000	342.46234
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

Thiokol Corporation
Elkton Division
P.O. Box 241
Elkton, Maryland 21922-0241
Emergency Phone (410) 392-1000

MSDS 157B
TE-P-372-7

MATERIAL SAFETY DATA SHEET

MSDS NO. 157 Rev. B
Date Issued: 09/12/89
Date Revised: 07/23/93

Revised By: L. K. Hartwell
L. K. Hartwell

Approved By:
K. W. Phillips

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms: Orion Igniter (TE-P-372-7)

B. DOT Shipping Description and Classification: Igniter, rocket motor, Class B explosive, EX #8908180, UN0315, 1.3G.

II. PHYSICAL DATA

A. Appearance and Odor: Pyrotechnic material housed in a silica phenolic case with an aluminum closure. No odor.

B. Volatiles: None.

III. COMPOSITION

Hazardous Ingredients	Percent	OSHA PEL	ACGIH TLV
A. Propellant TP-E-8035 (0.4 lb)			
1. Thiokol Polysulfide Polymer (LP-33 base)	23.0	NE	NE
2. Magnesium Oxide	1.0	15mg/m^3(fume)	10mg/m^3(fume)
3. Iron Oxide	2.0	10mg/m^3(fume)	5mg/m^3(fume)
4. Ammonium Perchlorate	74.0	15mg/m^3(total) 5mg/m^3(resp.)	10mg/m^3(total) 5mg/m^3(resp.)
B. Boron Potassium Nitrate (3 gms) B,KNO_3, 2A Pellets	100.0	NE	NE

A. Threshold Limit Value: See Section III. [illegible] only pertain to materials when in raw form. Materials are contained within the propellant by a binder system.

B. Effects of Overexposure:
   1. Respiratory: If igniter is activated, decomposition products can cause difficulty in breathing and respiratory damage.
   2. Eyes: No known hazard unless activated. Decomposition products are irritating to the eyes.
   3. Skin: Fired igniter residue may contain hydrochloric acid and other corrosive compounds which can cause skin irritation.
   4. Skin Absorption: No known hazard.
   5. Ingestion: No known hazard.
   6. Other: N/A

V. EMERGENCY AND FIRST-AID PROCEDURES

A. Inhalation: If decomposition products are inhaled, remove victim to fresh air. Call a physician and/or emergency facility immediately.

B. Eyes: If irritated, flush with water and contact physician.

C. Skin: Thermal burns or reaction from exposure to decomposition products, flush with water for 15 minutes and call a physician.

D. Other: N/A

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: N/A

B. Explosive Limits: DOT Class B explosive.

C. Extinguishing Media: Do not attempt to extinguish an initiated igniter. Static discharge, impact, and friction can cause igniter to ignite internally and emit toxic fumes, shrapnel, and fire. CO_2, H_2O, or foam may be used to restrict fire from spreading after igniter has burned.

VI. FIRE AND EXPLOSION HAZARD DATA (continued)

D. Special Fire Fighting Procedures: Igniter contains pyrotechnic materials. Do not fight fires involving these materials. Evacuate area immediately if ignition occurs. Fire fighting should be limited to preventing the spread of other fires.

E. Explosion Hazards: Static discharge, impact, and friction can initiate igniter and should be avoided. Igniter and operators should be grounded when handling this device.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Ignition materials become unstable when exposed to temperatures above 200°F.

B. Avoid shock, impact, and static charge buildup.

C. Hazardous Decomposition Products: CO, CO_2, COS, $FeCl_2$, H_2, H_2S, MgO, SO_2, S_2, and N_2 are theoretical exhaust products.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

A. Protective Measures:
   1. Ventilation: Initiated igniter will emit toxic fumes while burning. Firing area should be well ventilated before operators are exposed.
   2. Respiratory Protection: If personnel are exposed to exhaust gases use a NIOSH/OSHA approved respirator with organic vapor/acid gas cartridges or positive pressure airline.
   3. Protective Clothing: Acid-resistant gloves should be worn when handling decomposition products. Flame-resistant lab coats or coveralls, safety glasses, and safety shoes are recommended when handling explosives.

B. Handling and Storage Precautions: Protect igniter from ignition sources and elevated temperatures (above 200°F).

C. Other Precautions: Live igniters are DOT Class B Explosive. Access to this igniter should be limited to authorized personnel trained in the handling of pyrotechnic devices.

IX. ENVIRONMENTAL PROTECTION

A. Precautions if Component is Damaged: Damaged igniter must be protected from sources of ignition. If ignition occurs, toxic fumes, shrapnel, and fire may be emitted. Contact appropriate authorities.

B. Waste Disposal Method: Dispose of in accordance with federal, state and local regulations.

C. Fired igniter cases should be inspected and determined propellant-free before disposal.

WARNING: Manufactured with 1,1,1-trichloroethane, a substance which harms public health and environment by destroying ozone in the upper atmosphere.

"To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely.

NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESSED OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS."

JHCS Database

DODIC:	V187
NSN:	1337-00-889-2074
Nomenclature:	ROCKET MOTOR, M100 MGM 29
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8806880
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PGII

Inhabited Building Distance:		**Label (First Label):**	3
DOD Hazard Class/Division/Subdivision:	1.3	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0186	**Part/Dwg Number 1:**	1039072
DOD Component/ TRI-Service Coordination:	TY	**Part/Dwg Number 2:**	10102215
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	5900.0000	2676.1958
Net Explosive Weight: (Transportation Qty)	5900.0000	2676.1958
Net Explosive QD Weight: (Storage Quantity)	5900.0000	2676.1958
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

JHCS Database

DODIC:	J203
NSN:	1340-00-981-1250
Nomenclature:	ROCKET MOTOR, M37A1 FOR 762MM ROCKET
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8811664
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.1C UN 0280 PGII

Inhabited Building Distance:		**Label (First Label):**	1
DOD Hazard Class/Division/Subdivision:	1.1	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0280	**Part/Dwg Number 1:**	
DOD Component/ TRI-Service Coordination:	AN	**Part/Dwg Number 2:**	
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	1.930000	0.875434
Net Explosive Weight: (Transportation Qty)	1.930000	0.875434
Net Explosive QD Weight: (Storage Quantity)	1.930000	0.875434
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

MATERIAL SAFETY DATA SHEET (MSDS)

Serial No. 3280
(Assigned by Code 04)

Identity (As Used on Label)	Trade Name(s)/Synonyms
Cast Double Base Propellant	MARK 11 TALOS
Section I	
Manufacturer Naval Ordnance Station Indian Head, MD 20640-5000	Emergency Telephone Number (301)-743-4438 Telephone Number for information (301)-743-4484
Date Prepared 7/22/91	

Section II – Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED	% (optional)
Casting Powder				60 – 70
Casting Solvent				30 – 40

Section III – Physical/Chemical Characteristics

Impact Sensitivity (mm)		Specific Gravity (H2O)=1	
Friction Sensitivity (psig)		Heat of Explosion	
ESD Sensitivity (joules)		Evaporation Rate (Butyl Acetate=1)	

Solubility in Water: Non-Soluble

Appearance and Odor: Red or Black Grain, Sweet Odor

Section IV – Fire and Explosion Hazard Data

Flash Point (Method Used)		Autoignition Temperature	

Extinguishing Media: Water

Special Fire Fighting Procedures: Use extreme caution in fire-fighting situations. Self-contained breathing apparatus must be used.

Unusual Fire and Explosion Hazards: This material is a Class 1, Division 3 Explosive. This material gives off toxic fumes when burning.

NDW-NAVORDSTA 5100/11 (10/89)

Note: Blank Spaces are not permitted. If any item is nto applicable, or no information is available, the space must be marked to indicate that.

NAVORDSTA
MATERIAL SAFETY DATA SHEET

CHEMICAL NAME N/A
REGULAR TELEPHONE NO. (301) 743-4484
EMERGENCY TELEPHONE NO. (301) 743-4438
SYNONYMS: N/A
CHEMICAL FAMILY Double Base Propellant
FORMULA: N/A
MOLECULAR WEIGHT N/A
TRADE NAME AND SYNONYMS: ABL [redacted] ABL 1362, ABL 1481 CASTING POWDERS
DATE OF PREPARATION/CHANGE: 12/22/87

I. PHYSICAL DATA

	References		References
BOILING POINT: @ 760 mm Hg. N/A		FREEZING POINT: N/A	
SPECIFIC GRAVITY (H2O = 1) 1.6-1.69 typical		VAPOR PRESSURE @ °C Negligible	
VAPOR DENSITY (AIR = 1) N/A		SOLUBILITY IN WATER, % BY WT @ °C Negligible	
PERCENT VOLATILES BY VOLUME Negligible		EVAPORATION RATE (BUTYL ACETATE = 1) N/A	
APPEARANCE AND ODOR Small Granular Solids			

II. HAZARDOUS INGREDIENTS

Material	%	PEL or TLV (UNITS)	References
* Nitrocellulose	65.36 - 84.40	- Not established	
* Nitroglycerine	10.80 - 19.00	- 0.2 ppm	
* 2-Nitrodiphenylamine	0.80 - 2.20	- Not established	
* Lead Salicylate	2.00 - 3.30	- 50 ug/m^3	
* Lead Beta Resorcylate	0.00 - 3.30	- 50 ug/m^3	
Lead 2-Ethyl Hexoate	0.00 - 2.60	- 50 ug/m^3	
Aluminum Powder	0.00 - 9.46	- 10 mg/m^3	
* Carbon Black	0.00 - 0.37	- 3.5 mg/m^3	
Graphite (Glaze)	0.04	- 3.5 mg/m^3	

III. FIRE AND EXPLOSION HAZARD DATA

		References
FLASH POINT (TEST METHOD) N/A	AUTOIGNITION TEMPERATURE 145°C	
FLAMMABLE LIMITS IN AIR, % BY VOLUME	LOWER N/A UPPER N/A	

EXTINGUISHING MEDIA: Self oxidizing, Deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in a very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

NAVORDSTA 8000/2 (6/86) TEST

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

Prepared by: [signature]
Date Prepared: [illegible]

Approved by: [signature]
Date: [illegible]

IV. HEALTH HAZARD DATA

References

THRESHOLD LIMIT VALUE or PERMISSIBLE EXPOSURE LIMIT Not established See Section II

EFFECTS OF OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES: EYES: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. If flushing water does not relieve irritation, seek medical attention. SKIN: Wash with soap and running water. INHALATION: Remove to fresh air. If symptoms listed above develop, seek medical attention

V. REACTIVITY DATA

References

STABILITY				
UNSTABLE	STABLE			
	X	CONDITIONS TO AVOID	Avoid open flame, sparks and heat.	Sax
INCOMPATIBILITY (MATERIALS TO AVOID)	Acid and bases (Organic and inorganic)			N/A
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of Nitrogen and Carbon			SAX
HAZARDOUS POLYMERIZATION				
MAY OCCUR	WILL NOT OCCUR	CONDITIONS TO AVOID	NONE	N/A

VI. SPILL OR LEAK PROCEDURES

References

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction, impact and electrostatic discharge.

WASTE DISPOSAL METHOD: Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.

VII. SPECIAL PROTECTION INFORMATION

References

RESPIRATORY PROTECTION (SPECIFY TYPE): Selection of type respirator shall be lead exposure specified in accordance w/OPNAVINST 5100.23B, Cha.21, Par. 21004 (d)(2)

VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL (GENERAL)	OTHER: Adequate Ventilation

PROTECTIVE GLOVES	Cotton or leather	EYE PROTECTION	Safety glasses

OTHER PROTECTIVE EQUIPMENT: Flame retardant coveralls and conductive shoes

VIII. SPECIAL PRECAUTIONS

References

PRECAUTIONARY LABELING: Nitrocellulose (flammable solid) Nitroglycerine (skin) Lead Salicylate, Lead Beta Resorcylate, Lead 2-Ethyl Hexoate Aluminum powder.

OTHER HANDLING AND STORAGE CONDITIONS: Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21°C (70°F) at 50% Humidity.

NAVORDSTA
MATERIAL SAFETY DATA SHEET

IX. LABEL

DATE:
PAGE: 3 of 3

TRADE NAME:
Chemical Name or Common Name

DOUBLE BASE PROPELLANT

ABL 705, ABL 917, ABL 1362, ABL 1491, ABL 2434

DANGER!

EXTREMELY FLAMMABLE. SEVERE
FIRE AND EXPLOSIVE HAZARD.

KEEP AWAY FROM HEAT, SPARKS AND FLAME. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. AVOID BREATHING DUST AND VAPORS. DO NOT STORE IN DIRECT SUNLIGHT.

WHEN HANDLING WEAR SAFETY GLASSES, GLOVES AND PROTECTIVE CLOTHING. USE WITH ADEQUATE VENTILATION AND EMPLOY RESPIRATORY PROTECTION WHEN EXPOSED TO DUST AND VAPORS. WASH THOROUGHLY AFTER HANDLING.

EFFECTS OF OVEREXPOSURE:
CONTACT CAN CAUSE IRRITATION TO THE EYES AND SKIN. INHALATION OF DUST OR VAPORS CAN CAUSE IRRITATION TO MUCOUS MEMBRANES, DRYNESS OF MOUTH AND THROAT, HEADACHE, NAUSEA AND DIZZINESS.

FIRST AID PROCEDURES:

EYES:
IMMEDIATELY FLUSH WITH WATER. IF FLUSHING WITH WATER DOES NOT RELIEVE IRRITATION SEEK MEDICAL ATTENTION.

SKIN:
WASH WITH SOAP AND WARM WATER. REMOVE CONTAMINATED CLOTHING. IF IRRITATION DEVELOPS SEEK MEDICAL ATTENTION.

INHALATION:
REMOVE PERSON FROM CONTAMINATED AIR. IF SYMPTOMS LISTED ABOVE DEVELOP SEEK MEDICAL ATTENTION.

INGESTION:
SEEK MEDICAL ATTENTION.

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

Taurus Rocket Motor

JUL-25-1995 09:35 FROM TO 9164824341 P.02

Taurus

MATERIAL SAFETY DATA SHEET

(451)

HERCULES Page 1 of 3

CHEMICAL NAME N/A
SYNONYMS: N/A
FORMULA: N/A
TRADE NAME AND SYNONYMS: Gradient NOSIM-AA-2 Standard

REGULAR TELEPHONE NO. (703)639-7294
EMERGENCY TELEPHONE NO.
CHEMICAL FAMILY Double-Base Propellant
MOLECULAR WEIGHT ---

I. PHYSICAL DATA

BOILING POINT, 760mm. Hg N/A	FREEZING POINT N/A
SPECIFIC GRAVITY (H2O = 1) 1.6170	VAPOR PRESSURE @ °C: Negligible
VAPOR DENSITY (AIR = 1) N/A	SOLUBILITY IN WATER, % BY WT @ °C Negligible
PERCENT VOLATILES BY VOLUME N/A	EVAPORATION RATE (BUTYL ACETATE = 1) less than 1

APPEARANCE AND ODOR Flat sheet, brownish in color

II. HAZARDOUS INGREDIENTS

MATERIAL	%	TLV (UNITS)
Nitrocellulose (flammable solid)	51.0	Not established
Nitroglycerin (skin)	38.6	0.05 PPM*
2-Nitrodiphenylamine	2.0	Not established
Di-n-Propyl Adipate	1.6	Not established
Triacetin	2.7	Not established
Lead - Copper - Resorcylate - Salicylate	4.0	Not established
Candelilla Wax	0.1	Not established

Note: *OSHA PEL = 0.20 PPM (ceiling)

III. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (TEST METHOD) N/A		AUTOIGNITION TEMPERATURE 396.5oF	
FLAMMABLE LIMITS IN AIR, % BY VOLUME	LOWER N/A	UPPER	N/A

EXTINGUISHING MEDIA: Self-oxidizing; deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

HERCULES INCORPORATED
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

59

JUL 25 '95 09:58 PAGE.02

JUL 22 '97 16:05 9164824341 PAGE.02

IV. HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE	Not established. See Section II
EFFECTS OF OVEREXPOSURE	Throbbing headache and upset stomach
EMERGENCY AND FIRST AID PROCEDURES	Eyes: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. Call a physician. Skin: Wash with soap and running water. Inhalation: Remove to fresh air. Treat any irritation symptomatically. Call a physician.

V. REACTIVITY DATA

STABILITY		
UNSTABLE	STABLE	CONDITIONS TO AVOID: Avoid open flame, sparks and heat
	X	

INCOMPATIBILITY (MATERIALS TO AVOID)	Acids and bases (organic and inorganic)
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of nitrogen and carbon

HAZARDOUS POLYMERIZATION		
MAY OCCUR	WILL NOT OCCUR	CONDITIONS TO AVOID: None
	X	

VI. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction impact and electrostatic discharge.
WASTE DISPOSAL METHOD	Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.

VII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE)	Not required.			
VENTILATION	LOCAL EXHAUST: —		SPECIAL: --	
	MECHANICAL (GENERAL): --		OTHER:	Adequate ventilation
PROTECTIVE GLOVES	Cotton or Leather		EYE PROTECTION	Safety glasses
OTHER PROTECTIVE EQUIPMENT	Flame retardant coveralls and conductive shoes			

VIII. SPECIAL PRECAUTIONS

PRECAUTIONARY LABELING	Nitrocellulose (flammable solid) Nitroglycerin (skin) Lead-Copper-Resorcylate-Salicylate
OTHER HANDLING AND STORAGE CONDITIONS	Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21oC (70oF) at 50% humidity

MATERIAL SAFETY DATA SHEET

MSDS:
DATE:
PAGE: 3 of 3

TRADE NAME: PROPELLANT NOSIH-AA-2 STANDARD

IX SPECIAL PRECAUTIONS
PRECAUTIONARY LABELING:

Labeled and packaged in accordance with the Hazardous Materials Regulations of the Department of Transportation for Class B Explosives.

WARNING: FLAMMABLE Solid
Keep away from heat, sparks, and open flame.
Keep containers closed.
Use with adequate ventilation

FIRST AID:

EYES: In case of contact, immediately flush with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. Call a physician.

SKIN: Wash with soap and running water.

INHALATION: Remove to fresh air. Treat any irritation symptomatically. Call a physician.

OTHER HANDLING AND STORAGE CONDITIONS:
Storage also must conform to local, state and Federal Regulations including OSHA - 29CFR 1910.109 and BATF, 27CFR55, Subpart K.

Viper IIIA Rocket Motor

SECTION I

Trade Name: VIPER III
Common Name: ROCKET MOTOR

Manufacturer's Name: UNIVERSAL PROPULSION CO., INC.
Address: 25401 NORTH CENTRAL AVENUE
PHOENIX, AZ 85027-9801

Emergency Telephone No.: 24 HOUR 602-234-6663
Information Telephone No.: 602-869-8067
Preparer: W. Roberts

Date Received:
Date Prepared: 07/08/91

Chemical Name: NA

Supplier's Generic Name: NA

Synonyms: NA

Hazard Class: EXPLOSIVE

Other Identifying Data: UN 0186, PROPER SHIPPING NAME= ROCKET MOTORS

Explosive Class = 1.3C, COMPETENT AUTHORITY CA-9212010, EX-8805252

N.E.W. = 57.5 lbs

NFPA-704 =

HMIS =

This product contains a toxic chemical or chemicals subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372. Those chemicals are: Dibutyl Phthalate, CAS #84-74-2, 2.8% by weight.

SECTION II - HAZARDOUS INGREDIENTS/IDENTIFY INFORMATION

Chemical Name	OSHA-PEL (ppm)	ACGIH-TLV (ppm)	CAS Number	Percent
Polysulfide Rubber			NDA	<18
DiButylphthalate	5MG/M3	5MG/M3	NDA	<3
Magnesium Oxide 15mg/m3dust	5MG/M3	10MG/M3	NDA	<1
Sulfur			NDA	<.1
Diphenylguanidine (DPG)			NDA	<.2
Aluminum	5MG/M3	5MG/M3	NDA	<2
Ammonium Perchlorate			NDA	77

NOTE: If PEL or TLV is followed by the letter M, value is Mg/Cubic Meter

TTS Kit

51205-1 & -2

Part Number:	NFPA Rating	
51205-1 51205-2	2	(Keyword - Re: Health Hazard - Toxicity) Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURER'S NAME:	Universal Propulsion Company	**REGULAR TELEPHONE NO.:** **EMERGENCY TELEPHONE NO.:**	707-422-1880 800-424-9300
ADDRESS:	P.O. Box KK, Fairfield, CA 95433-0659		
TRADE NAME:	Flexible Confined Detonating Cord (FCDC)		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT Note: The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
X-Cord®, 2.5 grains/ft; Lead Sheath HNS II (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Lead (Tubing)	20062-22-0 7439-92-1	>1 >1	PEL-TWA = Not listed, Mfg. recommends 1.5 mg/m³ PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
Booster Cup, Loaded HNS I (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Aluminum (Booster Cup)	20062-22-0 7429-90-5	>1 >1	PEL-TWA = Not listed, Mfg. recommends 1.5 mg/m³ PEL-TWA = 5.0 mg/m³ (Respirable)
Note: Net Explosive Weight (N.E.W.)/ unit = 3.683 grams		100%	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	Low	EVAPORATION RATE (Butyl Acetate = 1)	NA

APPEARANCE AND ODOR: Lead sheathed detonating cord confined within a red and white nylon braid. Unit has a metallic tip attached to each end. No odor.

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	**FLAMMABLE LIMITS**	**Lower:** NA	**Upper:** NA

SPECIAL FIRE FIGHTING PROCEDURES: Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Uncontained initiation of this device may expel shrapnel. May rupture in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

HNS:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of HNS from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream HNS can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of HNS does occur.

Skin Absorption: Slight to moderate dermal absorption.

Eye contact: Redness and irritation, possible keratitis and cataract inducement

Ingestion: Once the ingested HNS passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anillism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Aluminum (Dust or Fume):

Inhalation: The respiratory effects caused by aluminum include: coughing, increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen, sense of tightness in the chest due to spasmodic contraction of the bronchi; difficult or labored breathing (dyspnea); and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis). Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD) which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 month's after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Lead: ***Warning:*** **This product contains lead, which is listed as a *California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.***

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in woman. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

EMERGENCY FIRST AID PROCEDURES

Eyes: Flush with water for 20 minutes. Call physician.

Skin: Wash immediately with cold water, then thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Mechanical shock, static electricity, heat, flame or sparks
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Alkalis, acids, corrosives, and strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Lead, lead oxides, antimony, antimony oxides, aluminum, aluminum oxides, hydrogen, nitrogen, nitrogen oxides, carbon monoxide, carbon dioxide, and other carbonaceous combustion by-products.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

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SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:
Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS
N/A. unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA Waste Codes D003 and D008.

Fired Units/Debris: Dispose as a characteristically Toxic Hazardous Waste, EPA Waste Code D008.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.

VENTILATION	**LOCAL EXHAUST:** Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels or TLV/PEL/TWA.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES: Normal: Leather Split: PBI or leather gloves as outer shells with nitrile gloves as inserts.		**EYE PROTECTION:** Safety glasses as a minimum. Blast shields where necessary.

OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg) to prevent electrostatic discharge ignition.

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or side packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store units in a properly sited and maintained magazine. Reference BATF, OSHA, DoD 4145.

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0658

ISSUE DATE: 11-01-95

REVISION DATE: 11-01-95, 10-18-96 9-19-97, 9-21-98

References:
Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doulls: Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1998.

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Part Number:	NFPA Rating:	(Keyword - Re: Health Hazard - Toxicity)
51202-1	2	Moderate Health Hazard
		(Keyword - Re: Combustibility - Flammability)
	3	Highly Combustible
		(Keyword - Re; Reactivity)
	3	Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURERS NAME:	Universal Propulsion Company	**REGULAR TELEPHONE NO.:**	707-422-1880
		EMERGENCY TELEPHONE NO.:	800-424-9300
ADDRESS:	P.O. Box KK, Fairfield, CA 94533-0659		
TRADE NAME:	Manifold Assembly		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT Note: The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
X-Cord®, 10.0 grains/ft.; Aluminum Sheath RDX Lead Tubing	 121-82-4 7439-92-1	 >1 >1	 PEL-TWA = 1.5 mg/m³ PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
Booster Cup, Loaded RDX Aluminum (Booster Cup)	 121-82-4 7429-90-5	 >1 >1	 PEL-TWA = 1.5 mg/m³ PEL-TWA = 5.0 mg/m³ (Respirable)
Note: The Net Explosive Weight(NEW)/unit =up to 0.30 grams		100%	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	NA	EVAPORATION RATE (Butyl Acetate = 1)	NA
APPEARANCE AND ODOR: Metallic block with an input and output port. No odor			

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	**FLAMMABLE LIMITS**	**Lower:** NA	**Upper:** NA

SPECIAL FIRE FIGHTING PROCEDURES: Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Uncontained initiation of this device may expel shrapnel. May rupture or explode in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Aluminum (Dust or Fume)

Inhalation: The respiratory effects caused by aluminum include: coughing, increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen; sense of tightness in the chest due to spasmodic contraction of the bronchi; difficult or labored breathing (dyspnea); and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis). Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

RDX:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of RDX from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream, RDX can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of RDX does occur.

Skin Absorption: Slight to moderate dermal absorption

Eye contact: Redness and irritation, possible cataract inducement

Ingestion: Once ingested, RDX passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Lead: ***Warning: This product contains lead, which is listed as a California Proposition 65 Caroinogen, Reproductive Toxin, and Developmental Toxin.***

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscerriage and stillbirth in women whose huebands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

EMERGENCY FIRST AID PROCEDURES:

Eyes: Flush with water for 20 minutes

Skin: Flush exposed eres with cold water for 10 min., then wash thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Mechanical shock, static electricity, heat, flame or sparks
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Alkalis, acids, corrosives, and strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Aluminum, aluminum oxides, carbon monoxide, carbon dioxide, other carbonaceous by-products, nitrogen, nitrogen oxides, and hydrogen.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations.

Unfired devices / units: Dispose as s characteristically Reactive Hazardous Waste, EPA waste code D003.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

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SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.		
VENTILATION	**LOCAL EXHAUST:** Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels or TLV/PEL/TWA.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES:	**Normal:** Leather **Spill:** PBI or leather gloves as outer shells with nitrile gloves as inserts.	**EYE PROTECTION:** Safety glasses as a minimum. Blast shields where necessary.
OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps (Wrist and Leg) to prevent electrostatic discharge ignition.		

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or slide packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store units in a properly sited and maintained magazine. Reference BATF, OSHA, DoD4145

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533

ISSUE DATE: 7-17-96

REVISION DATE: 9-24-98

References:

Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doull's Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1996.

Part Number:	NFPA Rating:	(Keyword - Re: Health Hazard - Toxicity)
51203-4	2	Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURER'S NAME:	Universal Propulsion Company	REGULAR TELEPHONE NO.:	707-422-1880
		EMERGENCY TELEPHONE NO.:	800-424-9300
ADDRESS:	P.O. Box KK Fairfield, CA 94533-0659		
TRADE NAME:	Safe & Arm Device		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

Note: MATERIAL OR COMPONENT — The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
Electric Detonator			
Zirconium	7440-67-7	>1	PEL-TWA = 5.0 mg/m³
Potassium Perchlorate	7778-74-7	>1	PEL-TWA = 5.0 mg/m³ (Respirable)
Lead Azide	13424-46-9	>1	PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
RDX	121-82-4	>1	PEL-TWA = 1.5 mg/m³
NOTE: Net Explosive Weight (NEW)/unit = .080 grams		100 %	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	Insoluble	EVAPORATION RATE (Butyl Acetate = 1)	NA

APPEARANCE AND ODOR: Metallic device containing a detonator. No odor.

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	FLAMMABLE LIMITS	Lower: NA	Upper: NA

SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device may expel shrapnel. May rupture or explode in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Lead Azide
(As Inorganic Lead)

Warning: This product contains lead, which is listed as a California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

RDX:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of RDX from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream, RDX can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of RDX does occur.

Skin Absorption: Slight to moderate dermal absorption

Eye contact: Redness and irritation possible cataract inducement

Ingestion: Once ingested, RDX passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Zirconium:

Inhalation: Irritation to nose, throat, and upper respiratory tract. Possible decrease in the forced expiratory volume (FEV 1) and vascular congestion and lung hemorrhages.

Skin Contact: Mild to moderate irritation.

Skin Absorption: NA

Eye contact: Mild to moderate irritation.

Ingestion: Severe irritation of the mouth, throat, and esophagus; gastroenteritis

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure;

Potassium Perchlorate:

Inhalation:	Irritation of the respiratory tract and possible pneumoconiosis. Possible methemoglobinemia.
Skin Contact:	Irritation, local oxidizing of skin.
Skin Absorption:	NA
Eye contact:	Irritation, conjunctivitis, and possible corneal damage.
Ingestion:	Gastroenteritis, possible methanoglobenimia

EMERGENCY FIRST AID PROCEDURES

Eyes:	Flush with water for 20 minutes. Call physician.
Skin:	Wash immediately with cold water, then thoroughly with soap and water
Inhalation:	Move to fresh air, call physician
Ingestion:	Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Heat, sparks, flame, friction and mechanical shock
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Strong acids, bases, oxidizers, and strong reducing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon dioxide, carbon monoxide, other carbonaceous by-products, nitrogen, nitrogen oxides, potassium, potassium oxides, potaesium chloide and chlorates, hydrogen, hydrogen chloide, zirconium, zirconium oxides, zirconium chloride and chlorates, lead, lead oxides, lead chloride and chlorates and chlorine.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking or exposed, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA waste codes D003 and D008.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

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SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.		
VENTILATION	**LOCAL EXHAUST.** Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels or TLV/PEL/TWA.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES:	**Normal:** Leather **Spill:** PBI or leather gloves as outer shells with nitrile gloves as inserts.	**EYE PROTECTION:** Safety glasses as a minimum. Blast shields where necessary.
OTHER PROTECTIVE EQUIPMENT:	Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg) to prevent electrostatic discharge ignition.	

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or side packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store assemblies in a properly sited and maintained magazine. Reference BATF, OSHA, DoD 4145

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0659

ISSUE DATE: 6/8/01

REVISION DATE: 6/8/01

References:

Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doull's Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1996.

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Part Number:	NFPA Rating:	(Keyword - Re: Health Hazard - Toxicity)
51204-1	2	Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURERS NAME: Universal Propulsion Company		REGULAR TELEPHONE NO. EMERGENCY TELEPHONE NO.	707-422-1880 800-424-9300
ADDRESS:	P.O. Box KK Fairfield, CA	94533-0659	
TRADE NAME:	Thrust Termination System		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT	CAS #	% by Weight	HAZARD DATA
JETCORD®,200 gr/ft; Copper Sheath HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Copper Tubing	20062-22-0 7440-50-8	>1 >1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³ PEL-TWA = 0.1 mg/m³ (fume)
Transfer Booster Booster Cup, Loaded HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Aluminum (Booster Cup)	20062-22-0 7429-90-5	>1 >1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³ PEL-TWA = 5.0 mg/m³
X-Cord®, 45.0 grains/ft (Lead Sheath) HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Lead Tubing	20062-22-0 7439-92-1	>1 >1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³ PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
NOTE: Net Explosive Weight (NEW)/unit = .050 grams		100 %	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	NA	EVAPORATION RATE (Butyl Acetate = 1)	NA
APPEARANCE AND ODOR: Rectangular shaped composite retainer, black in color, containing copper sheathed linear shaped charge. No odor.			

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	FLAMMABLE LIMITS	Lower: NA	Upper: NA

SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area to safe distance. Use a self contained, full-face, breathing apparatus in the positive pressure mode to contain incipient or resulting fire.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device will expel shrapnel. Will rupture in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: No exposure is normally possible unless the unit is damaged and leaking contents or the unit is initiated. Then exposure to hazardous ingredients is possible. No health hazard data is available on the mixture of materials as mixed in this device, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Copper (as dust or fume):

Inhalation:	Irritation to upper respiratory tract. Possible metal fume fever 24-48 hrs after exposure. Characterized by chills, fever, aching muscles, dryness in the throat and mouth, and headache. Possible pulmonary edema and lung damage. Possible hepatomegaly and development of jaundice due to liver damage. Possible headache, vertigo, and drowsiness due to interaction with the CNS. Possible degenerative changes to the basal ganglia of the brain. Possible ventricular extrasystoles, tachycardia, and occasional unifocal bigeminy with acute exposures. Possible kidney damage due to necrosis of the tubular cells as indicated by hematuria, glycosuria, cylindruria, and proteinuria. Possible hemolytic anemia and methemoglobinemia.
Skin Contact:	Irritation. Possible itching, pruritic dermatitis, erythema, dermatitis, and allergic contact dermatitis.
Skin Absorption:	NA
Eye contact:	Irritation. Possible conjunctivitis and keratitis. Possible corneal discoloration and necrosis.
Ingestion:	Possible gastric and intestinal mucosa erosion. Possible hepatomegaly and development of jaundice due to liver damage. Possible headache, vertigo, and drowsiness due to interaction with the CNS. Possible degenerative changes to the basal ganglia of the brain. Possible ventricular extrasystoles, tachycardia, and occasional unifocal bigeminy with acute exposures. Possible kidney damage due to necrosis of the tubular cells as indicated by hematuria, glycosuria, cylindruria, and proteinuria. Possible hemolytic anemia and methemoglobinemia.

HNS:

Inhalation:	Irritation to the respiratory tract mucous membrane. Absorption of HNS from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream HNS can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness
Skin Contact:	Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of HNS does occur.
Skin Absorption:	Slight to moderate dermal absorption
Eye contact:	Redness and irritation, possible cataract inducement
Ingestion:	Once the ingested HNS passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anillism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Lead: ***Warning: This product contains lead, which is listed as a California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.***

Inhalation:	Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.
Skin Contact:	Irritation, erythema
Skin Absorption:	Possible, Slight to moderate
Eye Contact	Irritation, Possible conjunctivitis and keratitis
Ingestion:	Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in woman whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: No exposure is normally possible unless the unit is damaged and leaking contents or the unit is initiated. Then exposure to hazardous ingredients is possible. No health hazard data is available on the mixture of materials as mixed in this device, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Aluminum: (Dust or Powder)

Inhalation: The respiratory effects caused by aluminum include: coughing; increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen; sense of tightness in the chest due to spasmodic contraction of the bronchi; difficult or labored breathing (dyspnea) and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis).. Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

EMERGENCY FIRST AID PROCEDURES:

Eyes: Flush with water for 20 minutes

Skin: Flush exposed area with cold water for 10 minutes, then wash thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Heat, static electricity, shock, and friction, open flames.
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Strong acids, bases, oxidizing agents, halogens, reducing agents, and organics

HAZARDOUS DECOMPOSITION PRODUCTS: Copper, copper oxides, aluminum, aluminum oxides, lead, lead oxides, hydrogen, nitrogen, nitrogen oxides, carbon monoxide, carbon dioxide, and other carbonaceous compounds.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

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SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA waste codes D003 and D008.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH/MSHA approved respirator if action levels or TWA/PEL/TLV levels are met or exceeded.

VENTILATION	**LOCAL EXHAUST:** Should be used during test firing of units in need to maintain airborne contaminants at or below their respective action levels or TLV/PEL/TWA levels.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES: Normal: Leather or PBI or both. Spill: PBI or leather gloves as outer shells with nitrile gloves as inner shells.		**EYE PROTECTION:** Safety glasses as a minimum. Blast shields if necessary.

OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg), conductive shoes to ensure that static charges are being drained off of your body.

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or slide packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store assemblies in a properly sited and maintained magazine in accordance with BATF, OSHA, DoD.

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0659

ISSUE DATE: 8/31/98

REVISION DATE: 8/31/98, 12/19/98

References:
Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doulls: Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1996.

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APPENDIX C

CERTIFICATES OF ANALYSES

EG&G TECHNICAL SERVICES INCORPORATED

Client Sample ID: TAURUS

HPLC

Lot-Sample #...:	H2K060267-001	Work Order #...:	FCHR51AA	Matrix.....:	SOLID
Date Sampled...:	11/26/01	Date Received..:	11/05/02		
Prep Date.....:	11/15/02	Analysis Date..:	11/21/02		
Prep Batch #...:	2318216				
Dilution Factor:	2				
% Moisture.....:		Method.....:	SW846 8332		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Nitroglycerin	6.2	5.0	mg/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1-Chloro-3-nitrobenzene	110	(70 - 130)

METHOD BLANK REPORT

HPLC

Client Lot #...: H2K060267 Work Order #...: FC3PF1AA Matrix.....: SOLID
MB Lot-Sample #: H2K140000-216

Prep Date.....: 11/15/02
Analysis Date..: 11/21/02 Prep Batch #...: 2318216
Dilution Factor: 1

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD
Nitroglycerin	ND	2.5	mg/kg	SW846 8332

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1-Chloro-3-nitrobenzene	112	(70 - 130)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

HPLC

Client Lot #...: H2K060267 Work Order #...: FC3PF1AC-LCS Matrix.....: SOLID
LCS Lot-Sample#: H2K140000-216 FC3PF1AD-LCSD
Prep Date.....: 11/15/02 Analysis Date..: 11/21/02
Prep Batch #...: 2318216
Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Nitroglycerin	**92**	**(70 - 130)**			**SW846 8332**
	92	**(70 - 130)**	**0.91**	**(0-25)**	**SW846 8332**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1-Chloro-3-nitrobenzene	108	(70 - 130)
	110	(70 - 130)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

LABORATORY CONTROL SAMPLE DATA REPORT

HPLC

Client Lot #...: H2K060267 Work Order #...: FC3PF1AC-LCS Matrix.....: SOLID
LCS Lot-Sample#: H2K140000-216 FC3PF1AD-LCSD
Prep Date.....: 11/15/02 Analysis Date..: 11/21/02
Prep Batch #...: 2318216
Dilution Factor: 1

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCENT RECOVERY	RPD	METHOD
Nitroglycerin	25.0	23.1	mg/kg	92		SW846 8332
	25.0	22.9	mg/kg	92	0.91	SW846 8332

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1-Chloro-3-nitrobenzene	108	(70 - 130)
	110	(70 - 130)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

EG&G TECHNICAL SERVICES INCORPORATED

Client Sample ID: TOMAHAWK

General Chemistry

Lot-Sample #...: H2K060267-002 Work Order #...: FCHTC Matrix.....: SOLID
Date Sampled...: 11/26/01 Date Received..: 11/05/02
% Moisture.....:

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Perchlorate	49000	1000	ug/kg	EPA-DW1 314.0	12/12/02	2350196

Dilution Factor: 25

METHOD BLANK REPORT

General Chemistry

ient Lot #...: H2K060267 Matrix.....: SOLID

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Perchlorate		Work Order #: FEW121AA		MB Lot-Sample #:	H2L160000-196	
	ND	40.0	ug/kg	EPA-DW1 314.0	12/12/02	2350196
		Dilution Factor: 1				

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

General Chemistry

Client Lot #...: H2K060267 Matrix.....: SOLID

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Perchlorate		Work Order #: FEW121AC	LCS Lot-Sample#: H2L160000-196		
	95	(85 - 115)	EPA-DW1 314.0	12/12/02	2350196
		Dilution Factor: 1			

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

LABORATORY CONTROL SAMPLE DATA REPORT

General Chemistry

Client Lot #...: H2K060267 Matrix.....: SOLID

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCNT RECVRY	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Perchlorate			Work Order #: FEW121AC LCS Lot-Sample#: H2L160000-196				
	1000	945	ug/kg	95	EPA-DW1 314.0	12/12/02	2350196
			Dilution Factor: 1				

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

MATRIX SPIKE SAMPLE EVALUATION REPORT

General Chemistry

ient Lot #...: H2K060267 Matrix.....: SOLID
te Sampled...: 11/20/02 Date Received..: 11/22/02

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
						% Moisture.....: 22	
Perchlorate		WO#: FDPE51AC-MS/FDPE51AD-MSD				MS Lot-Sample #: H2K220234-007	
	81	(80 - 120)			EPA-DW1 314.0	12/12/02	2350196
	87	(80 - 120)	6.7	(0-20)	EPA-DW1 314.0	12/12/02	2350196
		Dilution Factor: 1					

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Results and reporting limits have been adjusted for dry weight.

MATRIX SPIKE SAMPLE DATA REPORT

General Chemistry

ient Lot #...: H2K060267 Matrix.....: SOLID
ate Sampled...: 11/20/02 Date Received..: 11/22/02

PARAMETER	SAMPLE AMOUNT	SPIKE AMT	MEASRD AMOUNT	UNITS	PERCNT RECVRY	RPD	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
					% Moisture.....: 22				
Perchlorate			WO#: FDPE51AC-MS/FDPE51AD-MSD		MS Lot-Sample #: H2K220234-007				
	ND	386	314	ug/kg	81		EPA-DW1 314.0	12/12/02	2350196
	ND	386	335	ug/kg	87	6.7	EPA-DW1 314.0	12/12/02	2350196
			Dilution Factor: 1						

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Results and reporting limits have been adjusted for dry weight.

Analytical Report For 312057

for

EG & G Technical Services, Inc.

Project Manager : Monica Borowicz

Project Name : T-2 Sampling

December 17, 2003

GPL

Laboratories

GPL Laboratories, LLLP Certifies that the test results meet all requirements of the NELAC Standards unless otherwise noted.

Reviewed by, Project Manager	Approved by, Laboratory Director

202 Perry Parkway Gaithersburg, MD 20877 Phone (301) 926-6802 Fax: (301) 840-1209
www.gplab.com

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-004-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: CLP_SOLIDS
Date Analyzed: 12/10/2003
Time Analyzed: 15:00
Analysis Batch: 65127

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Percent Solids	92	1.0	%		1

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-001-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: IAAP
Date Analyzed: 12/16/2003
Time Analyzed: 09:23
Analysis Batch: 65228

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Nitrocellulose	120	15	mg/kg		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-004-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: SW1010
Date Analyzed: 12/11/2003
Time Analyzed: 00:00
Analysis Batch: 65124

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Flash Point	BQL	20	DC	U	1

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-003-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method: SW3010A
Prep Date: 12/13/2003
Prep Time: 00:00
Prep Batch: 64136

Analytical Method: SW6010B_TCLP
Date Analyzed: 12/16/2003
Time Analyzed: 00:27
Analysis Batch: 15866

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Lead	14000	100	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-002-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method: EXT_SW8330
Prep Date: 12/11/2003
Prep Time: 00:00
Prep Batch: 64095

Analytical Method: SW8330
Date Analyzed: 12/12/2003
Time Analyzed: 21:03
Analysis Batch: 65231

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Nitroglycerine	440000	10000	ug/kg		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-004-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: SW9014R
Date Analyzed: 12/11/2003
Time Analyzed: 16:00
Analysis Batch: 65214

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Cyanide, Reactive	0.070	0.020	mg/kg		1

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-004-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: SW9034R
Date Analyzed: 12/15/2003
Time Analyzed: 12:30
Analysis Batch: 65212

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Sulfide, Reactive	BQL	9.6	mg/kg	U	1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : T-2 Sampling

Date Printed December 17, 2003

GPL ID	Client ID
312057-001-001-1/1	T-2
312057-001-002-1/1	T-2
312057-001-003-1/1	T-2
312057-001-004-1/1	T-2

ATTACHMENT II.CC

INSPECTION SCHEDULE

ATTACHMENT II.CC-INSPECTION SCHEDULE

II.CC.1. Inspection Schedule

General inspections are routinely performed on buildings and structures located on Wallops Island. These inspections include the OB area and related facilities. Roving security patrol on the Island check for unauthorized entry onto the facility and report obvious building damage when it is encountered. The fire department performs fire drills and water supply systems inspections on a semi-annual schedule. Unplanned fire drills are also used to ensure proper preparation of fire-fighting capabilities on the Island. Prior to each semiannual OB groundwater monitoring event, the condition of monitoring wells and OB structures are noted in the site field book. In addition, OB subunits and pad assembly are inspected prior to each burn. After each burn, a Post Burn inspection is conducted.

II.CC.2. Types of Problems

The OB area is located on a remote part of the Island. An inspection of the area is performed prior to OB operations to determine if the subunits are in a vertical position and in sound shape to support the rocket motor with waste propellant. A visual inspection of the pad is also performed. Three subunits and one burn pad are available for OB operation. In the event a subunit is determined unfit for OB, one of the other subunits is used to support the rocket motor. In the event the burn pad is determined unfit for OB, the pad is not used until necessary repairs are made.

Rocket motors are inspected prior to, and after shipping to OB. This ensures that the rocket motor's integrity is not compromised in any way that could lead to an unplanned explosion or other release of waste constituents. The inspection also includes a survey of personal protective equipment, calibration of equipment, malfunctions, and weather conditions.

Groundwater monitoring equipment will be inspected prior to well purging for each groundwater monitoring sampling event.

A Post Burn visual inspection of the three subunits, pad, pan, and cover is performed after each burn event. If any of the units are damaged as a result of the OB operations, the damage is documented on the POST BURN OB AREA INSPECTION LOG and the damage is repaired prior to the next OB event. The POST BURN OB AREA INSPECTION LOG form is attached as Exhibit II.CC-2.

II.CC.3. Frequency of Inspections

An equipment/site inspection log has been incorporated into the work instructions (Exhibit II.CC-1) developed for the static firing of rocket motors. The work instruction identifies equipment associated with the OB process. Prior to any operation involving ordnance disposal at WFF, the site designated for hazardous waste disposal shall be inspected to detect any possible deterioration of equipment. The following will also be inspected: (a) rocket motors, (b) monitoring equipment's calibration, (c) safety and emergency equipment, and (d) other devices to be utilized during the operation. The inspection includes date, weather conditions, notations of any observations, and nature of corrective actions, if any.

The POST BURN OB AREA INSPECTION LOG form is attached as Exhibit II.CC-2. The post burn inspection will identify any wear and tear to the units after the completion of the OB operations.

The Carrier Systems Branch shall maintain the logs for a minimum of 3 years, from the date of inspection. A copy of all inspections will be kept at Building X-55 General Services in the OB record storage area.

The frequency of inspections is based upon the number of OB operations. Inspections are made prior to any thermal treatment of rocket motors. Any deterioration or malfunction is corrected prior to thermal treatment.

EXHIBIT II.CC-1

WORK INSTRUCTIONS

Work Instruction

DIRECTIVE NO.	546-WI-8072.1.43C	**APPROVED BY Signature:**	Original signed by
EFFECTIVE DATE:	11/01/2002	**NAME:**	Stewart Meyers
EXPIRATION DATE:	N/A	**TITLE:**	Branch Head

Responsible Office: 546.W/Carrier Systems Branch

Title: 6-Month Visual Inspection of Pyrotechnic Grounding Points

PREFACE

P1. PURPOSE

This procedure is a requirement of NSS 1740.12, "Safety Standard for Explosives, Propellants & Pyrotechnics," for a semi-annual visual inspection of pyrotechnic grounding points.

The purpose of this procedure is to perform a visual inspection of each pyrotechnic grounding point as defined in the data sheets of GDMS 546-WI-8072.1.23. Each point will be checked for condition of labeling, and deterioration or destruction of the hardware that constitutes the grounding system. Any point that fails the inspection shall be tagged out of service for use as a pyrotechnic ground, and a "Non-Conformance Report (NCR)" will be entered to the appropriate official for action.

After corrective action(s) have been made to the deficient system(s), the facility shall require a complete ground test of all points per GDMS 546-WI-8072.1.23 prior to certification for pyrotechnic grounding.

P2. APPLICABILITY

546.W Range Team

P3. REFERENCES

NSS 1740.12 "Safety Standard for Explosives, Propellants & Pyrotechnics"
GPG 8072.1 Process Control
GDMS 546-WI-8072.1.43 6 Month Visual Inspection of Pyrotechnic Grounding

P4. CANCELLATION

GDMS 546-WI-8072.1.43 Rev. B

P5. TOOLS, EQUIPMENT, AND MATERIALS

Small Wire Brush

PERSONNEL REQUIRED:
One Technician

P6. SAFETY PRECAUTIONS AND WARNINGS

1. There shall be no ordnance devices grounded to a system under test.

P7. TRAINING

On the job training is required to perform this work instruction.

P8. RECORDS

Quality Record Title	Record Custodian	Retention
Completed and signed-off Facility Data Sheet	Designated Technician	NRRS 8/5A1 Permanent. Records may be retired to an FRC when 2 years old. Transfer to NARA 15 years after completion of the project or when 25 years old, whichever is sooner.

P9. METRICS

None

P10. DEFINITIONS

NSS- NASA Safety Standard

INSTRUCTIONS

1. Print the appropriate data sheets for the facility or facilities to be inspected. The data sheets, when completed, will be the Quality Record.
2. Proceed to each facility to be inspected. Check each ground point listed on the appropriate facility data sheet for deterioration or destruction of the hardware that constitutes the grounding system.
3. Indicate acceptance of the ground point by checking "Pass" or "Fail" on the data sheet. Write the reason for a "Fail" status under the "Remarks" column.

4. Re-mark any labeling that is not legible. This action does not require an NCR.
5. Upon completion of the facility data sheet, the inspecting Technician shall sign and date the data sheet, and submit and document by case number, any NCR submitted for failed ground points.
6. Upon repair of failed ground points, the facility shall be completely re-tested in accordance with GDMS 546-WI-8072.1.23, Pyrotechnic Grounding Survey.

LIST OF CONTENTS:

Data Sheet	Page No.
Launch Area No. 1	4
Assembly Shop No. 1 (Building Y-15)	5
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Launch Pad No. 2, East	8
Assembly Shop No. 3 (Building W-65)	9
Launch Pad No. 4	11
Assembly Shop No. 5 (Building W-40)	12
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Environmental Test Facility (Building V-55)	14
Environmental Test Facility (Building V-45)	15
Pyrotechnic Storage Facility (Building V-67)	16
Rocket Motor Storage Facility (Building W-15)	18
Rocket Motor Storage Facility (Building M-15)	19
Rocket Motor Storage Facility (Building M-16)	20
Rocket Motor Storage Facility (Building M-20)	21
Rocket Motor Storage Facility (Building M-22)	22
Aircraft Hangar (Building D-1)	23
Aircraft Pyrotechnic Grounds (Runway 17-35)	25
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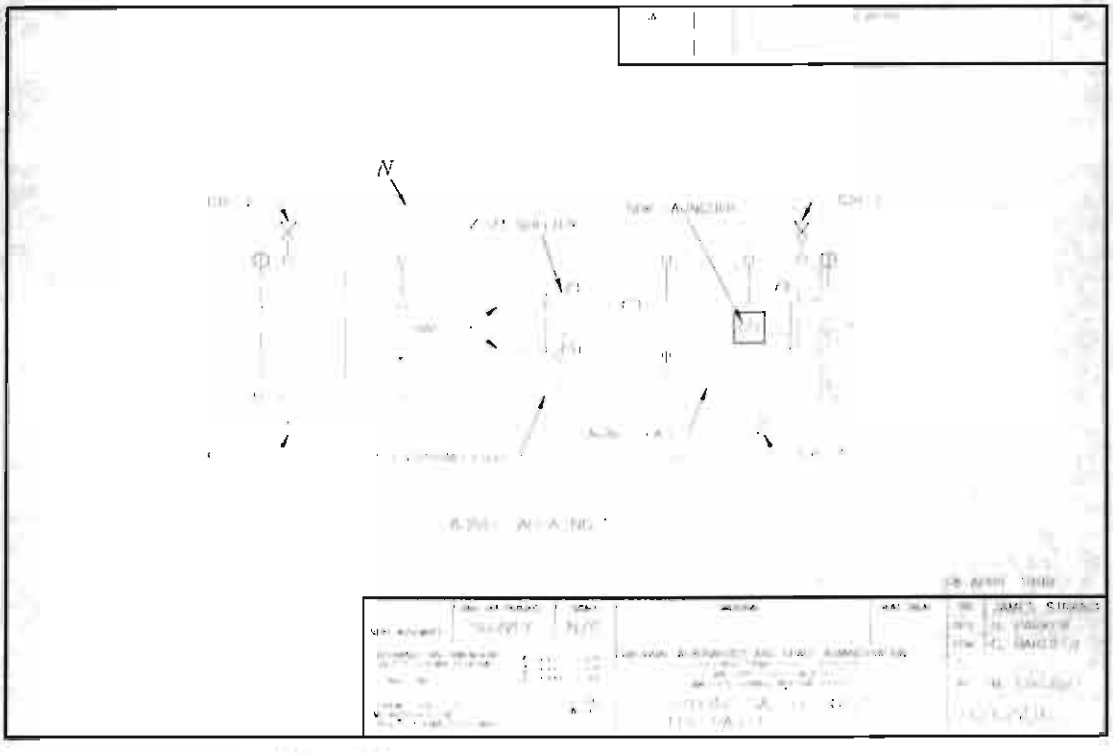
6-Month Visual Inspection of Pyrotechnic Grounding Points
Launch Area No. 1

Ground Point	Pass	Fail	Remarks
GTP-1			
GTP-2			
GTP-3			
GTP-4			
No. 1			
No. 2			
No. 3			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE



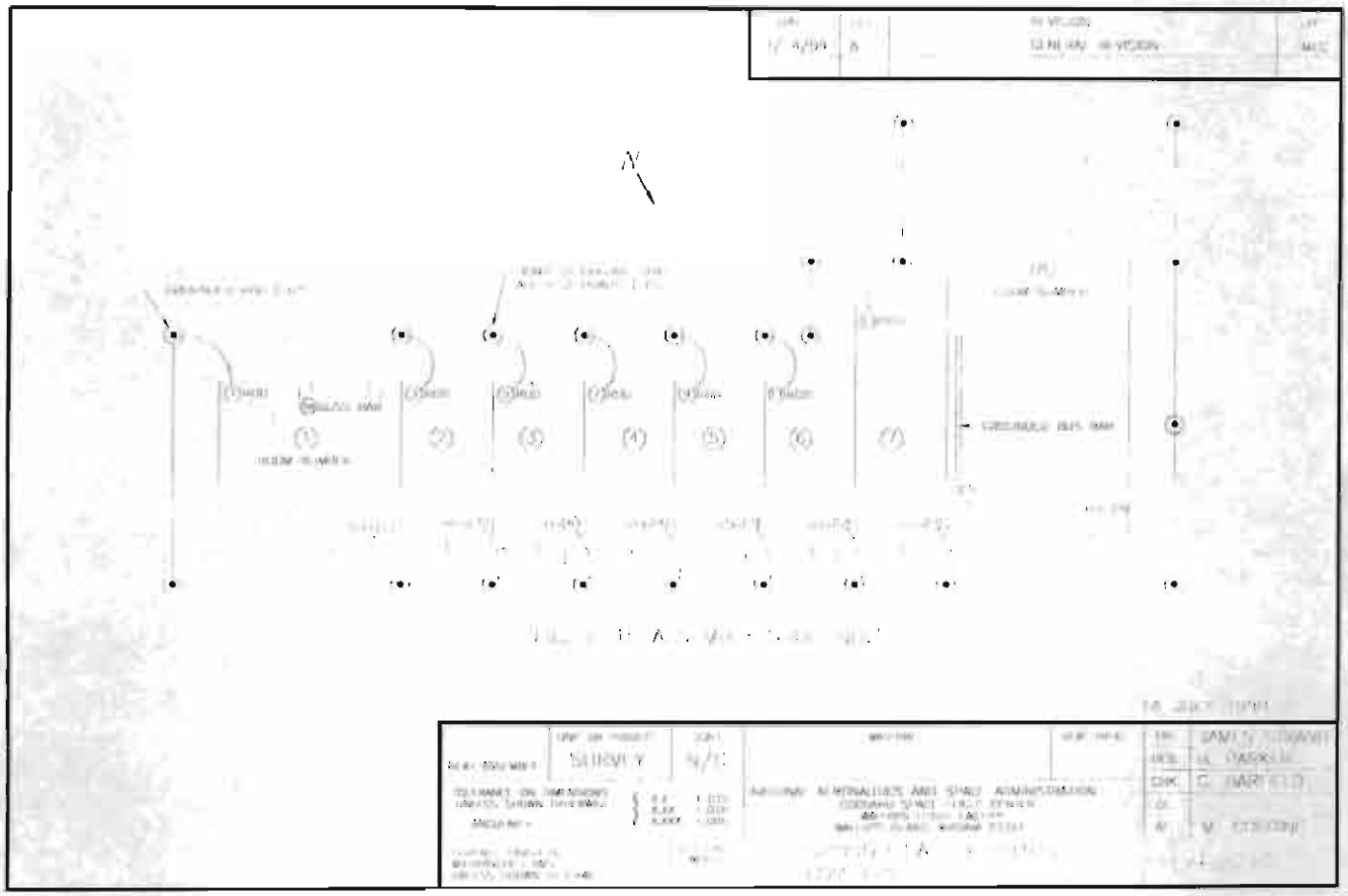
6-Month Visual Inspection of Pyrotechnic Grounding Points
Assembly Shop No. 1 (Building Y-15)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			
No. 7			
No. 8			
No. 9			
No. 10			
No. 11			
No. 12			
No. 13			
No. 14			
No. 15			
No. 16			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

6-Month Visual Inspection of Pyrotechnic Grounding Points
Assembly Shop No. 1 (Building Y-15)

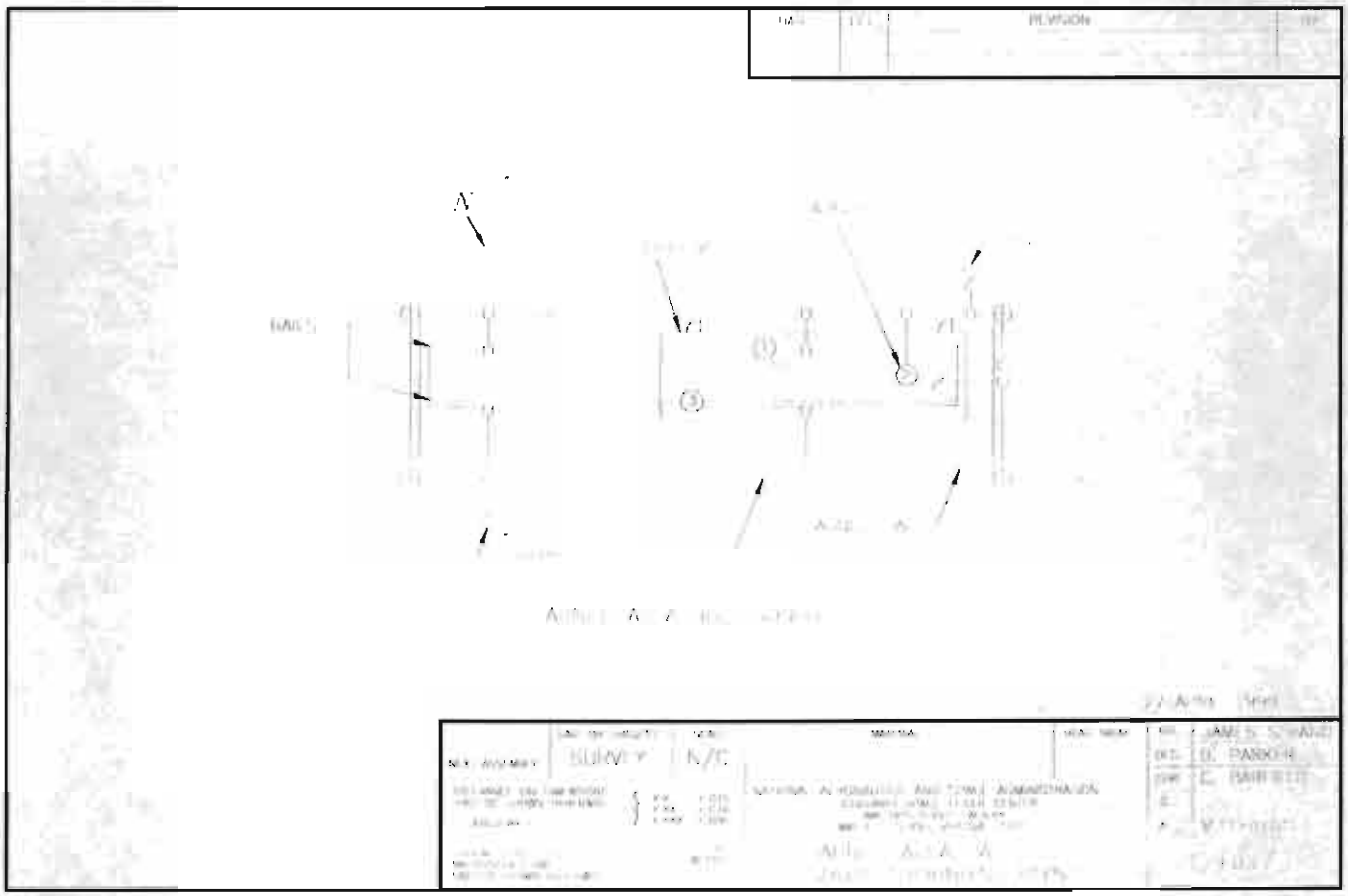


6-Month Visual Inspection of Pyrotechnic Grounding Points
Launch Pad No. 2, South

Ground Point	Pass	Fail	Remarks
GTP-1			
GTP-2			
No. 1			
No. 2			
No. 3			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

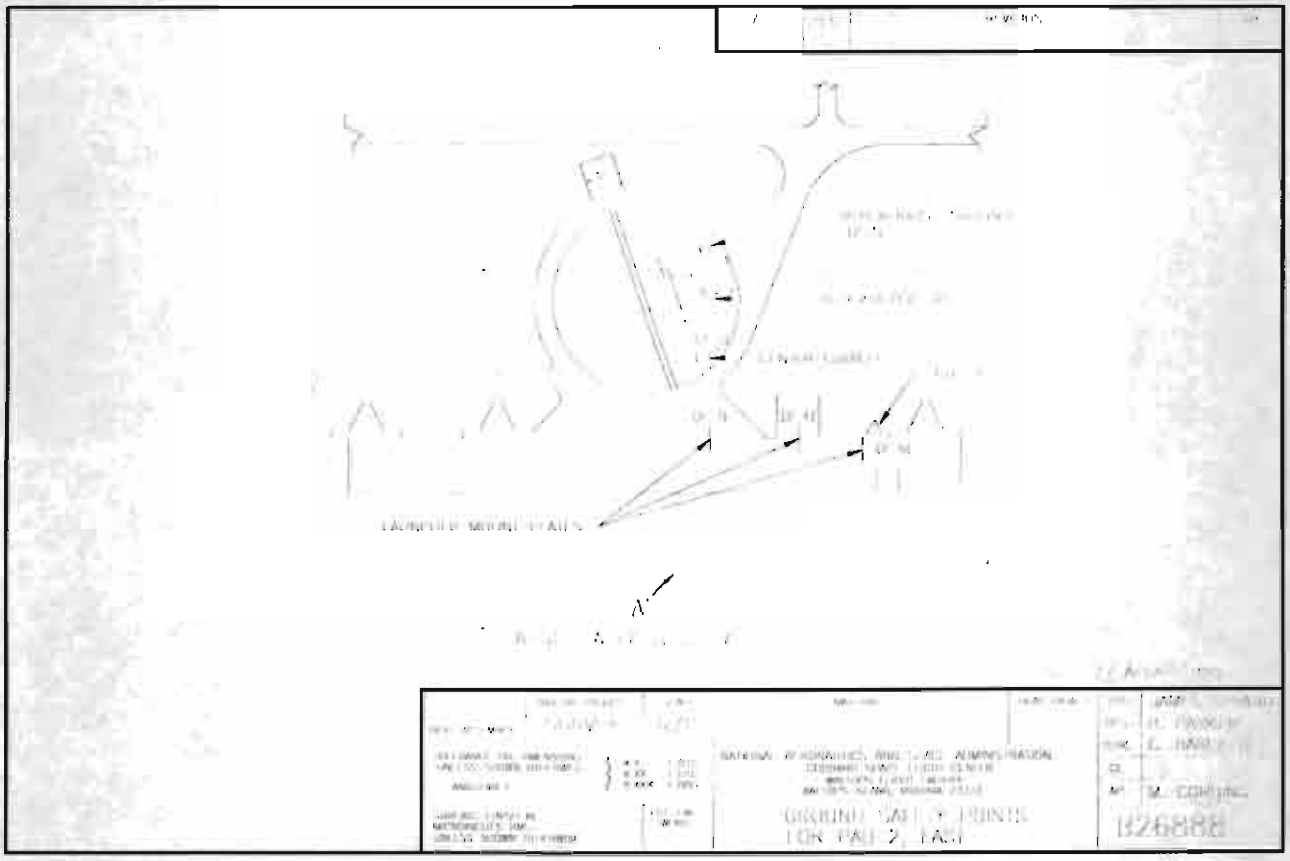


6-Month Visual Inspection of Pyrotechnic Grounding Points
Launch Pad No. 2, East

Ground Point	Pass	Fail	Remarks
GTP-1			
No. 2-1			
No. 2-2			
No. 2-3			
No. 2-4			
No. 2-5			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE



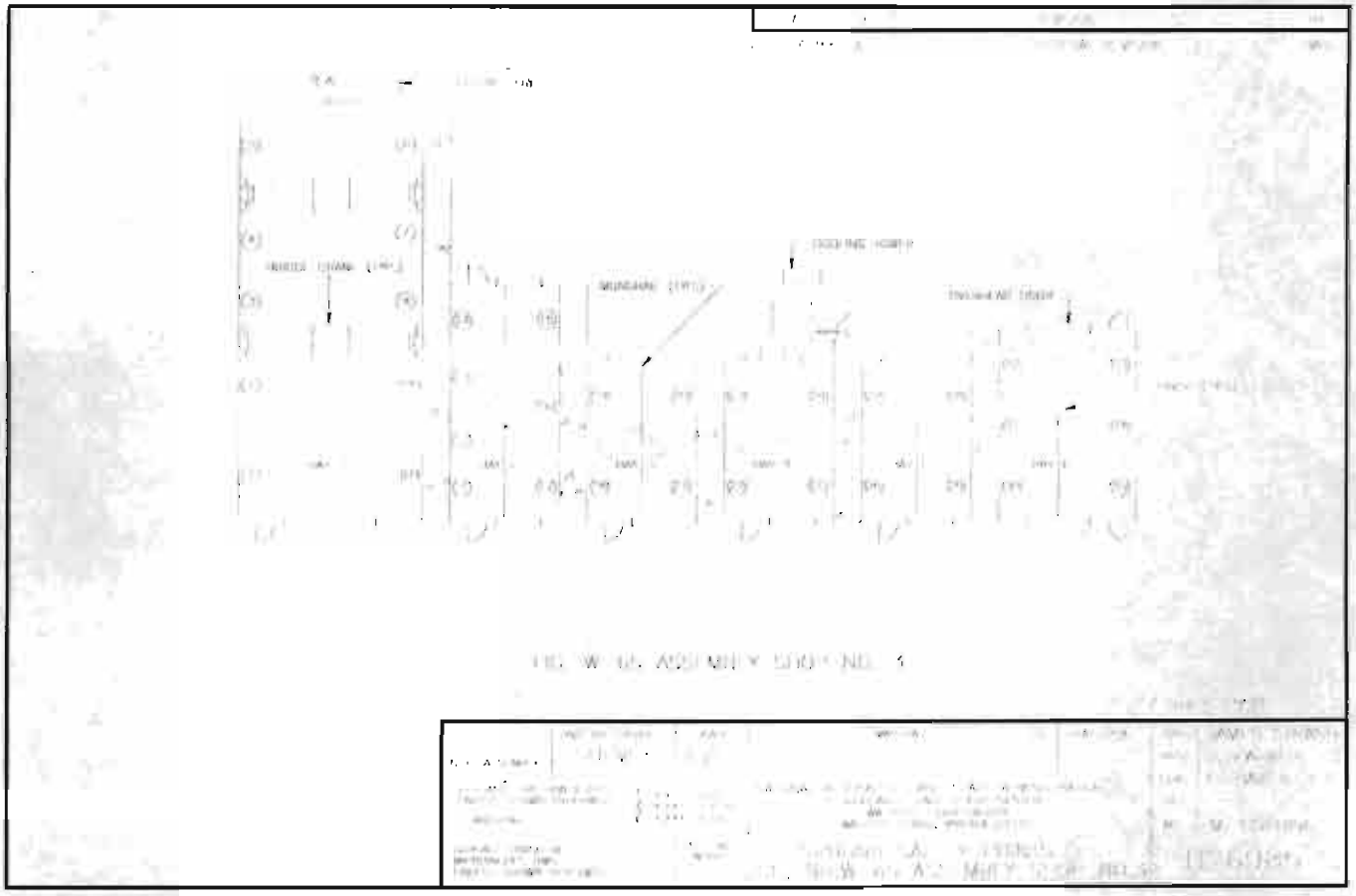
6-Month Visual Inspection of Pyrotechnic Grounding Points
Assembly Shop No. 3 (Building W-65)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 5a			
No. 6			
No. 7			
No. 8			
No. 9			
No. 10			
No. 11			
No. 12			
No. 13			
No. 14			
No. 15			
No. 16			
No. 17			
No. 18			
No. 19			
No. 20			
No. 21			
No. 22			
No. 23			
No. 24			
No. 25			
No. 26			
No. 27			
No. 28			
No. 29			
No. 30			
No. 31			
No. 33			
No. 34			
No. 35			

6-Month Visual Inspection of Pyrotechnic Grounding Points
Assembly Shop No. 3 (Building W-65)

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE



6-Month Visual Inspection of Pyrotechnic Grounding Points
Launch Pad No. 4

Ground Point	Pass	Fail	Remarks
GTP-1			
No. 2			
No. 3			

NCR for failed Ground Points filed on: _____
DATE CASE No.

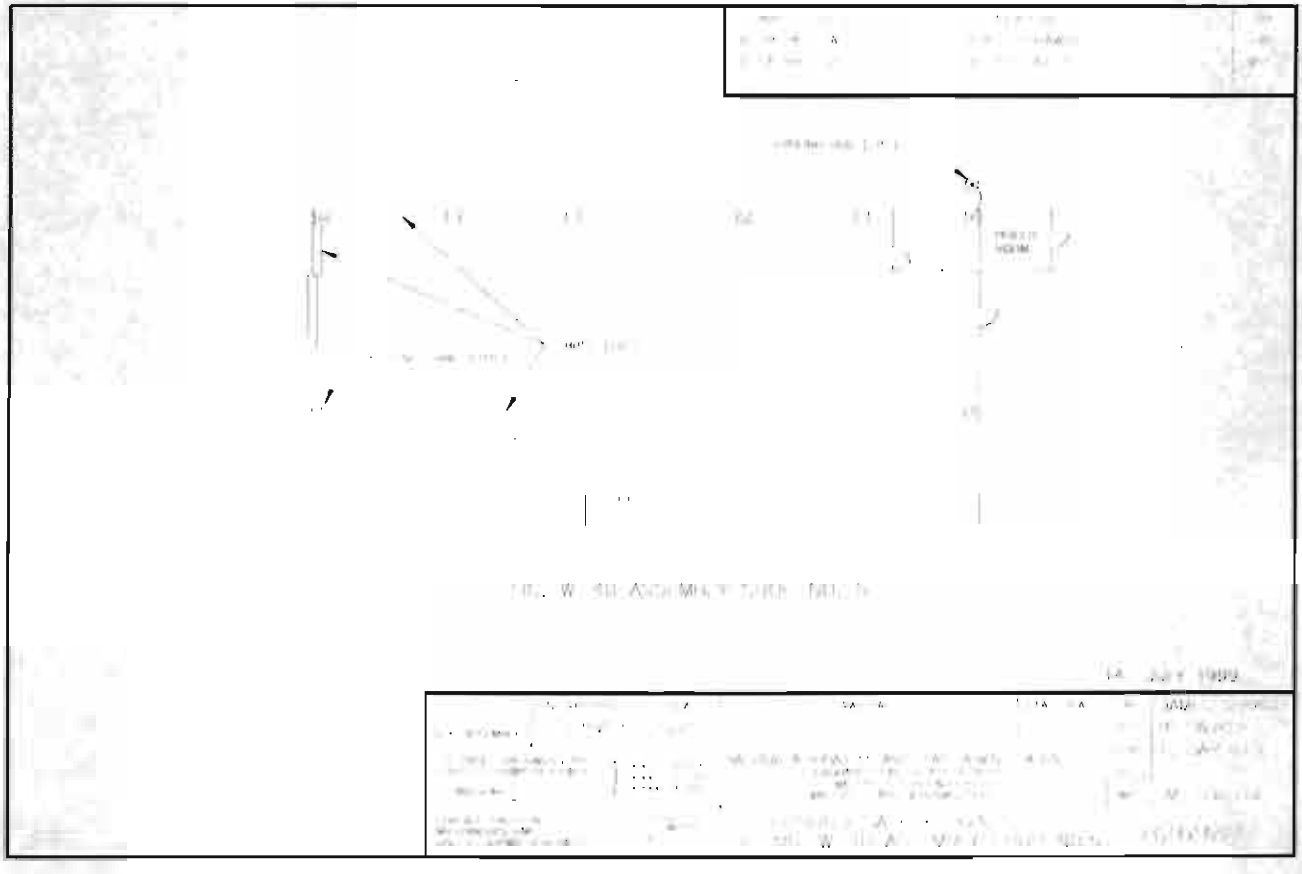
COMPLETED: _____
TECHNICIAN DATE

6-Month Visual Inspection of Pyrotechnic Grounding Points
Assembly Shop No. 5 (Building W-40)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

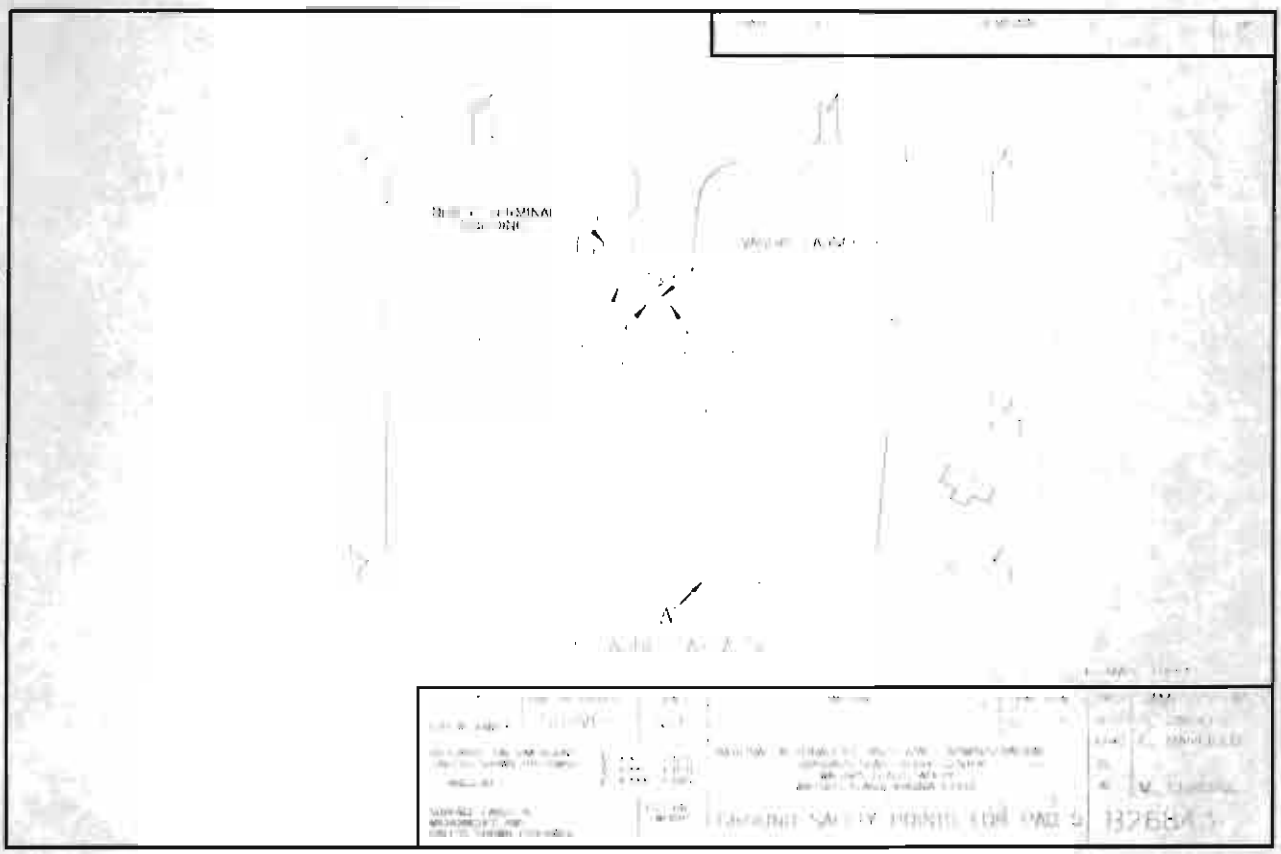


6-Month Visual Inspection of Pyrotechnic Grounding Points
Launch Pad No. 5

Ground Point	Pass	Fail	Remarks
GTP-1			
5-1			
5-2			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

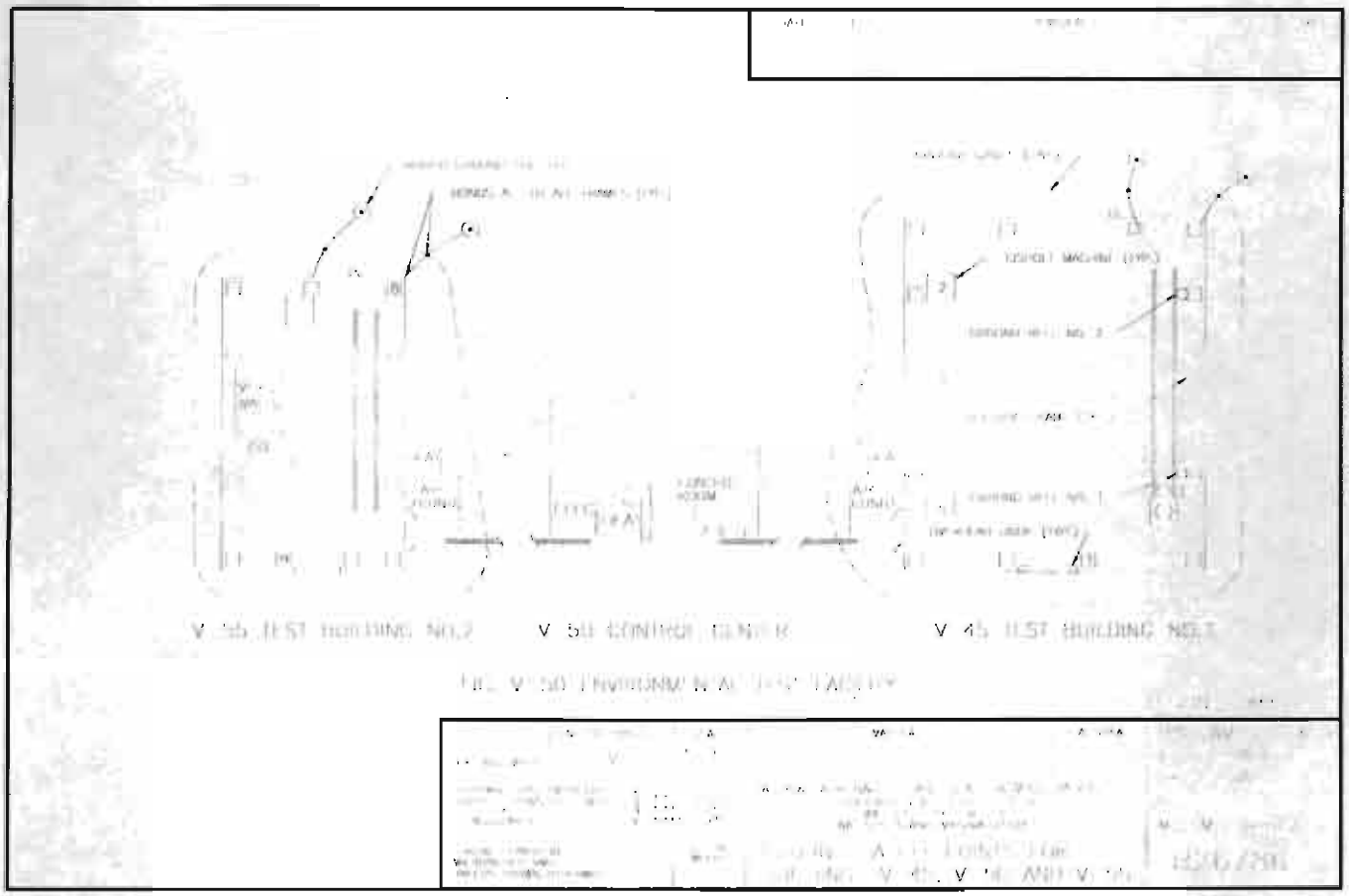


6-Month Visual Inspection of Pyrotechnic Grounding Points
Environmental Test Facility (Building V-55)

Ground Point	Pass	Fail	Remarks
No. 8			
No. 9			
No. 10			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

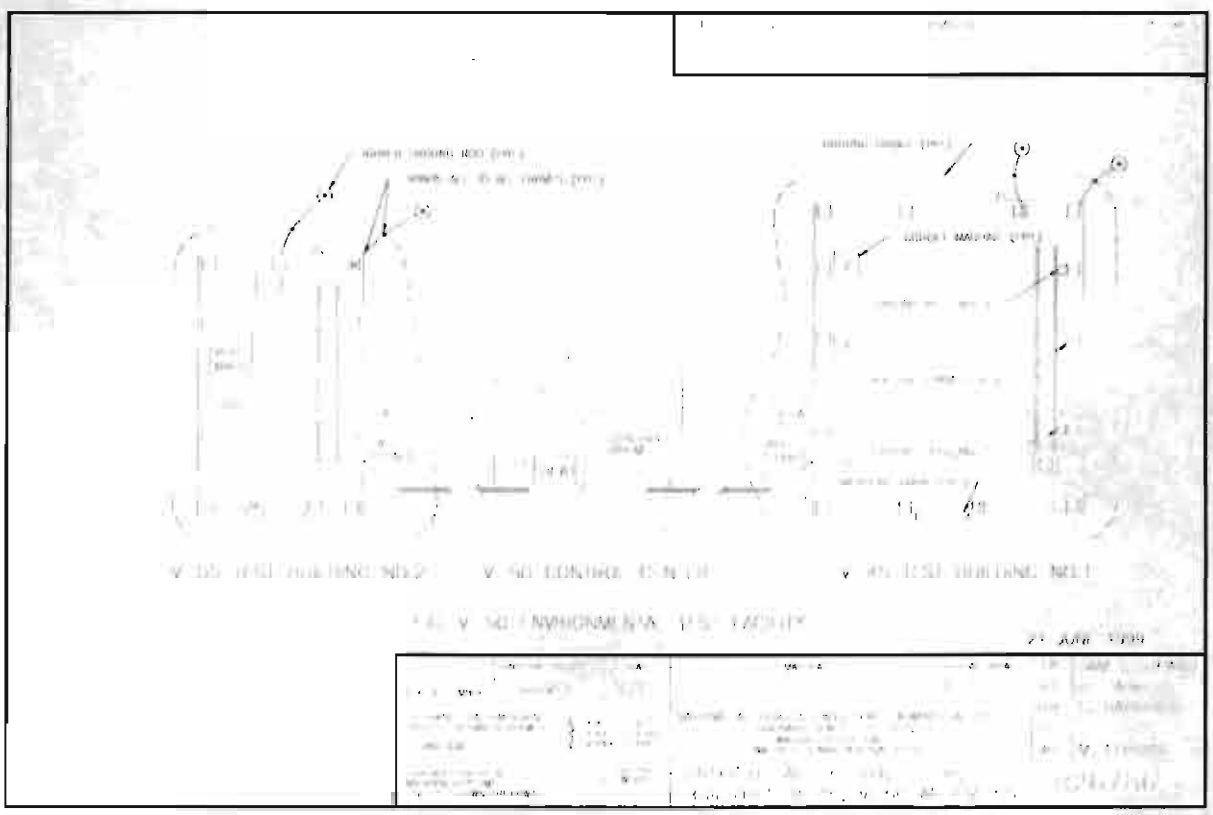


6-Month Visual Inspection of Pyrotechnic Grounding Points
Environmental Test Facility (Building V-45)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
Ground Reel No. 1			
Ground Reel No. 2			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE



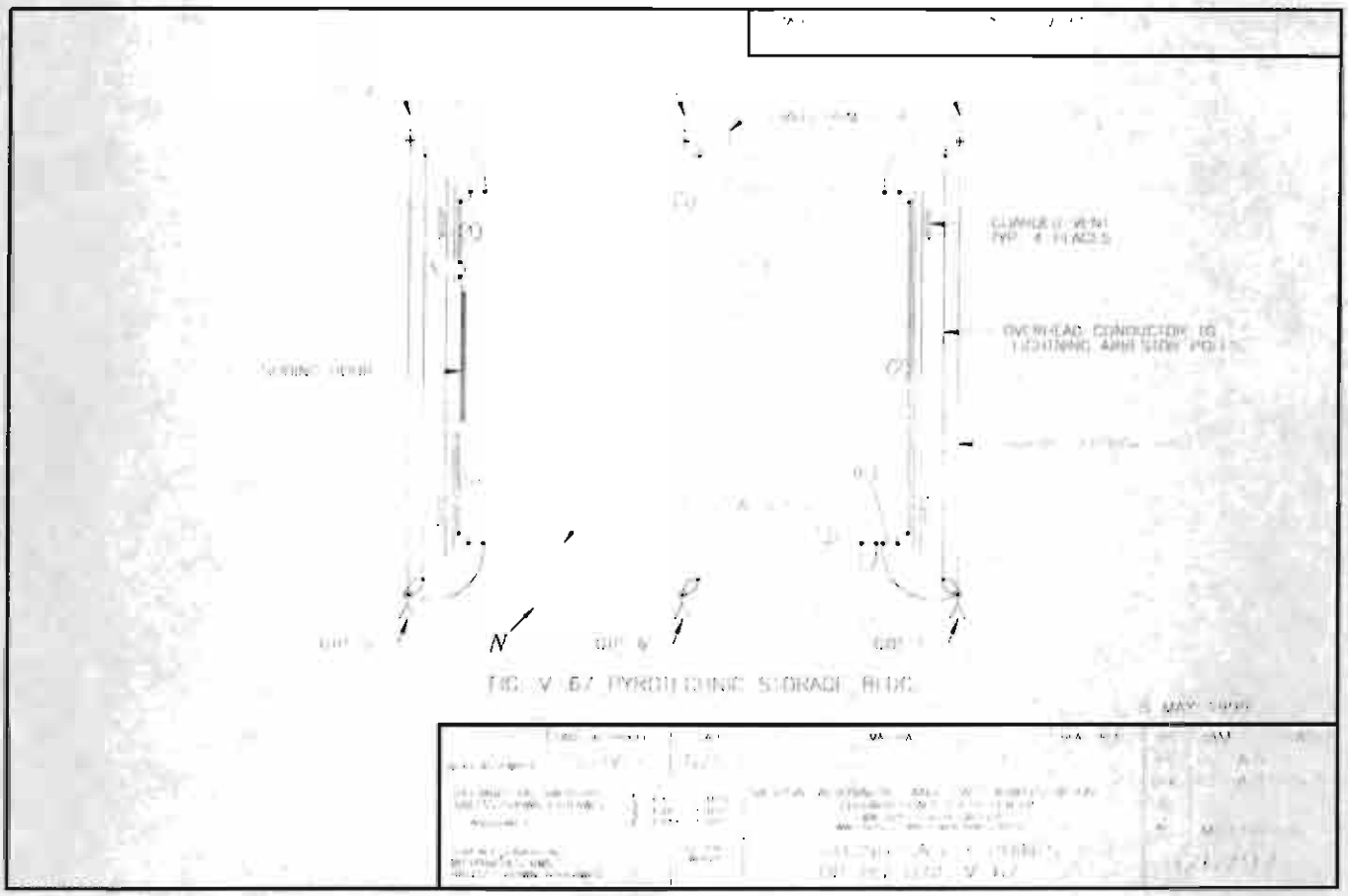
6-Month Visual Inspection of Pyrotechnic Grounding Points
Pyrotechnic Storage Facility (Building V-67)

Ground Point	Pass	Fail	Remarks
GTP-1			
GTP-2			
GTP-3			
GTP-4			
GTP-5			
GTP-6			
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

6-Month Visual Inspection of Pyrotechnic Grounding Points
Pyrotechnic Storage Facility (Building V-67)

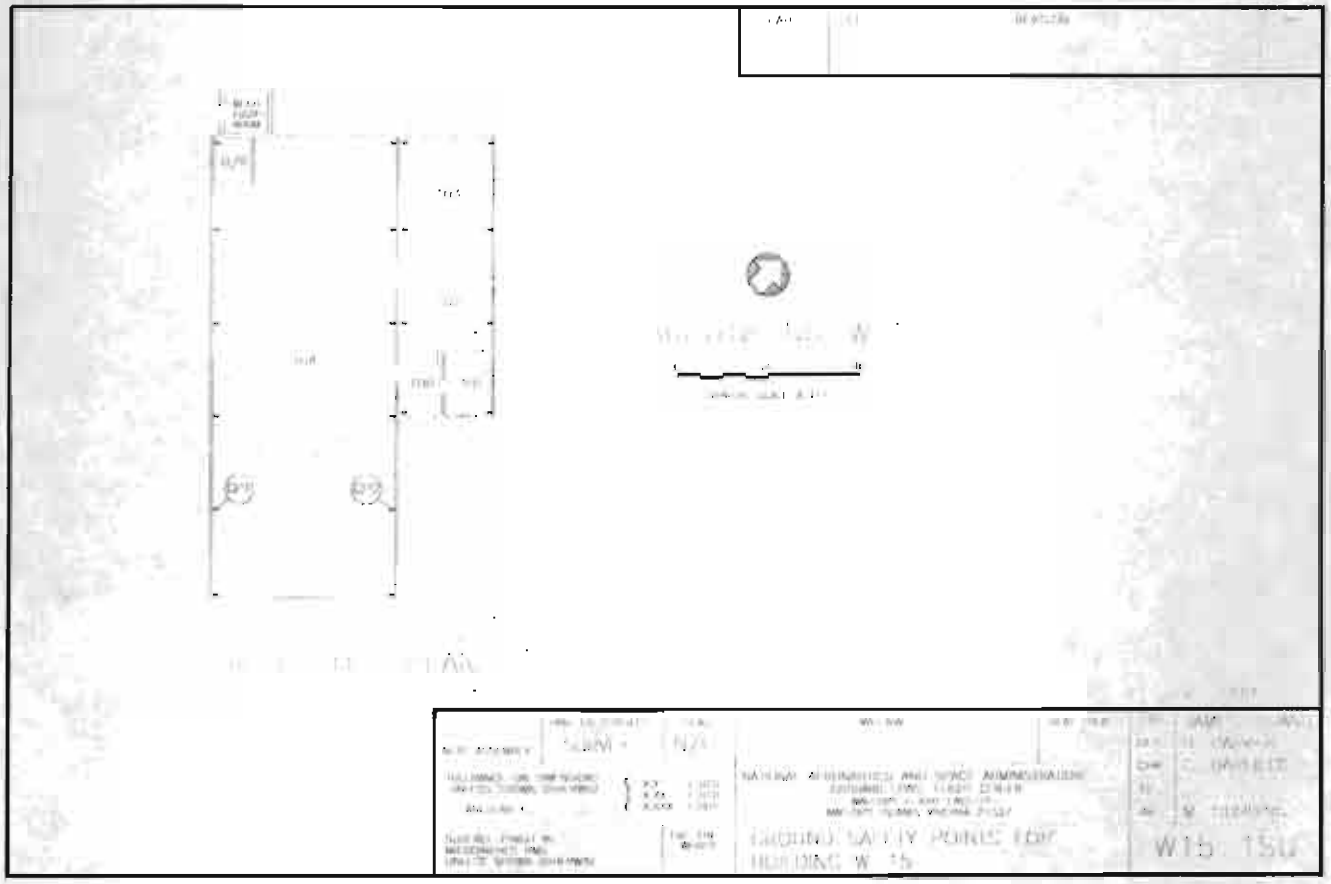


6-Month Visual Inspection of Pyrotechnic Grounding Points
Rocket Motor Storage Facility (Building W-15)

Ground Point	Pass	Fail	Remarks
GP-1			
GP-2			

NCR filed on: _____ _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

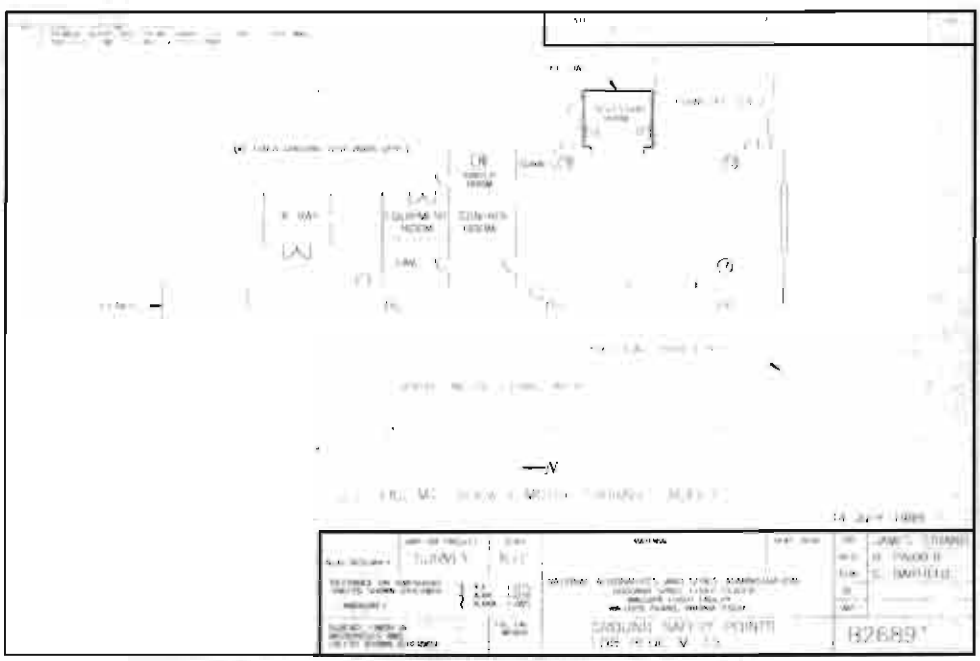


6-Month Visual Inspection of Pyrotechnic Grounding Points
Rocket Motor Storage Facility (Building M-15)

No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			
No. 7			
No. 8			
No. 9			
No. 10			
No. 11			
No. 12			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

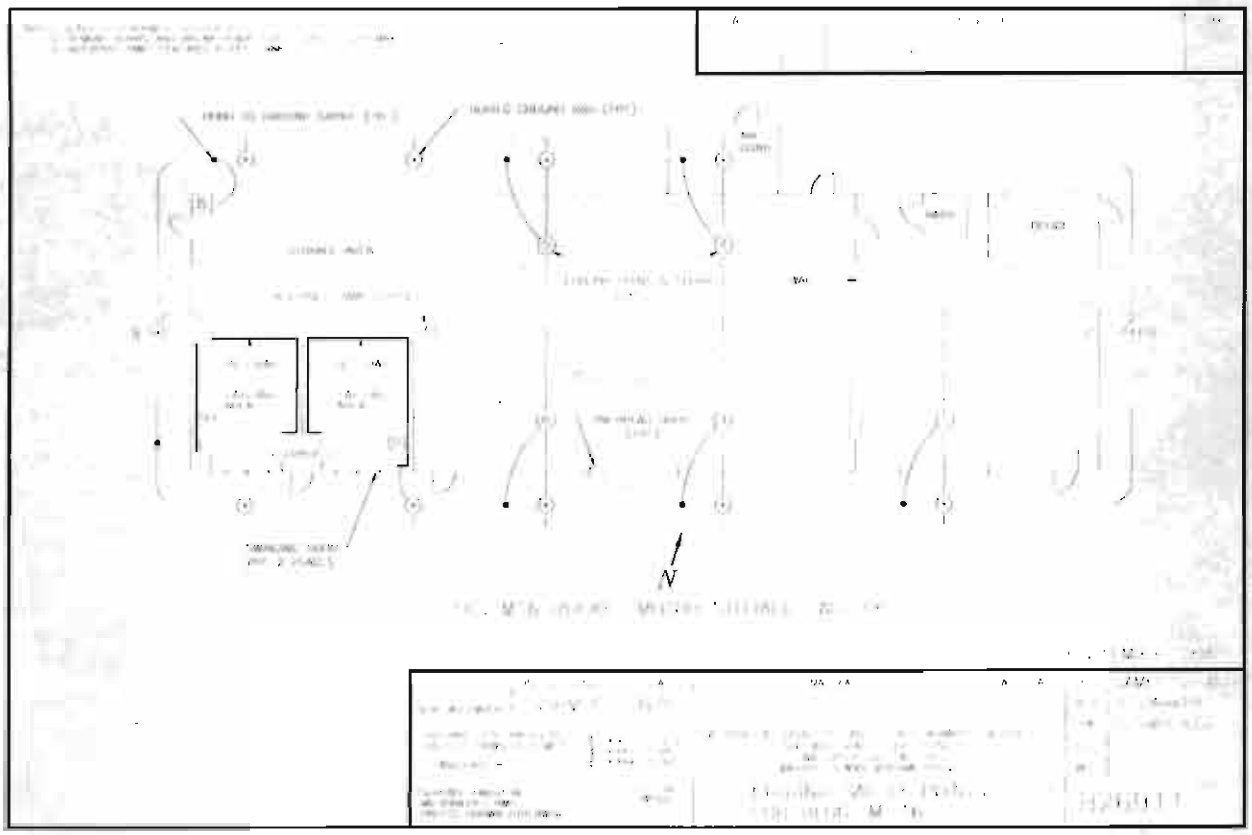


6-Month Visual Inspection of Pyrotechnic Grounding Points
Rocket Motor Storage Facility (Building M-16)

No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			
No. 7			
No. 8			
No. 9			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

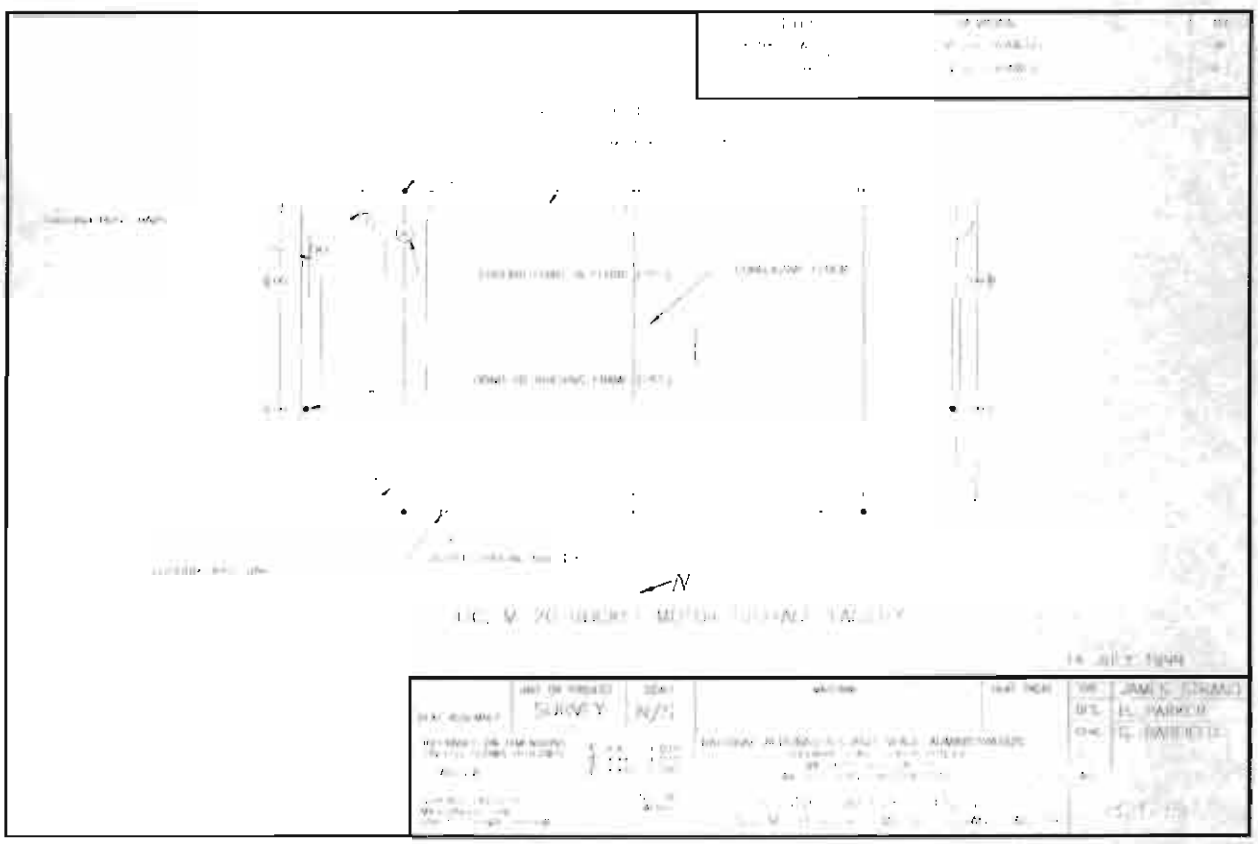


6-Month Visual Inspection of Pyrotechnic Grounding Points
Rocket Motor Storage Facility (Building M-20)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 6			
No. 7			
No. 8			
No. 9			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

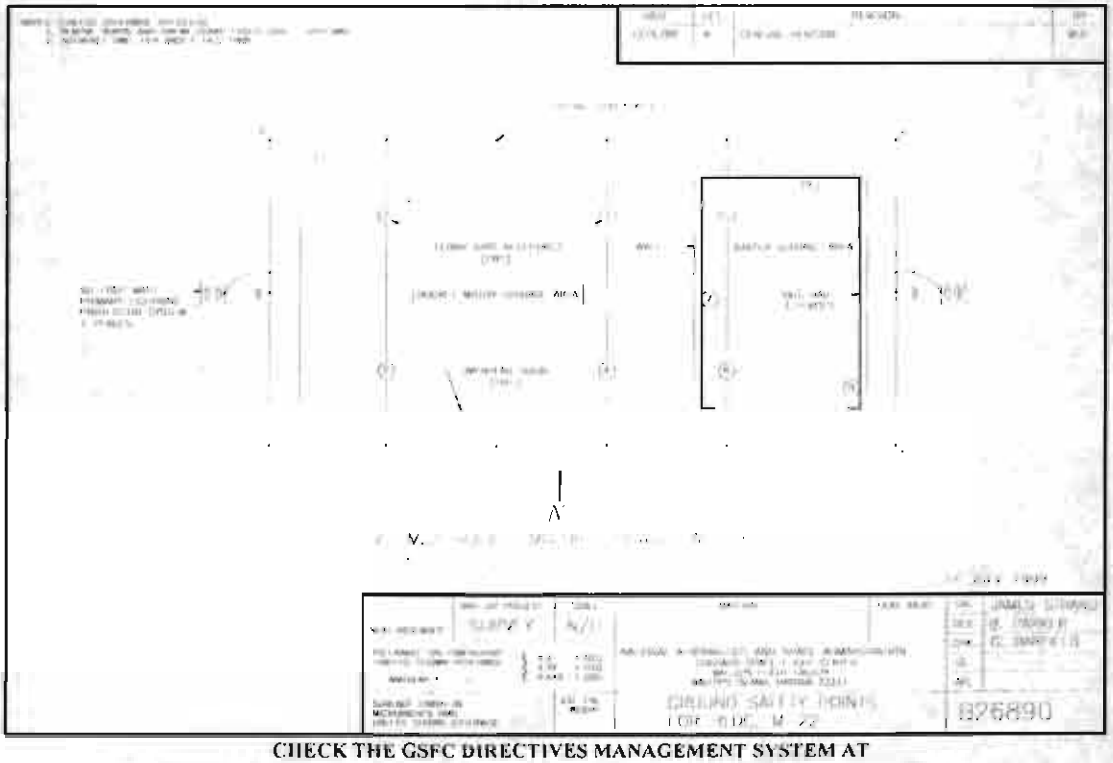


6-Month Visual Inspection of Pyrotechnic Grounding Points
Rocket Motor Storage Facility (Building M-22)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			
No. 7			
No. 8			
No. 9			
No. 10			
No. 11			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE



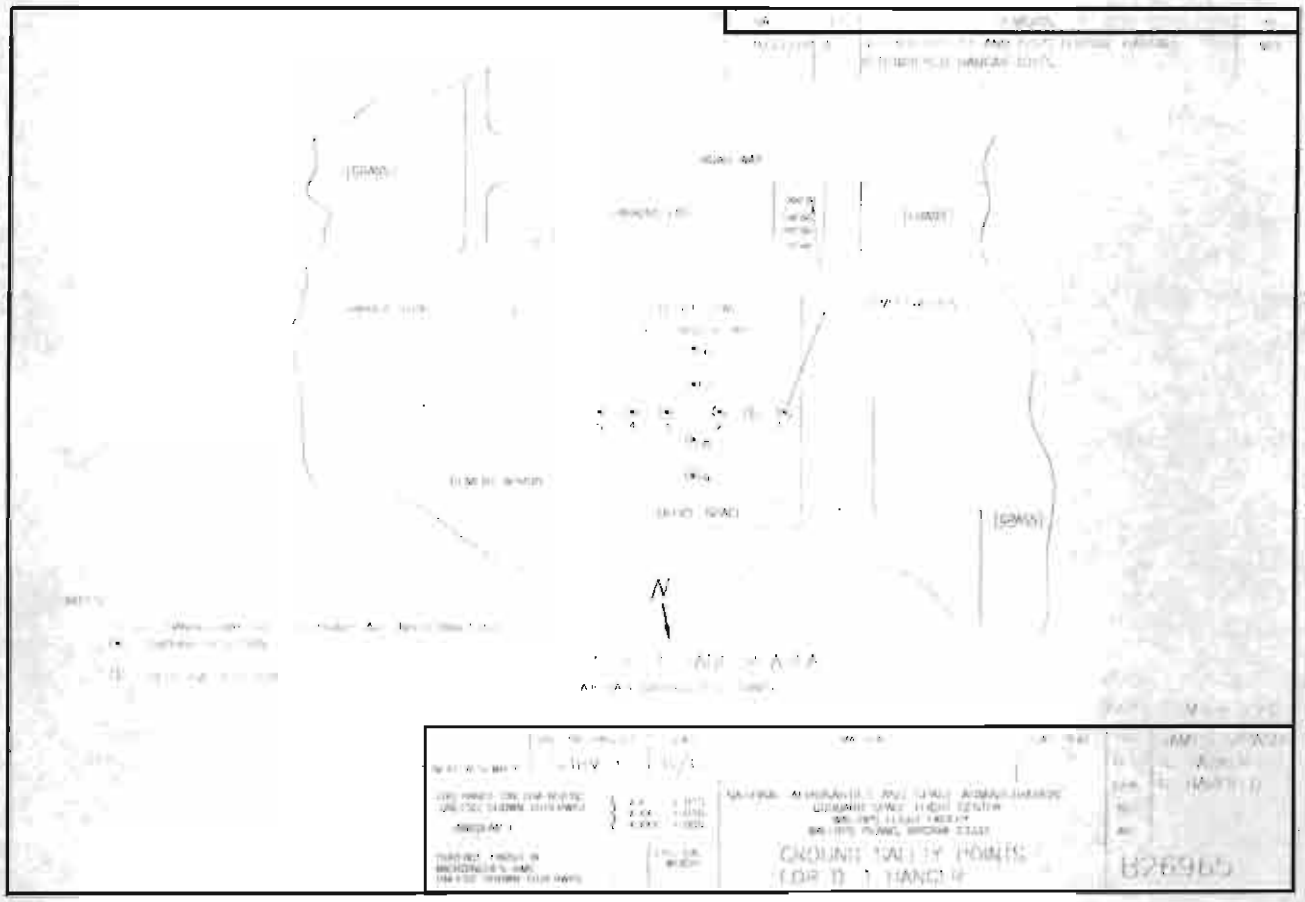
6-Month Visual Inspection of Pyrotechnic Grounding Points
Aircraft Hangar (Building D-1)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			
No. 7			
No. 8			
No. 9			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

6-Month Visual Inspection of Pyrotechnic Grounding Points
Aircraft Hangar (Building D-1)



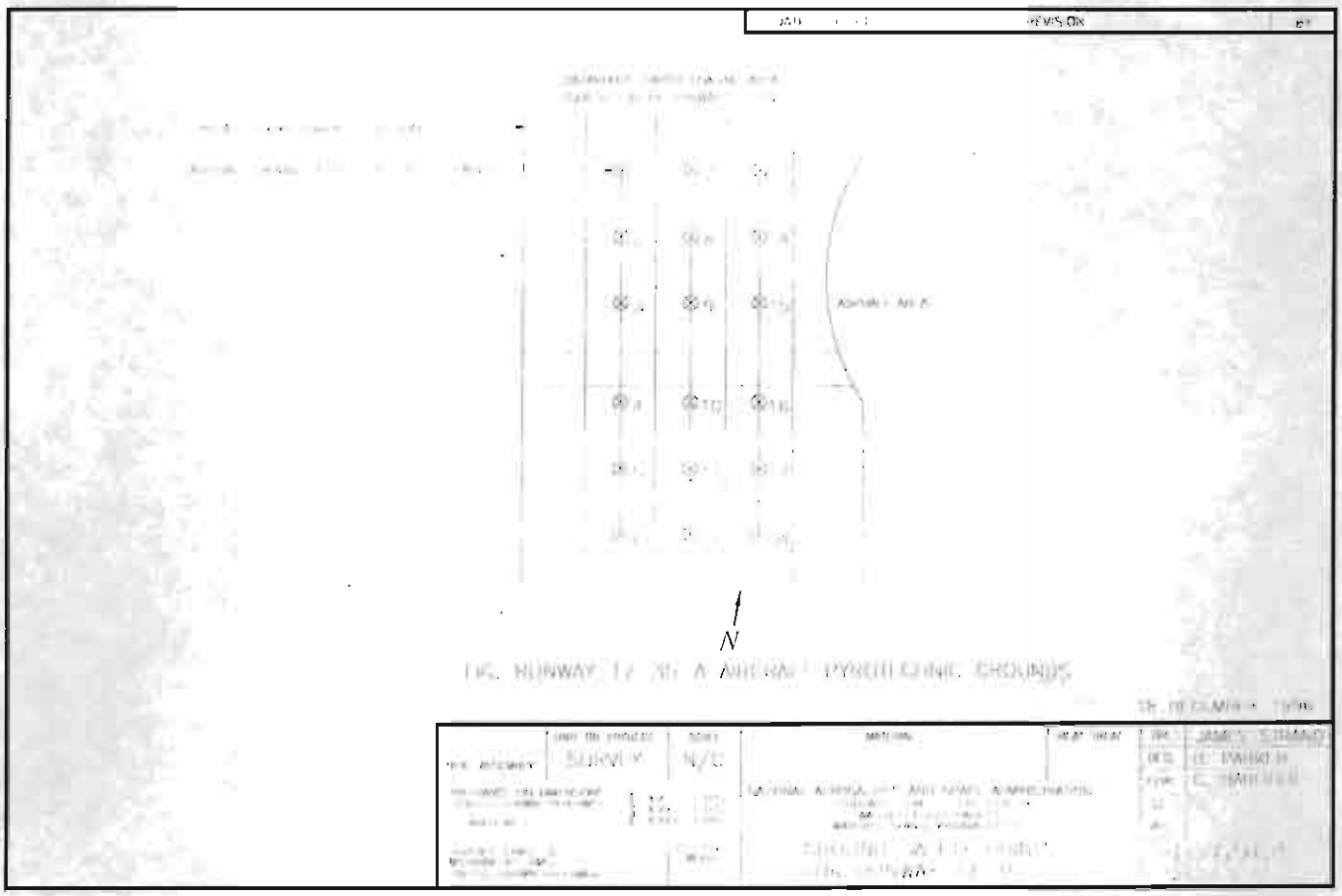
6-Month Visual Inspection of Pyrotechnic Grounding Points
Aircraft Pyrotechnic Grounds (Runway 17-35)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			
No. 7			
No. 8			
No. 9			
No. 10			
No. 11			
No. 12			
No. 13			
No. 14			
No. 15			
No. 16			
No. 17			
No. 18			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

6-Month Visual Inspection of Pyrotechnic Grounding Points
Aircraft Pyrotechnic Grounds (Runway 17-35)



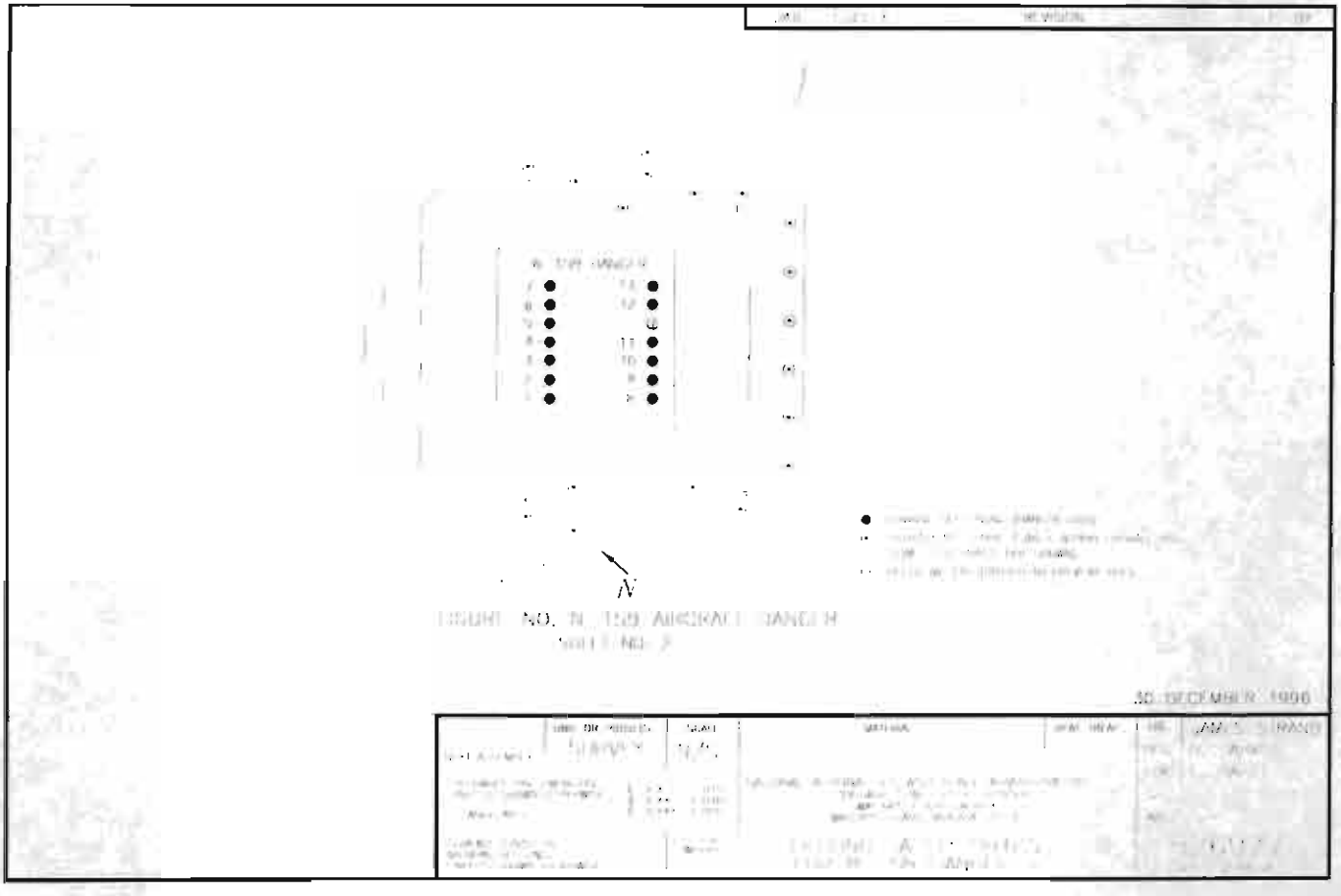
6-Month Visual Inspection of Pyrotechnic Grounding Points
Aircraft Hangar (Building N-159)

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
No. 5			
No. 6			
No. 7			
No. 8			
No. 9			
No. 10			
No. 11			
No. 12			
No. 13			
No. 14			
No. 15			
No. 16			
No. 17			
No. 18			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

6-Month Visual Inspection of Pyrotechnic Grounding Points
Aircraft Hangar (Building N-159)

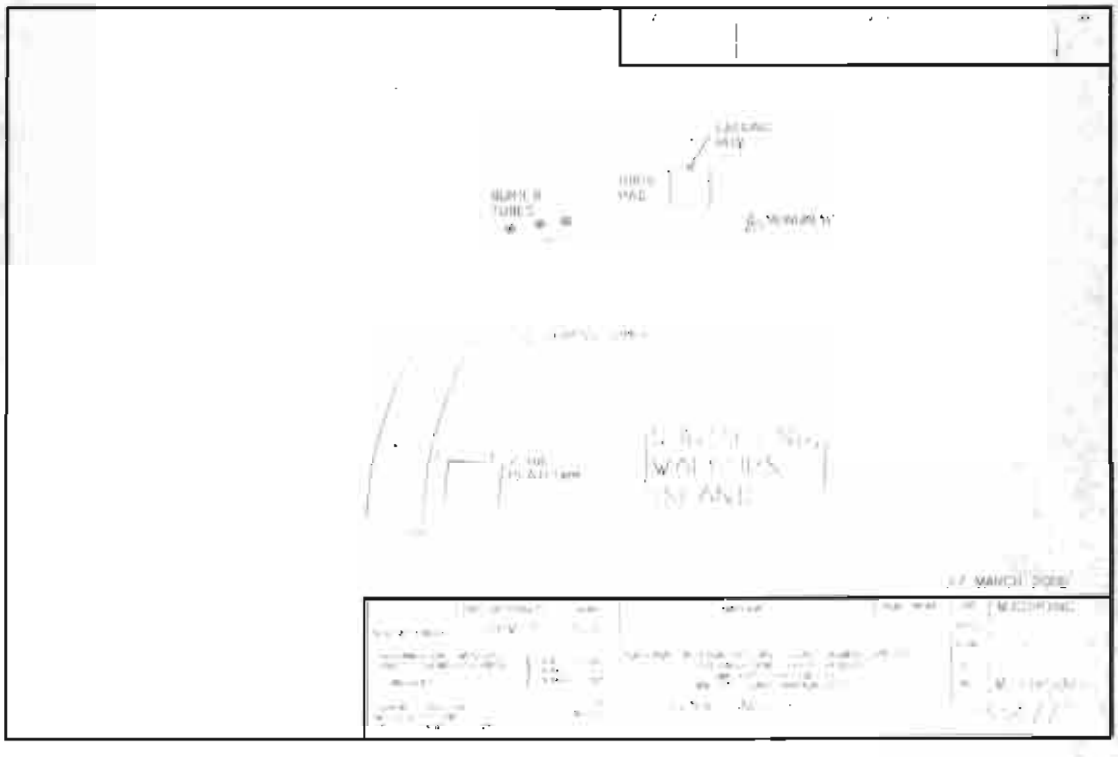


6-Month Visual Inspection of Pyrotechnic Grounding Points
GROUND MEASUREMENT DATA
OBOD Facility
South End Wallops Island, near Z100

Ground Point	Pass	Fail	Remarks
No. 1			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE

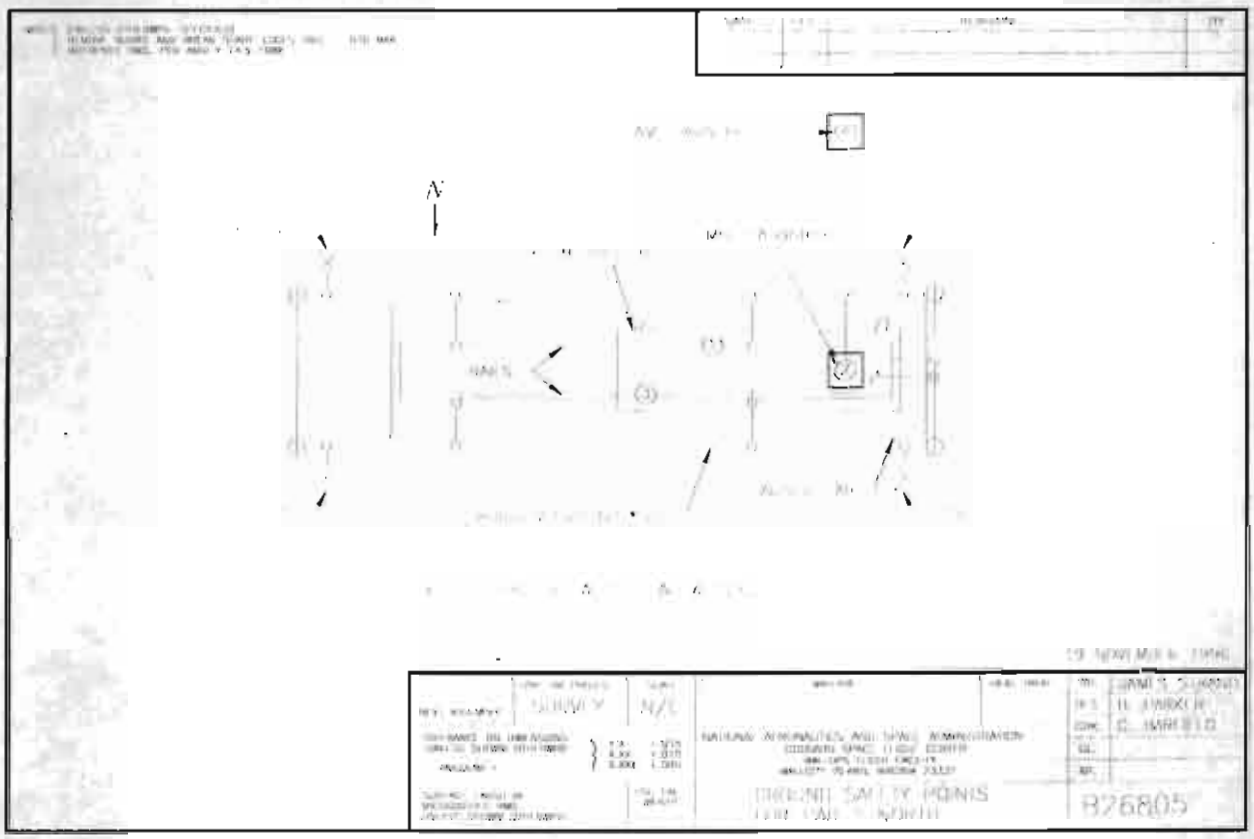


6-Month Visual Inspection of Pyrotechnic Grounding Points
Launch Pad 2 – North

Ground Point	Pass	Fail	Remarks
No. 1			
No. 2			
No. 3			
No. 4			
GTP-1			
GTP-2			
GTP-3			
GTP-4			

NCR for failed Ground Points filed on: _____
DATE CASE No.

COMPLETED: _____
TECHNICIAN DATE



CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	01/24/2000	Initial Release
A	08/11/2000	Added OBOD Facility datasheet, Canceled baseline, revised document with latest WI template, removed ref. to P/N 20-8-1, Added line 6 under instructions
B	12/04/2000	Added Launch Pad 2- North, cancelled Rev. A
C	11/01/2002	Revised D-1 hangar data sheet and figure to be consistent with 546-WI-8072.1.23, Rev. E change, Reformat on WI template, cancelled Rev. B

Work Instructions

DIRECTIVE NO. 546-WI-8072.1.44
EFFECTIVE DATE: 02/03/2000
EXPIRATION DATE: N/A

APPROVED BY Signature: original signed by
NAME: Stewart Meyers
TITLE: Branch Head

Responsible Office: 546.W Carrier Systems Branch

Title: Spin Motor Model M37A1 and Model M37E1- Disassembly for Disposal

P1. PURPOSE

To remove the solid propellant grain and igniter from Rocket Motor M37A1 (Honest John spin motor) and M37E1 (Taurus spin motor).

P2. SCOPE

This procedure is required to prepare spin motor(s) for open burn disposal. The grains and igniters will be removed and stored in containers. A Quality Record will be generated that will provide a summary of work performed and total quantities of N.E.W.

P3. DEFINITIONS

1. N.E.W.: **N**et **E**xplosive **W**eight
2. OSS: **O**peration **S**afety **S**upervisor
3. RF: **R**adio **F**requency

P4. RECORDS, REPORTS AND FORMS

Quality Record Title	Record Custodian	Retention
Completed and Signed- off Data Sheet	Designated Technician	NRRS 8/5A1 Permanent. Records may be retired to an FRC when 2 years old. Transfer to NARA 15 years after completion of the project or when 25 years old, whichever is sooner.

P5. SAFETY PRECAUTIONS AND WARNING NOTES

1. The conduct of this WI requires two personnel:
   a. one technician with valid Category II Ordnance Certification
   b. one OSS
2. The conduct of this WI shall be in an ordnance assembly building with current pyrotechnic ground certification.
3. Radio Frequency (RF) avoidance is required during conduct of this Work Instruction.
4. The technician shall use the following safety equipment during all steps in P9.
   a. Wear tested wrist static protection ('wrist stats')
   b. Wear proper eye protection
   c. Wear static dissipative shop coat

P6. REFERENCES

GPG 8072.1 Process Control

P7. TOOLS, EQUIPMENT, AND MATERIALS

1. Pipe vise stand
2. Pipe wrench
3. Diagonal cutters
4. Wire strippers
5. 5 gallon ordnance storage container, metal drum type, quantities as required labelled "Spin Motor Igniters, Container No. __, Total N.E.W.___lb. "
6. 5 gallon ordnance storage container, metal drum type, quantities as required labelled "Spin Motor Grains, Container No. __, Total N.E.W.___lb."
7. Miscellaneous lengths of ground braid with clips
8. Wrist stat, 2 ea.
9. Wrist stat tester
10. Cotton gloves
11. Safety Glasses
12. Anti-static lab coat
13. Scrap metal container on pallet
14. Scale for weighing grains and igniters
15. Stencil, "EMPTY," in 1/2 in. letters
16. White paint, aerosol can

P8. CANCELLATION

N/A

P9. INSTRUCTIONS

1. Follow all safety precautions in P5. Read Instructions 2.-23.
2. Record on the Data Sheet (pg. 4), the Building Number, and the names of the OSS and Technician. Duplicate copies of the Data Sheet as required.
3. Obtain RF avoidance. Record date and time on the Data Sheet for all clearances approved for each work period.
4. Put on wrist stats and connect to a certified pyrotechnic ground. Verify wrist stats with tester measuring between opposite hand or wrist-strap to ground. A green light indicates pass. Circle appropriate response on the Data Sheet.
5. Ground pipe vise stand to a certified pyrotechnic ground. Confirm ground by circling appropriate response on the Data Sheet.
6. Inspect igniter leads in spin motor. Twist together or short if accessible. Circle appropriate response on the Data Sheet.

7. Select motor to be disassembled, circle appropriate model number and record serial number on the Data Sheet. If not legible, record "unknown."
8. Clamp spin motor casing in pipe vise stand close to the headcap so that the nozzle is accessible for removal by the pipe wrench. Connect a ground braid jumper to the headcap. Confirm ground by circling appropriate response on the Data Sheet.
9. Using the pipe wrench, grip nozzle at the threaded connection to the motor casing. Apply torque counter-clockwise looking forward to unscrew. Nozzle will separate with igniter leads remaining attached to the igniter in the grain.
10. Cut igniter leads. Strip. and twist leads together. Confirm action by circling appropriate response on the Data Sheet.
11. Dispose nozzle in scrap metal container.
12. Put on cotton gloves. Grasp grain and pull out of casing. Place grain in container labelled "Spin Motor Grains." Record container number on the Data Sheet.
13. Remove disc type igniter. Place igniter in container labelled "Spin Motor Igniters." Record container number on the Data Sheet.
14. Remove motor case from stand. Label "Empty" and dispose in scrap metal container.
15. Repeat steps 4 through 14 for all motors to be disposed. Release RF avoidance between work periods. Record date and time on the Data Sheet for each RF closure. Maintain RF avoidance if proceeding to next step.
16. Measure one sample weight for each grain and igniter type and record on the Summary Data Sheet (pg. 5).
17. After all motors are disassembled, seal all containers.
18. Release RF avoidance. Record date and time on the Data Sheet. Remove safety equipment.
19. Complete container summary tables on the Summary Data Sheet.
20. Label each container with total N.E.W. (lb.) content.
21. Sign and date the Summary Data Sheet to indicate completion of the procedure.
22. Store containers in an approved ordnance storage area for Class 1.1.
23. Take all scrap metal to disposal.

P9. FLOW DIAGRAM

N/A

Quality Record Data Sheet
Sheet __of__

Building Number_____
Name of OSS_____ Name of Technician_____
RF Avoidance Obtained (DD/MM/YR.time) _____ _____ _____ _____
RF Avoidance Released (DD/MM/YR.time) _____ _____ _____ _____

Motor Type (circle one)	Record Serial Number	Wrist Stat Test (Pass/Fail)	Verify Vise Grounded (Yes/No)	Inspect Igniter Leads-Twisted or Grounded (Yes/Not Accessible)	Headcap Grounded (Yes/No)	Strip and Twist Ignition leads (Yes/No)	Grain Collection Container Number	Igniter Collection Container Number
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		
M37A1 / M37E1		P / F	Y / N	Y / n/a	Y / N	Y / N		

Quality Record Data Sheet
Sheet __of__

Summary Data

M37A1 Grain N.E.W. (measured sample, lb.) _____ M37A1 Igniter N.E.W. (measured sample, lb.) _____

M37E1 Grain N.E.W. (measured sample, lb.) _____ M37E1 Igniter N.E.W. (measured sample, lb.) _____

Total Number of M37A1 Motors Disassembled _____

Total Number of M37E1 Motors Disassembled _____

Container Number	Total Quantity M37A1 Grains	Total Quantity M37E1 Grains	Total N.E.W. (lb.)
Totals:			

Container Number	Total Quantity M37A1 Igniters	Total Quantity M37E1 Igniters	Total N.E.W. (lb.)
Totals:			

Work Instruction Completed _____
Technician Date

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	02/03/2000	Initial Release

Work Instruction

DIRECTIVE NO.	546-WI-8072.1.22 Rev B	**APPROVED BY Signature:**	Original signed by
EFFECTIVE DATE:	03/22/2002	**NAME:**	Stewart Meyers
EXPIRATION DATE:	N/A	**TITLE:**	Branch Head

Responsible Office: 546.W/Carrier Systems Branch

Title: Open Burning Procedure

PREFACE

P1. PURPOSE

This procedure describes how the solid propellant is burned at Wallops Flight Facility.

P2. APPLICABILITY

546.W Range Team

P3. REFERENCES

GPG 8072.1 Process Control

P4. CANCELLATION

546-WI-8072.1.22 Rev A

P5. TOOLS, EQUIPMENT, AND MATERIALS

EQUIPMENT REQUIRED:

Portable Firing Box
Pyro-Voltmeter
Igniter Circuit Tester
Igniter
Belden Cable (15', 2 conductor, shielded)
Transport Vehicle

P6. SAFETY PRECAUTIONS AND WARNING NOTES

1. Prior to any operation involving ordnance disposal at Wallops Flight Facility, the site designated for hazardous waste disposal shall be inspected to (a) detect any possible deterioration of equipment, (b) verify calibration of monitoring equipment, and (c) inspection of safety and emergency equipment and other devices to be utilized during the operation. Equipment/Site Inspection Log (Page 10) must be completed.

2. Prior to commencing Open Burn/Open Detonation (OBOD) operations verify the following:

   a. Notification to Range Control for them to make an announcement on the public address system that an OBOD operation is about to commence.

   b. Notification to all Island Personnel (in the immediate area) and Damage Control that an OBOD operation is about to commence.

   c. Damage Control will have personnel available with Haz-Mat training located at the disposal area barricade during the OBOD operations.

   d. Operations Safety Supervisor is present with a Ground Safety Plan.

Pad Supervisor

SAFETY/SECURITY ITEMS REQUIRED:

Standby Fire Protection
Standby Emergency First Aid
Haz-Mat Personnel
Barricade
Road Block Stands
2-Way Communications
Warning Signs
Wrist-stats
Wrist-stat checker
Grounding Straps
Safety Coats/Coveralls/Shoes
Safety Glasses/Goggles
Protective Head Gear/Face Shields
Hearing Protection

P7. TRAINING

On the job training is required to perform this work instruction.

P8. RECORDS

Quality Record Title	Record Custodian	Retention
Completed and Signed- off Procedure	Designated Technician	NRRS 8/5A1 Permanent. Records may be retired to an FRC when 2 years old. Transfer to NARA 15 years after completion of the project or when 25 years old, whichever is sooner.

P9. METRICS

N/A

P10. DEFINITIONS

N/A

INSTRUCTIONS

DATE: _____

REQUESTED BY: _____

TYPE OF PROPELLANT: _____

NET EXPLOSIVE WEIGHT: _____

REASON FOR DESTROYING: Excess Rocket Propellant and Outdated Pyrotechnics

TASK A - IGNITER CHECKOUT

The following steps are to be completed at the assembly building prior to transferring the igniter to the disposal area.

WARNING: Personnel must wear static dissipative clothing and wrist-straps. Verify wrist-straps have been tested (1 to 10 MΩ opposite hand or wrist-strap to ground).

1. Obtain RF Avoidance.

_____
TECHNICIAN

WARNING: A circuit anomaly in some igniter circuit testers (Alinco) make the device capable of initiating the electro-explosive device bridgewire. Before using an igniter circuit tester the following confidence test must be performed:

A. Connect a calibrated pyrotechnic voltmeter (the same voltmeter used for vehicle arming) to the input terminals of the Alinco and verify no AC or DC voltage output. Use 2.5 volt scale.

NO VOLTAGE VERIFIED _____ _____
TECHNICIAN

B. Depress "Key" switch and verify battery voltage is no more than 0.5 VDC, and no less than 0.25 VDC (to ensure battery is good and Alinco will work properly).

VDC _____ _____
TECHNICIAN

C. Disconnect voltmeter and connect calibrated NASA/WFF, 0-25 mA DC, milliammeter to the input terminals of the Alinco.

D. Set Alinco "Range" switch to the minimum setting, set the ohms dial indicator to "0.00", and press "key" switch. Milliammeter should indicate less than 5 milliamperes.

mA _____ _____
TECHNICIAN

E. If milliammeter indicates more than 5 milliamperes at any time, reject the Alinco and schedule it for repair before reuse.

mA _____ PASS/FAIL _____ _____
TECHNICIAN

2. Remove igniter from container and place on a grounded workbench.

   Igniter Type _____ Igniter Serial Number_____

   Igniter Lot Number _____ Date of Manufacturer_____

   Measure igniter bridgewire resistance _____

3. Measure and record the resistance of the 15 ft. shielded Belden cable. Provide this measurement to the Firing Console Operator.

   Resistance: _____

4. Connect the Belden cable to the ignition leads. Short and shield the leads opposite igniter.

   _____
   TECHNICIAN

5. Place igniter back in a **metal** shipping container for transportation to the disposal area.

6. Release RF Avoidance.

   _____
   TECHNICIAN

TASK B – PREPARATION FOR OPEN BURN/OPEN DETONATION

WARNING: Wrist-straps and static dissipative clothing must be worn when working/handling igniters or open propellant.

1. Place propellant in the transport container.

2. Transport igniter and propellant to the disposal area.

3. Obtain RF Avoidance.

_____
TECHNICIAN

4. Remove propellant (not to exceed 50 lb.) and the igniter from the transport containers. Ground to the grounding rod located near the OBOD pad.

_____
TECHNICIAN

5. Place igniter (with leads protruding) in the bottom of the 3' x 3' x 1-1/4' pre-constructed OBOD cinder-block enclosure (located on the pad). Ground igniter leads.

_____
TECHNICIAN

6. Place propellant (not to exceed 50 lb.) in the enclosure.

_____
TECHNICIAN

TASK C - OPEN BURN OPEN DETONATION OPERATION

1. Firing Console Operator will perform VA checks in accordance with established procedures.

2. Verify RF Avoidance is still in place.

   TECHNICIAN

3. Operations Safety Supervisor will clear the disposal danger area of all non-essential personnel.

   OSS

4. Verify AC portable firing box is disconnected from the firing line and is shorted.

   TECHNICIAN

5. Verify firing line is shorted at the barricade.

   TECHNICIAN

6. Confirm firing line is grounded and shorted (measure resistance).

   Record Resistance _____

   TECHNICIAN

WARNING: Wrist-straps and static dissipative clothing must be worn

7. Using a pyro-voltmeter check for NO VOLTAGE on firing line.

	No-Voltage
Line A to Line B	
Firing Line A to Ground	
Firing Line B to Ground	

   TECHNICIAN

8. If NO VOLTAGE is present connect firing cable to the shielded Belden cable (connected to the igniter).

   TECHNICIAN

9. Operations Safety Supervisor will clear ALL personnel from the disposal danger area and proceed to the barricade.

OSS

10. Firing Console Operator will measure total resistance of firing line plus igniter in accordance with established procedures.

11. Release RF Avoidance

TECHNICIAN

12. Pad Supervisor will notify Range Control that the OBOD operations are ready to commence.

TECHNICIAN

13. Operations Safety Supervisor shall verify that the disposal area is clear and all personnel are behind the barricade.

OSS

14. Firing Console Operator will perform firing console operation in accordance with established procedures.

15. The Pad Supervisor shall verbally count down from 10 seconds.

16. At T-0 the Firing Console Operator will ignite the igniter.

17. In the event of a NO-FIRE, proceed to TASK D, of this procedure, and notify Range Control that a NO-Fire has occurred.

TECHNICIAN

18. If propellant has been successfully disposed; wait approximately 15 minutes then commence with clean up of OBOD site. Store residuals in approved hazardous waste container.

19. Disconnect the firing lead from the portable AC firing box.

20. Notify Range Control that the OBOD operations are complete.

TECHNICIAN

TASK D - NO FIRE OPERATION

IN THE EVENT OF NO-FIRE, ALL PERSONNEL WILL REMAIN BEHIND THE BARRICADE

1. From the barricade measure the line resistance to determine if the squibs have been fired.

   Line Resistance _____

   _____
   TECHNICIAN

2. If the squibs have not fired, the ignition current should be increased (no more than 2 times the recommended firing current) and a second attempt will be made to fire the squibs.

   Ignition Current _____

   _____
   TECHNICIAN

3. If the squibs fail again, all operations will stop; Range Control shall be notified that OBOD operations have been terminated.

   _____
   TECHNICIAN

4. Disconnect and short the firing leads from the portable AC firing box.

   _____
   TECHNICIAN

5. All personnel shall remain behind the barricade for a minimum of 30 minutes.

6. After the 30 - minute wait, all personnel shall leave the area. Roadblocks positioned at the barricade will be manned for an additional 30 minutes.

7. Obtain RF avoidance.

   _____
   TECHNICIAN

8. Proceed to the pad and short the igniter leads (Belden cable).

9. Remove the igniter and examine.

   _____
   TECHNICIAN

FLOW DIAGRAM

N/A

EQUIPMENT/SITE INSPECTION LOG

Equipment/Facility	Condition	Corrective Action	Comments
Facility			
Concrete anchors			
Certified pyrotechnic ground			
Safety/Security			
Grounding straps			
Barricade			
Road block stands			
Warning signs			
2-Way Communications			
Stand-by Fire Protection			
Haz-Mat Specialist			
Stand-by Emergency First Aid			
Wrist-stats			
Safety Coats/Coveralls			
Safety Glasses/Goggles			
Safety Shoes			
Protective head gear			
Face Shields			
Equipment			
Igniter Circuit Tester			
Firing lines			
Pyro-Voltmeter			
Igniter leads			
Pettibone crane			
Lifting Strap			
Torque wrenches			
Miscellaneous			
Weather Conditions			

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	05/05/1999	Initial Release
A	09/06/1999	Added Quality Record Block; Updated location of Wallops Procedure
B	03/22/2002	Removed "(PN 13-2-2)" from title; re-formatted with latest WI template; incorporated instructions for PN 13-2-2 into WI

Work Instruction

DIRECTIVE NO.	546-WI-8072.1.17 Rev B	**APPROVED BY Signature:**	Original signed by
EFFECTIVE DATE:	03/22/2002	**NAME:**	Stewart Meyers
EXPIRATION DATE:	N/A	**TITLE:**	Branch Head

Responsible Office: 546.W/Carrier Systems Branch

Title: Tomahawk Static Firing

PREFACE

P1. PURPOSE

This procedure describes how the Tomahawk rocket motor will be static fired at Wallops Flight Facility. It includes the motor inspection, igniter checkout, preparation for static firing, firing operations, and no-fire operations.

P2. APPLICABILITY

546.W Range Team

P3. REFERENCES

GPG 8072.1	Process Control
WI-546-8072.1.47	Igniter Circuit Tester Confidence Test
Drawing (D29608)	Tomahawk Static Fire Fixture Assembly

P4. CANCELLATION

546-WI-8072.1.17 Rev A

P5. TOOLS, EQUIPMENT, AND MATERIALS

Portable Firing Box
Pyro-Voltmeter
Pettibone Crane
Forklift
Cajun Hold-Down Collar (6-1/4 inches inside diameter - steel)
10 x 32 x 5/8 Bolts (8 each)
Tomahawk Head Cap Fixture
Nylon Lifting Strap (5 ft., 3,000 lbs. capacity, 1 each)
Belden Cable (15', shielded)
Inhibisol Cleaning Solvent or Equivalent
Calibrated Torque Wrench (0 - 100 ft. lb.)
Transport Vehicle

P6. SAFETY PRECAUTIONS AND WARNING NOTES

1. Prior to any operation involving ordnance disposal at Wallops Flight Facility, the site designated for hazardous waste disposal shall be inspected to (a) detect any possible deterioration of equipment, (b) verify calibration of monitoring equipment, and (c) inspection of safety and emergency equipment and other devices to be utilized during the operation. Equipment/Site Inspection Log (page 14) must be completed.

2. Prior to commencing static firing operations verify the following:

   a. Notification to Range Control for them to make an announcement on the public address system that static firing is about to commence.

   b. Notification to all Island Personnel (in the immediate area) and Damage Control that static firing is about to commence.

   c. Damage Control will have personnel available with Haz-Mat training located at the disposal area barricade during the static firing operations

   d. Operations Safety Supervisor is present with a Ground Safety Plan

_____
Pad Supervisor

3. A circuit anomaly in some igniter circuit testers make the device capable of initiating the electro-explosive device bridgewire. Before each use of an igniter circuit tester, a confidence test must be performed in accordance with WI-546-8072.1.47, "Igniter Circuit Tester Confidence Test."

4. Wrist-stats, static dissipative clothing, and safety glasses must be worn when checking or handling pyrotechnics.

5. Wrist-stats must be checked for proper resistance prior to use. If wrist-stats are removed, resistance check must be repeated. . Acceptable wrist-stat resistance measurement shall be 1 MΩ to 10 MΩ opposite hand or wrist-stat to ground.

6. Hard hats and safety clothing are required for motor lifting.

7. Read precautions in Materials Safety Data Sheets (MSDS) prior to using any chemicals.

8. Safety glasses and rubber gloves must be worn when using cleaning solvents.

9. Safety glasses/visors must be worn during cutting, sanding, or drilling operations

SAFETY/SECURITY ITEMS REQUIRED:

Standby Fire Protection
Standby Emergency First Aid
Haz-Mat Personnel
Barricade
Road Block Stands
2-Way Communications
Warning Signs
Wrist-stats
Wrist-stat checker
Grounding Straps
Safety Coats/Coveralls/Shoes
Safety Glasses/Goggles
Protective Head Gear/Face Shields
Rubber Gloves
Torque Wrench

P7. TRAINING

On the job training is required to perform this work instruction.

P8. QUALITY RECORDS, REPORTS, AND FORMS

Quality Record Title	Record Custodian	Retention
Completed and Signed- off Procedure	Designated Technician	NRRS 8/5A1 Permanent. Records may be retired to an FRC when 2 years old. Transfer to NARA 15 years after completion of the project or when 25 years old, whichever is sooner.

P9. METRICS

N/A

P10. DEFINITIONS

C.G.- Center of Gravity
VA- Volt-Amp
OSS- Operations Safety Supervisor
mA- Milli-Amperes

INSTRUCTIONS: TOMAHAWK STATIC FIRING PROCEDURE

DATE: _____

MOTOR: _____

P/N _____ **S/N** _____
(if available)

REQUESTED BY: _____

METHOD OF DESTROYING: TUBE _____ **PAD** _____

REASON FOR DESTROYING: _____

_____

TASK A - QUALITY ASSURANCE

1. Technician will verify that the required procedural steps are accurately performed and complete. To attest that this has been accomplished, the technician will enter their name on each sign off indicating satisfactory completion of each step as performed. Discrepancies will be listed at the end of each task and initialed by the OSS.

2. Verify that all handling and lifting devices have been properly load tested and are within certification due date.

   _____
   TECHNICIAN

3. Verify that all measuring equipment has a valid calibration certification.

   Calibrated Torque Wrench (0 - 100 ft. lb.), Calibration Due Date_____
   Calibrated Torque Wrench (0-240 in. lb.), Calibration Due Date_____

4. Verify that all calibrated instrumentation has a valid calibration certification.

Igniter Circuit Tester_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Milliammeter _____
Manufacturer _____
Model No._____
Calibration Due Date_____

Pyro-Voltmeter_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Blasting Galvanometer_____
Manufacturer _____
Model No._____
Calibration Due Date_____

5. Verify no-voltage on crane hook in building.

_____
TECHNICIAN

TASK B – MOTOR INSPECTION AND IGNITER CHECKOUT

The following steps are to be completed at the assembly building prior to transferring the motor to the disposal area.

WARNING: Personnel must wear static dissipative clothing and wrist-stats. Verify wrist-stats have been tested (1 to 10 MΩ opposite hand or wrist-stat to ground).

1. Obtain RF Avoidance.

_____
TECHNICIAN

2. Remove motor and igniter container from shipping container. Place motor on transport trailer.

3. Verify provider of motor performed modified inspection of motor and igniter for disposal.
4. Remove igniter from container.

Igniter Lot Number _____ Date of Manufacturer_____

Record igniter bridgewire resistance _____
(obtained from the manufacturer's data sheet)

5. Measure and record the resistance of the 15 ft. shielded Belden cable. Provide this measurement to the Firing Console Operator.

Resistance: _____

6. Connect the Belden cable to the ignition leads. Short and shield the leads opposite igniter.

TECHNICIAN

7. Place igniter back in a metal shipping container for transportation to the disposal area.

8. Release RF Avoidance.

TECHNICIAN

TASK C – PREPARATION FOR STATIC FIRING

1. Transport motor and igniter to disposal area.

2. Ground motor to the certified grounding rod located near the static firing tube or static firing pad.

TECHNICIAN

WARNING: Wrist-stats and static dissipative clothing must be worn when working with igniters or initiators

3. Obtain RF Avoidance.

TECHNICIAN

4. Remove shipping closure from igniter boss. Using Inhibisol cleaning solvent clean igniter boss and igniter threads.

5. Visually inspect the igniter boss and igniter threads for evidence of corrosion, burrs, or other defects.

6. Remove igniter from shipping container.

7. Verify O-ring is properly installed on the igniter.

TECHNICIAN

8. Press igniter into the igniter boss. Secure the igniter with eight 10 x 32 x 5/8 screws. Torque to 5 ft. lbs. Verify the igniter is properly seated. Short, shield, and ground the igniter leads.

TECHNICIAN

TASK D - STATIC FIRING OPERATIONS FROM THE STATIC FIRING TUBE

1. Confirm RF Avoidance

   _____
   TECHNICIAN

2. With motor in horizontal position on trailer, attach headcap ring to the forward end of Tomahawk motor using 12 each ¼ x 28 x 1-1/2" bolts. Tighten bolts for a snug fit so that the headcap ring has no play on motor. (Approximate torque – 10 ft. lbs.) **Headcap is required to prevent weight of motor being applied to igniter when motor is placed in static firing tube.**

3. Pull the firing lead through the cut out in the headcap fixture. Tape firing lead to the side of the motor running up toward the nozzle of the motor.

   _____
   TECHNICIAN

4. Attach a nylon lifting strap to nozzle of motor and lift using a pettibone crane. Use a forklift to maintain level lifting until motor has cleared the trailer. Position motor over static firing tube and carefully lower the motor into the tube until the motor rests on the headcap ring. Remove strap.

5. Loosely place two each ½" x 2" 13 thread bolts and two washers into the holes located in one half of the hold down collar. **Hold down collar is a two piece assembly.**

6. Place each section of the hold down collar around the Tomahawk motor case just below the nozzle. Push the bolts through both sections of the collar fixture and secure with a nut and washer. Torque the nut to 60 ft. lbs.

   _____
   TECHNICIAN

7. Hook the turnbuckles to the shackles (7/16 grade B, embossed with "HS") in the hold down collar (four places). Rotate the collar so that a chain assembly is directly above each lug on the tube. Adjust ratchet mechanism on turnbuckle so that it will tighten. Tighten all turnbuckles so that the hooks on the lower end engage the lug welded on the motor tube. Tighten the turnbuckles hand-tight and uniformly. Adjust ratchet mechanism so that the handle is not engaged with the turnbuckle.

   _____
   TECHNICIAN

8. Short, shield, and ground igniter leads.

   _____
   TECHNICIAN

TASK E - PREPARATION FOR STATIC FIRING FROM DISPOSAL PAD

1. Confirm RF Avoidance.

   _____
   TECHNICIAN

2. With motor in horizontal position on trailer, attach headcap ring to the forward end of Tomahawk motor using 12 each ¼ - 28 x 1-1/2" bolts. Tighten bolts for a snug fit so that the headcap ring has no play on motor. (Approximate torque – 10 ft. lbs.)

   _____
   TECHNICIAN

3. Pull the firing lead through the cut out in headcap fixture.

   _____
   TECHNICIAN

4. Attach a nylon lifting strap to nozzle of motor and lift using a pettibone crane. Slowly lift the motor from the trailer. (Use a forklift to maintain level lifting until the motor has cleared the trailer).

5. Carefully lower Tomahawk motor with forward end down on the pad over the alignment holes. Rotate motor to align hold down collar lugs with pad lugs. Attach headcap fixture to the pad using four grade eight ¾ - 10 bolts with washers. Shim as necessary to maintain good contact between the fixture and the pad. Torque bolts to 100 ft. lbs.

   _____
   TECHNICIAN

6. Attach pad lugs to concrete anchors at four points using grade eight ¾-10 bolts with washers. Torque bolts to 100 ft. lbs.

   _____
   TECHNICIAN

7. Attach the swaged cable loop on the free end of the cable assembly to the hold down collar using a 7/16 grade B shackle. Verify shackle is embossed with the letters "HS" to be identified as grade B.

   _____
   TECHNICIAN

8. Attach the free end of the turnbuckle on the cable assembly to the pad lug with a 7/16 grade B shackle. Attach the remaining three cable assemblies in the same manner.

9. Adjust the ratchet on the turnbuckle so that it will tighten the assembly. Tighten turnbuckles uniformly until their cable assembly is taught. Turnbuckles should be hand-tight. Adjust the ratchet mechanism on the turnbuckles so that the handle does not engage the turnbuckle.

_____
TECHNICIAN

10. Short, shield, and ground the igniter lead.

_____
TECHNICIAN

TASK E - STATIC FIRING OPERATION

1. Firing Console Operator will perform VA checks in accordance with established procedures.

2. Confirm RF Avoidance.

_____
TECHNICIAN

3. Pad Supervisor will clear the disposal danger area of all unnecessary personnel.

_____
TECHNICIAN

4. Verify AC portable firing box is disconnected from the firing line and is shorted.

_____
TECHNICIAN

5. Verify firing line is shorted at the barricade.

_____
TECHNICIAN

6. Confirm firing line is shorted and grounded by measuring the resistance from the motor end.

Record Resistance _____

_____
TECHNICIAN

WARNING: Wrist-stats and static dissipative clothing must be worn

7. Using a pyro-voltmeter check for NO VOLTAGE on firing line.

	No-Voltage
Line A to Line B	
Firing Line A to Ground	
Firing Line B to Ground	

TECHNICIAN

8. If NO VOLTAGE is present connect firing cable to the shielded Belden cable, which is connected to the Tomahawk igniter.

TECHNICIAN

9. Pad Supervisor will clear ALL personnel from the disposal danger area and proceed to the barricade.

TECHNICIAN

10. Firing Console Operator will measure total resistance of firing line plus igniter in accordance with established procedures.

11. Release RF Avoidance

TECHNICIAN

12. Pad Supervisor will notify Range Control that the Static Firing is ready to commence.

TECHNICIAN

13. Operations Safety Supervisor shall verify that the disposal area is clear and all personnel are behind the barricade.

OSS

14. Firing Console Operator will perform firing console operation in accordance with established procedures.

15. The Pad Supervisor shall verbally count down from 10 seconds.

16. At T-0 the Firing Console Operator will ignite the igniter.

17. In the event of a NO-FIRE, proceed to TASK F, of this procedure, and notify Range Control that a NO-Fire has occurred.

_____
TECHNICIAN

18. Tube Disposal If motor has been successfully static fired; the case must remain in the tube for approximately 1 hour until the case has cooled sufficiently to be removed.

    Pad Disposal If the motor has been successfully static fired, the case must remain on the pad for approximately 1 hour until the case has cooled sufficiently to be removed.

19. Disconnect the firing lead from the portable AC firing box, remove motor from tube.

20. Notify Range Control that the static firing operations are complete.

_____
TECHNICIAN

TASK F - NO FIRE OPERATION

IN THE EVENT OF NO-FIRE, ALL PERSONNEL WILL REMAIN BEHIND THE BARRICADE

1. From the barricade measure the line resistance to determine if the squibs have been fired.

   Line Resistance _____

   _____
   TECHNICIAN

2. If the squibs have not fired, the ignition current should be increased (no more than 2 times the recommended firing current) and a second attempt will be made to fire the squibs.

   Ignition Current _____

   _____
   TECHNICIAN

3. If the squibs fail again, all operations will stop, Range Control shall be notified that static firing has been terminated.

   _____
   TECHNICIAN

4. Disconnect and short the firing leads from the portable AC firing box.

   _____
   TECHNICIAN

5. All personnel shall remain behind the barricade for a minimum of 30 minutes.

6. After the 30 - minute wait, all personnel shall leave the area. Roadblocks positioned at the barricade will be manned for an additional 30 minutes.

7. Obtain RF avoidance.

   _____
   TECHNICIAN

8. Proceed to the motor and short the igniter leads (Belden cable).

9. Remove motor from the tube or pad (whichever method was used) and examine the igniter.

   _____
   TECHNICIAN

FLOW DIAGRAM

N/A

EQUIPMENT/SITE INSPECTION LOG

Equipment/Facility	Condition	Corrective Action	Comments
Facility			
Concrete anchors			
Certified pyrotechnic ground			
Safety/Security			
Grounding straps			
Barricade			
Road block stands			
Warning signs			
2-Way Communications			
Stand-by Fire Protection			
Haz-Mat Specialist			
Stand-by Emergency First Aid			
Wrist-stats			
Safety Coats/Coveralls			
Safety Glasses/Goggles			
Safety Shoes			
Protective head gear			
Face Shields			
Equipment			
Igniter Circuit Tester			
Firing lines			
Pyro-Voltmeter			
Igniter leads			
Pettibone crane			
Lifting Strap			
Torque wrenches			
Miscellaneous			
Weather Conditions			

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	05/04/1999	Initial Release
A	09/06/1999	Added Quality Record Block; Updated location of Wallops Procedure
B	03/22/2002	Removed "(PN 13-1-4)" from title; re-formatted with latest WI template; incorporated instructions for PN 13-1-4 into WI

Work Instruction

DIRECTIVE NO.	546-WI-8072.1.21 Rev B	**APPROVED BY Signature:**	Original signed by
EFFECTIVE DATE:	03/22/2002	**NAME:**	Stewart Meyers
EXPIRATION DATE:	N/A	**TITLE:**	Branch Head

Responsible Office: 546.W/Carrier Systems Branch

Title: Taurus Static Firing

PREFACE

P1. PURPOSE

This procedure describes how the Taurus rocket motor will be static fired at Wallops Flight Facility. It includes the motor inspection, igniter checkout, preparation for static firing, firing operations, and no-fire operations.

P2. APPLICABILITY

546.W Range Team

P3. REFERENCES

GPG 8072.1	Process Control
WI-546-8072.1.47	Igniter Circuit Tester Confidence Test
Drawing B29854	Taurus Cable Fixture Ring

P4. CANCELLATION

546-WI-8072.1.21 Rev A

P5. TOOLS, EQUIPMENT, AND MATERIALS

Portable Firing Box
Pyro-Voltmeter
Pettibone Crane
Fork Lift
Nylon Lifting Strap (5 ft., 5,000 lbs. capacity, 1 each)
Belden Cable (15', 2 conductor, shielded)
3" ID x 48" Steel Pipe shielding
1" OD x 2-1/8" steel sleeve (4 each)
Taurus Cable Fixture Ring (4 each)
¾-10 Bolts, Grade 8, with Washers (8 each)
5/8 x 20 x 1-1/2" bolts
Steel Cable, 1/8" diameter x 3 feet with attached Snap Hook (4 each)
Inhibisol Cleaning Solvent or Equivalent
Calibrated Torque Wrench (0 - 100-ft. lb.)
Transport Vehicle

P6. SAFETY PRECAUTIONS AND WARNINGS

1. Prior to any operation involving ordnance disposal at Wallops Flight Facility, the site designated for hazardous waste disposal shall be inspected to (a) detect any possible deterioration of equipment, (b) verify calibration of monitoring equipment, and (c) inspection of safety and emergency equipment and other devices to be utilized during the operation. Equipment/Site Inspection Log (page 13) must be completed.

2. Prior to commencing static firing operations verify the following:

   a. Notification to Range Control to make an announcement on the public address system that static firing is about to commence.

   b. Notification to all Island Personnel (in the immediate area) and Damage Control that static firing is about to commence.

   c. Damage Control will have personnel available with Haz-Mat training located at the disposal area barricade during the static firing operations

   d. Operations Safety Supervisor is present with a Ground Safety Plan

_____
Pad Supervisor

3. A circuit anomaly in some igniter circuit testers make the device capable of initiating the electro-explosive device bridgewire. Before each use of an igniter circuit tester, a confidence test must be performed in accordance with WI-546-8072.1.47, "Igniter Circuit Tester Confidence Test."

4. Wrist-stats, static dissipative clothing, and safety glasses must be worn when checking or handling pyrotechnics.

5. Wrist-stats must be checked for proper resistance prior to use. If wrist-stats are removed, resistance check must be repeated. Acceptable wrist-stat resistance measurement shall be 1 MΩ to 10 MΩ opposite hand or wrist-stat to ground.

6. Hard hats and safety clothing are required for motor lifting.

7. Read precautions in Materials Safety Data Sheets (MSDS) prior to using any chemicals.

8. Safety glasses and rubber gloves must be worn when using cleaning solvents.

9. Safety glasses/visors must be worn during cutting, sanding, or drilling operations

SAFETY/SECURITY ITEMS REQUIRED:

Standby Fire Protection
Standby Emergency First Aid
Haz-Mat Personnel
Barricade
Road Block Stands
2-Way Communications
Warning Signs
Wrist-stats
Wrist-stat checker
Grounding Straps
Safety Coats/Coveralls/Shoes
Safety Glasses/Goggles
Protective Head Gear/Face Shields
Rubber Gloves

P7. TRAINING

On the job training is required to perform this work instruction.

P8. RECORDS

Quality Record Title	Record Custodian	Retention
Completed and Signed- off Procedure	Designated Technician	NRRS 8/5A1 Permanent. Records may be retired to an FRC when 2 years old. Transfer to NARA 15 years after completion of the project or when 25 years old, whichever is sooner.

P9. METRICS

N/A

P10. DEFINITIONS

C.G.- Center of Gravity
VA- Volt-Amp
OSS- Operations Safety Supervisor
mA- Milli-Amperes

INSTRUCTIONS: TAURUS STATIC FIRING PROCEDURE

DATE: _____

MOTOR: _____

P/N _____ **S/N** _____
(if available)

REQUESTED BY: _____

REASON FOR DESTROYING: _____

_____

TASK A – QUALITY ASSURANCE

1. Technician will verify that the required procedural steps are accurately performed and complete. To attest that this has been accomplished, the technician will enter their name on each sign off indicating satisfactory completion of each step as performed. Discrepancies will be listed at the end of each task and initialed by the OSS.

2. Verify that all handling and lifting devices have been properly load tested and are within certification due date.

_____
TECHNICIAN

3. Verify that all measuring equipment has a valid calibration certification.

Calibrated Torque Wrench (0 - 100 ft. lb.), Calibration Due Date_____
Calibrated Torque Wrench (0-240 in. lb.), Calibration Due Date_____

4. Verify that all calibrated instrumentation has a valid calibration certification.

Igniter Circuit Tester_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Milliammeter _____
Manufacturer _____
Model No._____
Calibration Due Date_____

Pyro-Voltmeter_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Blasting Galvanometer_____
Manufacturer _____
Model No._____
Calibration Due Date_____

5. Verify no-voltage on crane hook in building.

_____
TECHNICIAN

TASK B - MOTOR INSPECTION

The following steps are to be completed at the assembly building prior to transferring the motor to the disposal area.

WARNING: Personnel must wear static dissipative clothing and wrist-stats, verify wrist-stats have been tested (1 to 10 MΩ opposite hand or wrist-stat to ground).

_____
TECHNICIAN

1. Obtain RF Avoidance.

_____
TECHNICIAN

2. Remove motor and igniter container from shipping container. Place motor on transport trailer.

_____
TECHNICIAN

3. Ground motor to facility ground.

_____
TECHNICIAN

4. Verify provider of motor performed modified inspection of motor for disposal.

   Motor Lot Number _____ Date of Manufacturer _____

   Igniter Lot Number _____ Date of Manufacturer _____

   Igniter Bridgewire resistance _____
   (obtained from the manufacturer's data sheet)

5. Remove the fin shoes and discard.

_____
TECHNICIAN

6. Measure and record the resistance of the 15 ft. shielded Belden cable. Provide this measurement to the Firing Console Operator.

   Resistance: _____

7. Connect the Belden cable to the ignition leads. Short and shield the leads opposite igniter.

_____
TECHNICIAN

8. Place igniter back in a metal shipping container for transportation to the disposal area.

TECHNICIAN

9. Release RF Avoidance.

TECHNICIAN

TASK C - PREPARATION FOR STATIC FIRING FROM DISPOSAL PAD

1. Attach headcap fixture to the pad using four each 5/8 x 20 x 1-1/2" bolts. Shim as necessary to maintain good contact between the fixture and the pad. Torque bolts to 100 ft. lbs.

TECHNICIAN

2. Attach pad lugs to concrete anchors at four points using grade eight ¾ - 10 bolts with washers. Torque to 100 ft. lbs.

TECHNICIAN

3. Transport motor and igniter to disposal area.

4. Ground motor to the grounding rod located near the static-firing pad.

TECHNICIAN

WARNING: Wrist-stats and static dissipative clothing must be worn

5. Obtain RF Avoidance.

TECHNICIAN

6. Remove shipping closure from igniter boss. Using Inhibisol cleaning solvent clean igniter boss and igniter threads.

7. Visually inspect the igniter boss for evidence of corrosion, burrs, or other defects.

8. Remove igniter from shipping container.

9. Inspect O-ring (MS-28775-447) for cuts, gouges, or other defects.

10. Install O-ring on the igniter. Align igniter alignment key with groove in igniter boss. Push igniter into motor until igniter seats. Using handle, rotate igniter clockwise until igniter locks. Remove handle. **IGNITER IS NOW ARMED.**

TECHNICIAN

11. Short, shield, and ground the igniter leads.

TECHNICIAN

12. Attach a nylon lifting strap to nozzle of motor and lift using a pettibone crane. Use a forklift to maintain level lifting until motor has cleared the trailer. Rotate the motor so that the hole pattern on the motor is aligned with the hole pattern on the headcap fixture. Position motor over disposal pad and carefully lower the motor until the motor rests into the headcap fixture. Remove strap.

13. Pull the firing lead through the cut out in the headcap fixture.

TECHNICIAN

14. Loosely place two each ½" x 2" 13 thread bolts and two washers into the holes located in one half of the hold down collar. Hold down collar is a two piece assembly.

15. Place each section of the hold down collar around the Taurus motor nozzle at the fin shoe mounting surface. Align the collar lugs located on the collar with the pad lugs. Push the bolts through both sections of the collar fixture and secure with a nut and washer. Torque the nut to 60-ft. lbs.

TECHNICIAN

16. On the pad cable assembly install a 3" ID x 48" steel pipe shielding over each cable. Install a 1" OD x 2-1/8" steel sleeve inside the swaged cable loops of the cable assembly.

17. Attach the swaged cable loop on the end of the cable assembly to the motor collar lug using a 7/16 grade B shackle. Repeat for the other 3 cables.

TECHNICIAN

18. Attach the free end of the turnbuckle on the cable assembly to the pad lug with a certified 7/16 grade B shackle. Attach the remaining three cable assemblies in the same manner. Verify that the shackle is embossed with the letters "HS" to be identified as grade B.

TECHNICIAN

21. To ensure that the pipe sleeves remain close to the motor case, crimp a 1/8" diameter steel cable (with attached snap hook) to the bottom of the pipe sleeve and hook this cable to the motor collar lug shackle. Repeat for the other 3 cable assemblies.

_____
TECHNICIAN

22. Adjust the turnbuckle so that it will tighten the assembly. Tighten the turnbuckles uniformly until their cable assembly is taught. Turnbuckles should be hand-tight.

_____
TECHNICIAN

23. Ground the igniter lead.

_____
TECHNICIAN

TASK C - STATIC FIRING OPERATION

1. Firing Console Operator will perform VA checks in accordance with established procedures.

2. Verify RF Avoidance is still in place.

TECHNICIAN

3. Pad Supervisor will clear the disposal danger area of all non-essential personnel.

TECHNICIAN

4. Verify AC portable firing box is disconnected from the firing line and is shorted.

TECHNICIAN

5. Verify firing line is shorted at the barricade.

TECHNICIAN

6. Confirm firing line is shorted and grounded by measuring the resistance from the motor end.

Record Resistance _____

TECHNICIAN

WARNING: Wrist-stats and static dissipative clothing must be worn

7. Using a pyro-voltmeter check for NO VOLTAGE on firing line.

	No-Voltage
Line A to Line B	
Firing Line A to Ground	
Firing Line B to Ground	

TECHNICIAN

8. If NO VOLTAGE is present connect firing cable to the shielded Belden cable, which is connected to the igniter.

TECHNICIAN

9. Pad Supervisor will clear ALL personnel from the disposal danger area and proceed to the barricade.

TECHNICIAN

10. Firing Console Operator will measure total resistance of firing line plus igniter in accordance with established procedures.

11. Release RF Avoidance

TECHNICIAN

12. Pad Supervisor will notify Range Control that the Static Firing is ready to commence.

TECHNICIAN

13. Operations Safety Supervisor shall verify that the disposal area is clear and all personnel are behind the barricade.

OSS

14. Firing Console Operator will perform firing console operation in accordance with established procedures.

15. The Pad Supervisor shall verbally count down from 10 seconds.

16. At T-0 the Firing Console Operator will ignite the igniter.

17. In the event of a NO-FIRE, proceed to TASK D, of this procedure, and notify Range Control that a NO-Fire has occurred.

TECHNICIAN

18. If motor has been successfully static fired, the case must remain on the pad for approximately 1 hour until the case has cooled sufficiently to be removed.

19. Disconnect the firing lead from the portable AC firing box, remove motor from pad.

20. Notify Range Control that the static firing operations are complete.

TECHNICIAN

TASK D - NO FIRE OPERATION

IN THE EVENT OF NO-FIRE, ALL PERSONNEL WILL REMAIN BEHIND THE BARRICADE

1. From the barricade measure the line resistance to determine if the squibs have been fired.

   Line Resistance _____

   _____
   TECHNICIAN

2. If the squibs have not fired, the ignition current should be increased (no more than 2 times the recommended firing current) and a second attempt will be made to fire the squibs.

   Ignition Current _____

   _____
   TECHNICIAN

3. If the squibs fail again, all operations will stop; Range Control shall be notified that static firing has been terminated.

   _____
   TECHNICIAN

4. Disconnect and short the firing leads from the portable AC firing box.

   _____
   TECHNICIAN

5. All personnel shall remain behind the barricade for a minimum of 30 minutes.

6. After the 30-minute wait, all personnel shall leave the area. Roadblocks positioned at the barricade will be manned for an additional 30 minutes.

7. Obtain RF avoidance.

   _____
   TECHNICIAN

8. Proceed to the motor and short the igniter leads (Belden cable).

9. Remove motor from the pad and examine the igniter.

   _____
   TECHNICIAN

FLOW DIAGRAM

N/A

EQUIPMENT/SITE INSPECTION LOG

Equipment/Facility	Condition	Corrective Action	Comments
Facility			
Concrete anchors			
Certified pyrotechnic ground			
Safety/Security			
Grounding straps			
Barricade			
Road block stands			
Warning signs			
2-Way Communications			
Stand-by Fire Protection			
Haz-Mat Specialist			
Stand-by Emergency First Aid			
Wrist-stats			
Safety Coats/Coveralls			
Safety Glasses/Goggles			
Safety Shoes			
Protective head gear			
Face Shields			
Equipment			
Igniter Circuit Tester			
Firing lines			
Pyro-Voltmeter			
Igniter leads			
Pettibone crane			
Lifting Strap			
Torque wrenches			
Miscellaneous			
Weather Conditions			

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	05/05/1999	Initial Release
A	09/06/1999	Added Quality Record Block; Updated location of Wallops Procedure
B	03/22/2002	Removed "(PN 13-1-6)" from title; re-formatted with latest WI template; incorporated instructions for PN 13-1-6 into WI

Work Instructions

DIRECTIVE NO.: 546-WI-8072.1.46
EFFECTIVE DATE: 04/13/2000
EXPIRATION DATE: N/A

APPROVED BY Signature: original signed by
NAME: Stewart Meyers
TITLE: Branch Head

Responsible Office: 546.W Carrier Systems Branch

Title: Improved Orion Static Firing

P1. PURPOSE

This Work Instruction defines the tasks required for preparation and static firing of an Improved Orion Rocket Motor.

P2. SCOPE

This Work Instruction will cover the tasks involving the motor inspection, inspection and installation of the igniter, installation of the initiator, manufacture of igniter (if required), preparation for static firing from the disposal pad, prerequisite tasks to the static firing operation, the static firing operation, and the NO-FIRE operation. Content of this procedure is adopted from Launch Vehicles Branch Procedure No. 13-1-3, Orion Static Firing, dated March 4, 1998.

P3. DEFINITIONS

C.G.- **C**enter of **G**ravity
VA- **V**olt-**A**mp
OSS- **O**perations **S**afety **S**upervisor
mA- **M**illi-**A**mperes

P4. RECORDS, REPORTS AND FORMS

Quality Record Title	Record Custodian	Retention
Completed Procedure	Designated Technician	NRRS 8/5A1 Permanent. Records may be retired to an FRC when 2 years old. Transfer to NARA 15 years after completion of the project or when 25 years old, whichever is sooner.

P5. SAFETY PRECAUTIONS AND WARNING NOTES

1. A circuit anomaly in some igniter circuit testers make the device capable of initiating the electro-explosive device bridgewire. Before each use of an igniter circuit tester, a confidence test must be performed.

2. Safety/Security Items Required:

   Standby Fire Protection
   Standby Emergency First Aid
   Haz-Mat Personnel
   Barricade
   Road Block Stands
   2-Way Communications
   Warning Signs
   Wrist-stats
   Wrist-stat checker
   Grounding Straps
   Safety Coats/Coveralls/Shoes
   Safety Glasses/Goggles
   Protective Head Gear/Face Shields
   Rubber Gloves

3. The Improved Orion is classified by the US Department of Transportation as a Class 1.3 explosive and is sensitive to electricity, excessive shock, heat and RF energy. Extreme care is to be taken during the handling to prevent static electricity buildup, which could be discharged into the propellant. The motor case shall be adequately grounded at all times. The permissible storage and operational temperature ranges are:

   Storage Limits: -40 °F to +140 °F
   Operational Limits: -25 °F to +125 °F

4. Wrist-stats, static dissipative clothing, and safety glasses must be worn when checking or handling pyrotechnics.

5. Wrist-stats must be checked for proper resistance prior to use. If wrist-stats are removed, resistance check must be repeated. . Acceptable wrist-stat resistance measurement shall be 1 MΩ to 10 MΩ opposite hand or wrist-stat to ground.

6. Hard hats and safety clothing are required for motor lifting.

7. Read precautions in Materials Safety Data Sheets (MSDS) prior to using any chemicals.

8. Safety glasses and rubber gloves must be worn when using cleaning solvents.

9. Safety glasses/visors must be worn during cutting, sanding, or drilling operations.

P6. REFERENCES

GPG 8072.1 Process Control
NSROC Procedure 31-15-2 (Latest Rev.), Improved Orion Inspection
WFF 565.W Procedure 20-6-12 Portable A/C Ground Firing Box-Booster Only
WI-546-8072.1.47 Igniter Circuit Tester Confidence Test

P7. TOOLS, EQUIPMENT, AND MATERIALS

Overhead Hoist or Crane System, 3,000 lb. min. capacity
Transport Trailer
Portable Firing Box
Igniter Circuit Tester, Alinco
Milliammeter
Pyro-Voltmeter
Blasting Galvanometer
Pettibone Crane
Fork Lift
Nylon Lifting Strap, certified (5 ft., 3,000 lbs. capacity, 1 each)
Cargo Strap
Belden Cable (15' , 2 conductor, shielded)
Holex 7900 Initiator
Holex 7900 Mating Connector (if applicable)
Initiator Test Box
Initiator Port Closure Plug
O-Ring MS-28778-5 (initiator port)
O-Ring MS-28775-223 (igniter)
Orion Static Firing Motor Lugs (4 each) WFF Dwg. B-50-01303
7/16 Grade B Shackle (8 each)
Turnbuckle and Cable assembly (4 each)
Orion Static Firing Headcap Fixture
9/16-18 bolts, NAS 464 (8 each)
¾ - 10, grade eight bolts with washers (8 each)
1/4-28 UNF-3A bolts, MS20004 or equal (12 each)
1/4-28 x 1 Socket Head Cap Screw, Unbrako 20097-4F-16B (5 each)
Inhibisol Cleaning Solvent or Equivalent
Dow Corning 33 Lubricant or Equivalent
Calibrated Torque Wrench (0 - 100 ft. lb.)
Calibrated Torque Wrench (0-240 in. lb.)
3/4 in. deep socket
5/8 in. deep socket
Allen Wrench Set
Inspection Mirror
Safety Flashlight
Transport Vehicle

P8. CANCELLATION

N/A

P9. QUALITY ASSURANCE

1. Technician will verify that the required procedural steps are accurately performed and complete. To attest that this has been accomplished, the technician will enter their name on each sign off indicating satisfactory completion of each step as performed. Discrepancies will be listed at the end of each task and initialed by the OSS.

2. Verify that all handling and lifting devices have been properly load tested and are within certification due date.

_____
TECHNICIAN

3. Verify that all measuring equipment has a valid calibration certification.

Calibrated Torque Wrench (0 - 100 ft. lb.), Calibration Due Date_____
Calibrated Torque Wrench (0-240 in. lb.), Calibration Due Date_____

4. Verify that all calibrated instrumentation has a valid calibration certification.

Igniter Circuit
Tester_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Pyro-Voltmeter_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Milliammeter _____
Manufacturer _____
Model No._____
Calibration Due Date_____

Blasting Galvanometer_____
Manufacturer_____
Model No._____
Calibration Due Date_____

5. Verify no-voltage on crane hook in building.

_____
TECHNICIAN

P10. INSTRUCTIONS

Personnel Required:
Work/Pad Supervisor
Technician
Operations Safety Supervisor

TASKS
TASK A- MOTOR INSPECTION /IGNITER & INITIATOR INSPECTION/INSTALLATION
TASK B- WFF MANUFACTURED IGNITER (IF REQUIRED)
TASK C- PREREQUISITE TASKS TO THE STATIC FIRING OPERATION
TASK D- PREPARATION FOR STATIC FIRING FROM DISPOSAL PAD
TASK E- STATIC FIRING OPERATION
TASK F- NO FIRE OPERATION

TASK A- MOTOR INSPECTION /IGNITER & INITIATOR INSPECTION/INSTALLATION

The following steps are to be completed at the assembly building prior to transferring the motor to the disposal area.

WARNING: Personnel must wear static dissipative clothing, safety glasses/visors and wrist-stats while performing work associated with pyrotechnics. Verify wrist-stats have been tested (1 MΩ to 10 MΩ opposite hand or wrist-stat to ground).

_____
TECHNICIAN

1. Verify transport trailer is equipped with proper pads or cutouts for this motor. Verify proper position of the cutouts.

_____
TECHNICIAN

2. Visually inspect the exterior of the shipping container for indications of damage, rough handling, or moisture. Using cutting shears, cut and remove the metal straps. Remove lid.

_____
TECHNICIAN

3. Verify that motor fastening devices are installed and secure. Inspect container interior for moisture, shifting of components, or other indications of defects.

_____
TECHNICIAN

4. Remove motor securing material. Place a handling strap around the motor at the approximate center of gravity. Attach the handling strap to an overhead hoist or crane system.

TECHNICIAN

5. Ground motor to a certified pyrotechnic ground.

TECHNICIAN

WARNING: Hard hats and safety clothing are required for motor lifting.

6. Carefully lift the motor from the shipping container, manually supporting nozzle end. Place the motor on the workstand and remove handling strap. Remove crane from work area. Retain shipping container for further use.

TECHNICIAN

7. Visually inspect the motor case for evidence of nicks, dents, or other defects.

TECHNICIAN

8. Position SAFE/ARM mechanism in "SAFE" postion as indicated by flat side of shaft aligned horizontal to thrust axis of motor.

TECHNICIAN

9. Cut initiator leads directly behind the initiator, strip and short.

TECHNICIAN

10. Remove initiator using 5/8 in. deep socket. Set aside for disposal.

TECHNICIAN

11. Remove igniter attaching bolts (5 ea. 1/4-28 x 1 in.) using a 3/16 in. allen wrench. Remove igniter.. Use caution to prevent damaging the vinyl lacquer coating on the igniter basket.

TECHNICIAN

12. Using a #2 phillips screwdriver, remove seven 1/4 in.-28 screws from the stiffener. Remove stiffener and discard.

TECHNICIAN

13. Visually inspect the forward dome for evidence of nicks, dents, or other defects.

TECHNICIAN

14. Using the safety flashlight, visually inspect propellant through the forward and aft end of motor for evidence of separation, cracks, voids or other defects.

_____
TECHNICIAN

15. Visually inspect the igniter and initiator bosses machined surfaces and threads for corrosion, cracks, or other defects. Clean as required with Inhibisol and Scotchbrite pad.

_____
TECHNICIAN

16. Visually inspect the igniter for the presence of dirt, rust, corrosion, deterioration, or foreign material.

_____
TECHNICIAN

17. Visually inspect the igniter basket for the presence of cuts, punctures, deterioration or other damage to the vinyl lacquer coating.

_____
TECHNICIAN

NOTE: In the event that this igniter is not suitable for static firing, it will be used as a plug. Proceed with following tasks to re-install. Use initiator port closure plug instead of 7900-1 initiator. Use TASK B of this procedure to manufacture an igniter for disposal.

18. Visually inspect the O-ring groove for dirt, rust, corrosion, or other damage. Clean as required with Inhibisol and Scotchbrite pad.

_____
TECHNICIAN

19. Inspect the new igniter O-ring, P/N MS-28775-223 for cuts, imperfections, or other evidence of damage. Verify that the shelf life of the O-ring has not expired. The expiration date is 5 years from the cure date.

_____ _____
Expiration Date TECHNICIAN

20. Record Igniter Lot Number and date of manufacture.

Igniter Lot Number _____ Date of Manufacture _____

_____
TECHNICIAN

21. Using DC-33, lubricate O-ring, O-ring seat, and O-ring groove on igniter. Install O-ring on igniter.

_____
TECHNICIAN

22. Install igniter using 5 ea. 1/4-28 x 1 socket head cap screws (Unbrako 20097-4F-16B). Torque to 100 -125 in. lb.

_____
TECHNICIAN

23. Exercise the SAFE/ARM mechanism to verify proper operation.

_____
TECHNICIAN

24. Position SAFE/ARM mechanism in "SAFE" position as indicated by flat side of shaft aligned horizontal to thrust axis of motor.

_____
TECHNICIAN

25. Inspect initiator (7900-1) for evidence of damage. Remove initiator from package and attach ground strap.

_____
TECHNICIAN

26. Place initiator on workbench and perform visual inspection. Install in test box.

_____
TECHNICIAN

27. Remove initiator short. Record serial number of initiator.

Serial Number_____

_____
TECHNICIAN

28. Perform the following Igniter Circuit Tester Confidence Test on the Igniter Circuit Tester and the Blasting Galvanometer.

Alinco Confidence Test

28a. Connect a calibrated pyrotechnic voltmeter (the same voltmeter used for vehicle arming) to the input terminals of the Alinco. Set the scale to the 2.5 volt range. Verify no AC or DC voltage output.

No Voltage Verifed_____

_____
TECHNICIAN

28b. Depress "KEY" switch and verify battery voltage is no more than 0.5 VDC and no less than 0.25 VDC. This test verifies internal battery is good.

TECHNICIAN

28c. Disconnect the pyrotechnic voltmeter and connect a NASA/WFF calibrated, 0-25 mA DC milliammeter to the input terminals of the Alinco.

TECHNICIAN

28d. Set Alinco "RANGE" switch to the minimum setting. Set the "OHMS" dial indicator to "0.00." Depress the "KEY" switch and record the measurement in the block below corresponding to the model being tested.

Alinco Model No.	Maximum Reading (mA)	Measurement
101-5 A1	10	
101-5 BF	5	

TECHNICIAN

28e. If milliameter reading exceeds the maximum reading for the model tested, reject the Alinco and schedule it for repair before reuse. Indicate results of test.

Pass_____ Fail_____

TECHNICIAN

Blasting Galvanometer Confidence Test

28f. Connect a NASA/WFF calibrated, 0-25 mA DC milliammeter to the terminals of the Blasting Galvanometer.

TECHNICIAN

28g. If milliammeter indicates more than 7 mA, reject the Blasting Galvanometer and schedule it for repair before reuse. Indicate results of test.

Pass_____ Fail_____

TECHNICIAN

29. Using the Blasting Galvanometer, perform open circuit check between pins of initiator and shell of initiator. Verify open circuit.

Measurement	Circle One
Pin A to Pin C	Open / Fail
Pin B to Pin D	Open / Fail
Pin A to Shell	Open / Fail
Pin B to Shell	Open / Fail
Pin C to Shell	Open / Fail
Pin D to Shell	Open / Fail

_____
TECHNICIAN

30. Using the Igniter Circuit Tester, perform resistance measurements between Pins A to B, and Pins C to D. Nominal resistance is 1.0 Ω +/- .10.

Initiator Resistance: Pin A to B _____
Pin C to D _____

_____
TECHNICIAN

31. Replace short. Remove initiator from the test box.

_____
TECHNICIAN

32. Inspect the new O-ring, P/N MS-28778-5 for cuts, imperfections, or other evidence of damage. Verify that the shelf life of the O-ring has not expired. The expiration date is 5 years from the cure date.

_____ _____
Expiration Date TECHNICIAN

33. Using DC-33, lubricate O-ring, O-ring seat, and O-ring groove on initiator. Install O-ring on initiator.

_____
TECHNICIAN

34. Using a 3/4 in. deep socket, install the 7900-1 initiator in the igniter and torque to 120 in.-lb. +/- 5 in.-lb.

_____
TECHNICIAN

35. Re-install plastic shipping safe around igniter

_____
TECHNICIAN

36. Measure and record the resistance of the 15 ft. shielded Belden cable. Provide this measurement to the Firing Console Operator.

Resistance: _____

_____
TECHNICIAN

37. Discrepancies and Acceptance

List discrepancies below:

_____
_____
_____
_____

Technician shall sign to indicate satisfactory completion of Task A, except as noted above.

_____ _____
Date Technician

Work Supervisor shall sign to indicate satisfactory completion of each step, Task A, except as noted above.

_____ _____
Date Supervisor

TASK B- WFF MANUFACTURED IGNITER

In the event that an inspected Improved Orion igniter is not available for static firing it will be necessary to manufacture an igniter from Nike igniter powder and an excess Taurus spin motor igniter.

Equipment/Materials Required:

Velostat (cut into 3" x 10" piece to form a cylinder)
Nike Igniter
Taurus Spin Motor Igniter or Match Squib
Igniter Circuit Tester
Wire Stripper
Knife
Anti-static Masking Tape
Butt Connector Lug (wire size: 22 to 16 guage)
Platform Scales

WARNING: Personnel must wear static dissipative clothing and wrist-stats. Verify wrist-stats have been tested (1 MΩ to 10 MΩ opposite hand or wrist-stat to ground).

_____
TECHNICIAN

1. Obtain RF Avoidance

_____
TECHNICIAN

2. Ground the Nike igniter to a certified pyrotechnic ground.

_____
TECHNICIAN

3. Short and ground the Taurus spin motor igniter to a certified pyrotechnic ground.

_____
TECHNICIAN

4. Perform the following Igniter Circuit Tester Confidence Test on the Igniter Circuit Tester and the Blasting Galvanometer.

Alinco Confidence Test

4a. Connect a calibrated pyrotechnic voltmeter (the same voltmeter used for vehicle arming) to the input terminals of the Alinco. Set the scale to the 2.5 volt range. Verify no AC or DC voltage output.

No Voltage Verifed_____

_____
TECHNICIAN

4b. Depress "KEY" switch and verify battery voltage is no more than 0.5 VDC and no less than 0.25 VDC. This test verifies internal battery is good.

_____
TECHNICIAN

4c. Disconnect the pyrotechnic voltmeter and connect a NASA/WFF calibrated, 0-25 mA DC milliammeter to the input terminals of the Alinco.

_____
TECHNICIAN

4d. Set Alinco "RANGE" switch to the minimum setting. Set the "OHMS" dial indicator to "0.00." Depress the "KEY" switch and record the measurement in the block below corresponding to the model being tested.

Alinco Model No.	Maximum Reading (mA)	Measurement
101-5 A1	10	
101-5 BF	5	

_____
TECHNICIAN

4e. If milliameter reading exceeds the maximum reading for the model tested, reject the Alinco and schedule it for repair before reuse. Indicate results of test.

Pass_____ Fail_____

_____
TECHNICIAN

Blasting Galvanometer Confidence Test

4f. Connect a NASA/WFF calibrated, 0-25 mA DC milliammeter to the terminals of the Blasting Galvanometer.

_____
TECHNICIAN

4g. If milliammeter indicates more than 7 mA, reject the Blasting Galvanometer and schedule it for repair before reuse. Indicate results of test.

Pass_____ Fail_____

_____
TECHNICIAN

5. Using an igniter circuit tester, measure the Taurus spin motor's igniter resistance. (Minimum Resistance .47 ohms, Maximum Resistance .77 ohms)

   Resistance _____ _____
   TECHNICIAN

6. Measure and record resistance of the 15' shielded Belden cable. Provide this measurement to Firing Control Operator.

   Resistance _____ _____
   TECHNICIAN

7. Using wire strippers, strip the spin motor igniter leads and Belden cable leads approximately ½ ". Attach Belden cable to spin motor leads using a butt connector lug. Verify crimped in place.
   _____
   TECHNICIAN

8. Short and ground the Belden cable.
   _____
   TECHNICIAN

9. Cut a 3" x 10" piece of Velostat conductive plastic and form it into a cylinder, sealing edges with duct tape.

NOTE: The opening going down the center of the Orion motor grain is approximately 2" in diameter

10. On the Nike igniter, cut around the plastic disk located in the center of the powder cup and pop out the disk.

11. Pour all the igniter powder located in the igniter into a static free paper cup.

NOTE: There is approximately two pounds of powder in a Nike igniter

12. Pour 8 oz. of the Nike igniter powder into the Velostat cylinder.

13. Insert the spin motor igniter with attached Belden cable into the Velostat cylinder (on top of the igniter powder).

14. Add an additional 8 oz. of Nike igniter powder into the Velostat cylinder on top of the igniter.

15. Using anti-static masking tape, seal the cylinder with the Belden cable protruding.

16. Store the WFF manufactured igniter in the Nike igniter storage box located in the assembly area until ready to use in static firing.

_____
TECHNICIAN

17. Release RF Avoidance.

_____
TECHNICIAN

18. Discrepancies and Acceptance

List discrepancies below:

_____
_____
_____
_____

Technician shall sign to indicate satisfactory completion of Task B, except as noted above.

_____ _____
Date Technician

Work Supervisor shall sign to indicate satisfactory completion of each step, Task B, except as noted above.

_____ _____
Date Supervisor

TASK C- PREREQUISITE TASKS TO THE STATIC FIRING OPERATION

1. Record the following information on the day of the static firing operation:

DATE: _____

MOTOR: _____

P/N _____ **S/N** _____
(if available)

REQUESTED BY: _____

REASON FOR DESTROYING: _____

_____

2. Prior to any operation involving ordnance disposal at Wallops Flight Facility, the site designated for hazardous waste disposal shall be inspected to (a) detect any possible deterioration of equipment, (b) verify calibration of monitoring equipment, and (c) inspection of safety and emergency equipment and other devices to be utilized during the operation. Complete the Equipment/Site Inspection Log (pg. 17.) to document findings.

EQUIPMENT/SITE INSPECTION LOG

Equipment/Facility	Condition	Corrective Action	Comments
Facility			
Concrete anchors			
Certified pyrotechnic ground			
Safety/Security			
Grounding straps			
Barricade			
Road block stands			
Warning signs			
2-Way Communications			
Stand-by Fire Protection			
Haz-Mat Specialist			
Stand-by Emergency First Aid			
Wrist-stats			
Safety Coats/Coveralls			WHERE IS PAD, BERM, LAUNCH INSPECTED?
Safety Glasses/Goggles			
Safety Shoes			
Protective head gear			
Face Shields			
Equipment			
Igniter Circuit Tester			
Firing lines			
Pyro-Voltmeter			
Igniter leads			
Pettibone crane			
Lifting Strap			
Torque wrenches			
Miscellaneous			
Weather Conditions			

3. Prior to commencing static firing operations verify the following:

   a. Notification to Range Control to make an announcement on the public address system that static firing is about to commence.

   b. Notification to all Island Personnel (in the immediate area) and Damage Control that static firing is about to commence.

   c. Damage Control will have personnel available with Haz-Mat training located at the disposal area barricade during the static firing operations

   d. Operations Safety Supervisor is present with a Ground Safety Plan

_____
Pad Supervisor

4. Discrepancies and Acceptance

List discrepancies below:

_____
_____
_____
_____

Technician shall sign to indicate satisfactory completion of Task C, except as noted above.

_____ _____
Date/Time Technician

Pad Supervisor shall sign to indicate satisfactory completion of each step, Task C, except as noted above.

_____ _____
Date/Time Pad Supervisor

TASK D- PREPARATION FOR STATIC FIRING FROM DISPOSAL PAD

1. Transport motor to disposal area. If applicable, transport the WFF manufactured igniter.

WARNING: Personnel must wear static dissipative clothing, safety glasses/visor and wrist-stats. Verify wrist-stats have been tested (1 MΩ to 10 MΩ opposite hand or wrist-stat to ground).

_____
TECHNICIAN

2. Ground motor to the certified pyrotechnic ground located near the static firing pad.

_____
TECHNICIAN

3. Attach headcap fixture to the motor headcap using twelve ¼ - 28 UNF-3A bolts, meeting strength requirements MS2004 (Aircraft). Torque bolts to 10 - 20 ft. lbs. **(Standard igniter only)** Verify access through fixture for means to operate SAFE/ARM mechanism.

_____
TECHNICIAN

4. With motor in horizontal position on trailer, attach motor lugs to motor. Motor lugs are to be attached to the threaded holes located near the longitudinal center of the motor using two 9/16 -18 bolts. Attach one lug to each of the four locations. Torque bolts to 80 ft. lbs.

_____
TECHNICIAN

5. If WFF manufactured igniter is to be used, proceed to step 9.

6. Obtain RF Avoidance

_____
TECHNICIAN

7. Install a Holex 7900 mating connector on the shielded Belden cable. Pass the leads through the hole provided in the adapter. Short and ground the two firing leads to the motor case. Remove shorting cap from initiator and install the Holex 7900 mating connector to the initiator.

_____
TECHNICIAN

8. Release RF Avoidance.

TECHNICIAN

9. Attach a nylon lifting strap to nozzle of motor and lift using a pettibone crane. Slowly lift the motor from the trailer. (Use a forklift to maintain level lifting until the motor has cleared the trailer).

TECHNICIAN

10. Carefully lower Orion motor with forward end down on the pad over the alignment holes. Align motor lugs with pad lugs. Attach headcap fixture to the pad using four grade eight ¾ - 10 bolts with washers. Shim as necessary to maintain good contact between the fixture and the pad. Torque bolts to 100 ft. lbs.

TECHNICIAN

11. Attach pad lugs to concrete anchors at four points using grade eight ¾-10 bolts with washers. Torque bolts to 100 ft. lbs.

TECHNICIAN

12. Attach the swaged cable loop on the free end of the cable assembly to the motor lug using a 7/16 grade B shackle. Verify shackle is embossed with the letters "HS," which identifies them as grade B.

TECHNICIAN

13. Attach the free end of the turnbuckle on cable assembly to the pad lug with a 7/16 grade B shackle. Attach the remaining three cable assemblies in the same manner.

TECHNICIAN

14. Adjust the ratchet on the turnbuckle so that it will tighten the assembly. Tighten turnbuckles uniformly until their cable assembly is taught. Turnbuckles should be hand-tight. Adjust the ratchet mechanism on the turnbuckles so that the handle does not engage the turnbuckle. Release lifting sling and crane.

TECHNICIAN

Perform steps 15 thru 17 only if the WFF manufactured igniter is used

15. Obtain RF Avoidance.

TECHNICIAN

16. Carefully insert the WFF manufactured igniter through the nozzle end. Lower approximately 8 feet. Ground the igniter lead.

_____
TECHNICIAN

17. Release RF Avoidance.

_____
TECHNICIAN

18. Discrepancies and Acceptance

List discrepancies below:

_____
_____
_____
_____

Technician shall sign to indicate satisfactory completion of Task D, except as noted above.

_____ _____
Date Technician

Work Supervisor shall sign to indicate satisfactory completion of each step, Task D, except as noted above.

_____ _____
Date Supervisor

TASK E- STATIC FIRING OPERATION

WARNING: Personnel must wear static dissipative clothing, safety glasses/visor and wrist-stats. Verify wrist-stats have been tested (1 MΩ to 10 MΩ opposite hand or wrist-stat to ground).

_____
TECHNICIAN

1. Firing Console Operator will perform VA checks as per Procedure 20-6-12, TASK A.

_____
TECHNICIAN

2. Obtain RF Avoidance.

_____
TECHNICIAN

3. Pad Supervisor will clear the disposal danger area of all unnecessary personnel.

_____
TECHNICIAN

4. Verify AC portable firing box is disconnected from the firing line and is shorted at the barricade.

_____
TECHNICIAN

5. Confirm firing line is shorted and grounded by measuring the resistance from the motor end.

Record Resistance _____ _____
TECHNICIAN

6. Using a pyro-voltmeter check for NO VOLTAGE on firing line.

	No-Voltage
Line A to Line B	
Firing Line A to Ground	
Firing Line B to Ground	

_____
TECHNICIAN

7. If NO VOLTAGE is present, connect firing cable to the shielded Belden cable which is connected to the igniter.

TECHNICIAN

8. **(Standard igniter only)** Move the SAFE/ARM mechanism to the "ARM" position.

TECHNICIAN

9. Pad Supervisor will clear ALL personnel from the disposal danger area and proceed to the barricade.

TECHNICIAN

10. Firing Console Operator will measure total resistance of firing line plus igniter as per Procedure 20-6-12 (TASK A, Steps 1 and 2).

11. Release RF Avoidance

TECHNICIAN

12. Pad Supervisor will notify Range Control that the Static Firing is ready to commence.

TECHNICIAN

13. Technician shall verify that the disposal area is clear and all personnel are behind the barricade.

TECHNICIAN

14. Firing Console Operator will perform Procedure 20-6-12 (TASK B, Steps 3 through 9).

TECHNICIAN

15. The Pad Supervisor shall verbally count down from 10 seconds.

16. At T-0 the Firing Console Operator will ignite the igniter.

17. In the event of a NO-FIRE, proceed to TASK F, of this procedure, and notify Range Control that a NO-Fire has occurred.

TECHNICIAN

18. If motor has been successfully static fired, the case must remain on the pad for approximately 1 hour until the case has cooled sufficiently to be removed.

19. Disconnect the firing leads from the portable AC firing box, remove motor from pad.

20. Notify Range Control that the static firing operations are complete.

_____
TECHNICIAN

21. Discrepancies and Acceptance

List discrepancies below:

_____
_____
_____
_____

Technician shall sign to indicate satisfactory completion of Task E, except as noted above.

_____ _____
Date Technician

Work Supervisor shall sign to indicate satisfactory completion of each step, Task E, except as noted above.

_____ _____
Date Supervisor

TASK F- NO FIRE OPERATION

IN THE EVENT OF NO-FIRE, ALL PERSONNEL WILL WAIT 30 MINUTES BEHIND THE BARRICADE

1. From the barricade, measure the line resistance to determine if the squibs have been fired.

   Line Resistance _____

   _____
   TECHNICIAN

2. If the squibs have not fired, the ignition current should be increased (no more than 2 times the recommended firing current) and a second attempt will be made to fire the squibs.

   Ignition Current _____ _____
   TECHNICIAN

3. If the squibs fail again, all operations will stop. Notify Range Control that static firing has been terminated.

   _____
   TECHNICIAN

4. All personnel shall leave the area and road blocks at the barricade will be manned for one hour.

5. After 1 hour, disconnect and short the firing leads from the portable AC firing box.

6. Obtain RF avoidance.

   _____
   TECHNICIAN

7. Proceed to the motor. Ground motor case to certified pyrotechnic ground. Move the SAFE/ARM device to the "SAFE" position. Short the igniter leads (Belden cable) to the motor case.

8. Remove motor from the pad and examine the igniter. _____
   TECHNICIAN

9. Discrepancies and Acceptance

List discrepancies below:

_____
_____
_____
_____

Technician shall sign to indicate satisfactory completion of Task F, except as noted above.

_____ _____
Date Technician

Work Supervisor shall sign to indicate satisfactory completion of each step, Task F, except as noted above.

_____ _____
Date Supervisor

P11. FLOW DIAGRAM

N/A

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	04/13/2000	Initial Release

Work Instruction

DIRECTIVE NO.	546-WI-8072.1.16 Rev B	**APPROVED BY Signature:**	Original signed by
EFFECTIVE DATE:	03/22/2002	**NAME:**	Stewart Meyers
EXPIRATION DATE:	N/A	**TITLE:**	Branch Head

Responsible Office: 546.W/Carrier Systems Branch

Title: Orion Static Firing

PREFACE

P1. PURPOSE

This procedure describes how the Orion rocket motor will be static fired at Wallops Flight Facility. It includes the motor inspection, igniter checkout, preparation for static firing, firing operations, and no-fire operations.

P2. APPLICABILITY

546.W Range Team

P3. REFERENCES

GPG 8072.1	Process Control
WI-546-8072.1.47	Igniter Circuit Tester Confidence Test

P4. CANCELLATION

546-WI-8072.1.16 Rev A

P5. TOOLS, EQUIPMENT, AND MATERIALS

Portable Firing Box
Igniter Circuit Tester
Pyro-Voltmeter
Pettibone Crane
Fork Lift
Nylon Lifting Strap (5 ft., 3,000 lbs. capacity, 1 each)
Belden Cable (15', 2 conductor, shielded)
2-3/8" Crowsfoot
Molex 3300 Mating Connector (if applicable)
Orion Static Firing Motor Lugs (4 each)
9/16-18 bolts, NAS 464 (8 each)
Orion Static Firing Headcap Fixture
¾ - 10, grade eight bolts with washers (8 each)
Inhibisol Cleaning Solvent or Equivalent
Calibrated Torque Wrench (0 - 100 ft. lb.)
Nylon Lifting Strap (5 ft., 3,000 lbs. capacity, 1 each)
Transport Vehicle

P6. SAFETY PRECAUTIONS AND WARNING NOTES

1. Prior to any operation involving ordnance disposal at Wallops Flight Facility, the site designated for hazardous waste disposal shall be inspected to (a) detect any possible deterioration of equipment, (b) verify calibration of monitoring equipment, and (c) inspection of safety and emergency equipment and other devices to be utilized during the operation. Equipment/Site Inspection Log (page 16) must be completed.

2. Prior to commencing static firing operations verify the following:

   a. Notification to Range Control to make an announcement on the public address system that static firing is about to commence.

   b. Notification to all Island Personnel (in the immediate area) and Damage Control that static firing is about to commence.

   c. Damage Control will have personnel available with Haz-Mat training located at the disposal area barricade during the static firing operations

   d. Operations Safety Supervisor is present with a Ground Safety Plan

_____
Pad Supervisor

3. A circuit anomaly in some igniter circuit testers make the device capable of initiating the electro-explosive device bridgewire. Before each use of an igniter circuit tester, a confidence test must be performed in accordance with WI-546-8072.1.47, "Igniter Circuit Tester Confidence Test."

4. Wrist-stats, static dissipative clothing, and safety glasses must be worn when checking or handling pyrotechnics.

5. Wrist-stats must be checked for proper resistance prior to use. If wrist-stats are removed, resistance check must be repeated. Acceptable wrist-stat resistance measurement shall be 1 MΩ to 10 MΩ opposite hand or wrist-stat to ground.

6. Hard hats and safety clothing are required for motor lifting.

7. Read precautions in Materials Safety Data Sheets (MSDS) prior to using any chemicals.

8. Safety glasses and rubber gloves must be worn when using cleaning solvents.

9. Safety glasses/visors must be worn during cutting, sanding, or drilling operations

SAFETY/SECURITY ITEMS REQUIRED:

Standby Fire Protection
Standby Emergency First Aid
Haz-Mat Personnel
Barricade
Road Block Stands
2-Way Communications
Warning Signs
Wrist-stats
Wrist-stat checker
Grounding Straps
Safety Coats/Coveralls/Shoes
Safety Glasses/Goggles
Protective Head Gear/Face Shields
Rubber Gloves

P7. TRAINING

On the job training is required to perform this work instruction.

P8. RECORDS

Quality Record Title	Record Custodian	Retention
Completed and Signed- off Procedure	Designated Technician	NRRS 8/5A1 Permanent. Records may be retired to an FRC when 2 years old. Transfer to NARA 15 years after completion of the project or when 25 years old, whichever is sooner.

P9. METRICS

N/A

P10. DEFINITIONS

C.G.- Center of Gravity
VA- Volt-Amp
OSS- Operations Safety Supervisor
mA- Milli-Amperes

INSTRUCTIONS: ORION STATIC FIRING PROCEDURE

DATE: _____

MOTOR: _____

P/N _____ **S/N** _____
(if available)

REQUESTED BY: _____

REASON FOR DESTROYING: _____

_____

TASK A – QUALITY ASSURANCE

1. Technician will verify that the required procedural steps are accurately performed and complete. To attest that this has been accomplished, the technician will enter their name on each sign off indicating satisfactory completion of each step as performed. Discrepancies will be listed at the end of each task and initialed by the OSS.

2. Verify that all handling and lifting devices have been properly load tested and are within certification due date.

_____
TECHNICIAN

3. Verify that all measuring equipment has a valid calibration certification.

Calibrated Torque Wrench (0 - 100 ft. lb.), Calibration Due Date_____
Calibrated Torque Wrench (0-240 in. lb.), Calibration Due Date_____

4. Verify that all calibrated instrumentation has a valid calibration certification.

Igniter Circuit Tester_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Milliammeter _____
Manufacturer _____
Model No._____
Calibration Due Date_____

Pyro-Voltmeter_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Blasting Galvanometer_____
Manufacturer _____
Model No._____
Calibration Due Date_____

5. Verify no-voltage on crane hook in building.

TECHNICIAN

TASK B - MOTOR INSPECTION AND IGNITER CHECKOUT

The following steps are to be completed at the assembly building prior to transferring the motor to the disposal area.

1. Remove motor from shipping container and place on transport trailer.

2. Verify provider of motor performed modified inspection of motor for disposal.

   Lot Number _____ Date of Manufacturer _____

WARNING: Igniter personnel must wear wrist-stats, verify wrist-stats have been tested (1 to 10 MΩ opposite hand or wrist-stat to ground).

TECHNICIAN

NOTE: In the event that this igniter is not suitable for static firing, it will be used as a plug. Proceed to TASK C of this procedure, manufacturing an igniter for disposal.

3. Obtain RF Avoidance.

TECHNICIAN

4. Remove igniter from shipping container. Visually inspect igniter for evidence of damage.

   Record Serial Number _____

   Record igniter bridgewire resistance _____

5. Measure and record the resistance of the 15 ft. shielded Belden cable. Provide this measurement to the Firing Console Operator.

   Resistance: _____

6. Connect the Belden cable to the ignition leads. Short and shield the leads opposite igniter.

TECHNICIAN

7. Place igniter back in a metal shipping container for transportation to the disposal area.

8. Release RF Avoidance.

TECHNICIAN

TASK C - WFF MANUFACTURED IGNITER

In the event that an Orion igniter is not available for static firing it will be necessary to manufacture a igniter from Nike igniter powder and a excess Taurus spin motor igniter.

Equipment/Materials Required:

Velostat (cut into 3" x 10" piece to form a cylinder)
Nike Igniter
Taurus Spin Motor Igniter or Match Squib
Igniter Circuit Tester
Wire Stripper
Knife
Duct Tape
Butt Connector Lug (wire size: 22 to 16 guage)
Platform Scales

WARNING: Personnel must wear static dissipative clothing and wrist-stats. Verify wrist-stats have been tested (1 to 10 MΩ opposite hand or wrist-stat to ground).

_____
TECHNICIAN

1. Obtain RF Avoidance

_____
TECHNICIAN

2. Ground the Nike igniter to facility ground.

_____
TECHNICIAN

3. Short and ground the Taurus spin motor igniter to facility ground.

_____
TECHNICIAN

WARNING: A circuit anomaly in some igniter circuit testers (Alinco) make the device capable of initiating the electro-explosive device bridgewire. Before using an igniter circuit tester the following confidence test must be performed:

A. Connect a calibrated pyrotechnic voltmeter (the same voltmeter used for vehicle arming) to the input terminals of the Alinco and verify no AC or DC voltage output. Use 2.5 volt scale.

NO VOLTAGE VERIFIED _____ _____
TECHNICIAN

B. Depress "Key" switch and verify battery voltage is no more than 0.5 VDC, and no less than 0.25 VDC (to ensure battery is good and Alinco will work properly).

VDC _____ _____
TECHNICIAN

C. Disconnect voltmeter and connect calibrated NASA/WFF, 0-25 mA DC, milliammeter to the input terminals of the Alinco.

D. Set Alinco "Range" switch to the minimum setting, set the ohms dial indicator to "0.00", and press "key" switch. Milliammeter should indicate less than 5 milliamperes.

mA _____ _____
TECHNICIAN

E. If milliammeter indicates more than 5 milliamperes at any time, reject the Alinco and schedule it for repair before reuse.

mA _____ PASS/FAIL_____ _____
TECHNICIAN

4. Using an igniter circuit tester, measure the Taurus spin motor's igniter resistance. (Minimum Resistance .47 ohms, Maximum Resistance .77 ohms)

Resistance _____

5. Measure and record resistance of the 15' shielded Belden cable. Provide this measurement to Firing Control Operator.

Resistance _____

6. Using wire strippers, strip the spin motor igniter leads and Belden cable leads approximately ½ ". Attach Belden cable to spin motor leads using a butt connector lug. Verify crimped in place.

_____
TECHNICIAN

7. Short and ground the Belden cable. _____
TECHNICIAN

8. Cut a 3" x 10" piece of Velostat conductive plastic and form it into a cylinder sealing edges with duct tape.

NOTE: The opening going down the center of the Orion motor grain is approximately 2" in diameter

9. On the Nike igniter, cut around the plastic disk located in the center of the powder cup and pop out the disk.

10. Pour all the igniter powder located in the igniter into a static free paper cup.

NOTE: There is approximately two pound of powder in a Nike igniter

11. Pour 8 oz. of the Nike igniter powder into the Velostat cylinder.

12. Insert the spin motor igniter with attached Belden cable into the Velostat cylinder (on top of the igniter powder).

13. Add an additional 8 oz. of Nike igniter powder into the Velostat cylinder on top of the igniter.

14. Using duct tape seal the cylinder with the Belden cable protruding.

15. Store the WFF manufactured igniter in the Nike igniter storage box located in the assembly area until ready to use in static firing.

_____
TECHNICIAN

16. Release RF Avoidance.

_____
TECHNICIAN

TASK C - PREPARATION FOR STATIC FIRING FROM DISPOSAL PAD

1. Transport motor and igniter to disposal area.

2. Ground motor to the certified grounding rod located near the static firing tube.

_____
TECHNICIAN

WARNING: Wrist-stats and static dissipative clothing must be worn when working igniters or initiators

3. Obtain RF Avoidance.

TECHNICIAN

4. Remove shipping closure from igniter boss. Using Inhibisol cleaning solvent clean igniter boss and igniter threads.

5. Visually inspect the igniter boss and igniter threads for evidence of corrosion, burrs, or other defects.

6. Remove igniter (not WFF manufactured) from shipping container.

7. Screw igniter, hand-tight into igniter boss. Ground the igniter.

TECHNICIAN

8. Secure the igniter using a 2-3/8" crowsfoot. Verify that the igniter is properly seated and torque to 30 ± 2 ft. lbs.

TECHNICIAN

9. **Do not do this step if using the WFF manufactured igniter.**

If applicable, install a Holex 3300 mating connector on the shielded Belden cable. Remove shorting cap from initiator and install the Holex 3300 mating connector to the initiator. Pass the lead through the hole provided in the adapter. Short and ground the two firing leads.

TECHNICIAN

10. Release RF Avoidance.

TECHNICIAN

11. With motor in horizontal position on trailer attach motor lugs to motor. Motor lugs are to be attached to the threaded holes located near the longitudinal center of the motor using two 9/16 - 18 bolts. Attach one lug to each of the four locations. Torque bolts to 80 ft. lbs.

TECHNICIAN

12. Attach headcap fixture to the motor headcap using twelve ¼ - 28 UNF-3A bolts, meeting strength requirements MS2004 (Aircraft). Torque bolts to 10 - 20 ft. lbs.

13. **Do not do this step if using a the WFF manufactured igniter.**
If applicable, pull the firing lead through the cut out in headcap fixture.

TECHNICIAN

14. Attach a nylon lifting strap to nozzle of motor and lift using a pettibone crane. Slowly lift the motor from the trailer. (Use a forklift to maintain level lifting until the motor has cleared the trailer).

15. Carefully lower Orion motor with forward end down on the pad over the alignment holes. Align motor lugs with pad lugs. Attach headcap fixture to the pad using four grade eight ¾ - 10 bolts with washers. Shim as necessary to maintain good contact between the fixture and the pad. Torque bolts to 100 ft. lbs.

TECHNICIAN

16. Attach pad lugs to concrete anchors at four points using grade eight ¾-10 bolts with washers. Torque bolts to 100 ft. lbs.

TECHNICIAN

17. Attach the swaged cable loop on the free end of the cable assembly to the motor lug using a 7/16 grade B shackle. Verify shackle is embossed with the letters "HS" to be identified as grade B.

TECHNICIAN

18. Attach the free end of the turnbuckle on cable assembly to the pad lug with a 7/16 grade B shackle. Attach the remaining three cable assemblies in the same manner.

19. Adjust the ratchet on the turnbuckle so that it will tighten the assembly. Tighten turnbuckles uniformly until their cable assembly is taught. Turnbuckles should be hand-tight. Adjust the ratchet mechanism on the turnbuckles so that the handle does not engage the turnbuckle.

TECHNICIAN

20. **Perform this step only if the WFF manufactured igniter is used**
Carefully insert the WFF manufactured igniter through the nozzle end. Lower approximately 8 feet.

TECHNICIAN

21. Ground the igniter lead.

TECHNICIAN

TASK D - STATIC FIRING OPERATION

1. Firing Console Operator will perform VA checks as per approved procedures.

2. Obtain RF Avoidance.

_____
TECHNICIAN

3. Pad Supervisor will clear the disposal danger area of all unnecessary personnel.

_____
TECHNICIAN

4. Verify AC portable firing box is disconnected from the firing line and is shorted.

_____
TECHNICIAN

5. Verify firing line is shorted at the barricade.

_____
TECHNICIAN

6. Confirm firing line is shorted and grounded by measuring the resistance from the motor end.

Record Resistance _____

_____
TECHNICIAN

WARNING: Wrist-stats and static dissipative clothing must be worn

7. Using a pyro-voltmeter check for NO VOLTAGE on firing line.

	No-Voltage
Line A to Line B	
Firing Line A to Ground	
Firing Line B to Ground	

_____
TECHNICIAN

8. If NO VOLTAGE is present connect firing cable to the shielded Belden cable, which is connected to the Orion igniter.

_____
TECHNICIAN

9. Pad Supervisor will clear ALL personnel from the disposal danger area and proceed to the barricade.

TECHNICIAN

10. Firing Console Operator will measure total resistance of firing line plus igniter in accordance with approved procedures.

11. Release RF Avoidance

TECHNICIAN

12. Pad Supervisor will notify Range Control that the Static Firing is ready to commence.

TECHNICIAN

13. Operations Safety Supervisor shall verify that the disposal area is clear and all personnel are behind the barricade.

OSS

14. Firing Console Operator will perform igniter firing in accordance with approved procedures.

15. The Pad Supervisor shall verbally count down from 10 seconds.

16. At T-0 the Firing Console Operator will ignite the igniter.

17. In the event of a NO-FIRE, proceed to TASK C, of this procedure, and notify Range Control that a NO-Fire has occurred.

TECHNICIAN

18. If motor has been successfully static fired, the case must remain on the pad for approximately 1 hour until the case has cooled sufficiently to be removed.

19. Disconnect the firing leads form the portable AC firing box, remove motor from pad.

20. Notify Range Control that the static firing operations are complete.

TECHNICIAN

TASK E - NO FIRE OPERATION

IN THE EVENT OF NO-FIRE, ALL PERSONNEL WILL WAIT 30 MINUTES BEHIND THE BARRICADE

1. From the barricade measure the line resistance to determine if the squibs have been fired.

   Line Resistance _____ _____
   TECHNICIAN

2. If the squibs have not fired, the ignition current should be increased (no more than 2 times the recommended firing current) and a second attempt will be made to fire the squibs.

   Ignition Current _____ _____
   TECHNICIAN

3. If the squihs fail again, all operations will stop, Range Control shall be notified that static firing has been terminated.

   _____
   TECHNICIAN

4. All personnel shall leave the area and road blocks at the barricade will be manned for one hour.

5. After 1 hour, disconnect and short the firing leads from the portable AC firing box.

6. Obtain RF avoidance.

   _____
   TECHNICIAN

7. Proceed to the motor and short the igniter leads (Belden cable).

8. Remove motor from the tube and examine the igniter.

   _____
   TECHNICIAN

FLOW DIAGRAM

N/A

EQUIPMENT/SITE INSPECTION LOG

Equipment/Facility	Condition	Corrective Action	Comments
Facility			
Concrete anchors			
Certified pyrotechnic ground			
Safety/Security			
Grounding straps			
Barricade			
Road block stands			
Warning signs			
2-Way Communications			
Stand-by Fire Protection			
Haz-Mat Specialist			
Stand-by Emergency First Aid			
Wrist-stats			
Safety Coats/Coveralls			
Safety Glasses/Goggles			
Safety Shoes			
Protective head gear			
Face Shields			
Equipment			
Igniter Circuit Tester			
Firing lines			
Pyro-Voltmeter			
Igniter leads			
Pettibone crane			
Lifting Strap			
Torque wrenches			
Miscellaneous			
Weather Conditions			

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	05/04/1999	Initial Release
A	09/03/1999	Added Quality Record Block; Updated location of Wallops Procedure
B	03/22/2002	Removed "(PN 13-1-3)" from title; re-formatted with latest WI template; incorporated instructions for PN 13-1-3 into WI

Work Instruction

DIRECTIVE NO.	546-WI-8072.1.15 Rev B	**APPROVED BY Signature:**	Original signed by
EFFECTIVE DATE:	03/22/2002	**NAME:**	Stewart Meyers
EXPIRATION DATE:	N/A	**TITLE:**	Branch Head

Responsible Office: 546.W/Carrier Systems Branch

Title: Nike Static Firing

PREFACE

P1. PURPOSE

This procedure describes how the Nike rocket motor will be static fired at Wallops Flight Facility. It includes the motor inspection, igniter checkout, preparation for static firing, firing operations, and no-fire operations.

P2. APPLICABILITY

546.W Range Team

P3. REFERENCES

GPG 8072.1	Process Control
WI-546-8072.1.47	Igniter Circuit Tester Confidence Test
Drawing D-50-01142	Headcap Ring
Drawing D-50-01247	Nike Static Fire Fixture
Drawing D-50-01139	Nike Static Fire Collar Assembly

P4. CANCELLATION

546-WI-8072.1.15 Rev A

P5. TOOLS, EQUIPMENT, AND MATERIALS

Portable Firing Box
Igniter Circuit Tester
Pyro-Voltmeter
Pettibone Crane
Nylon Lifting Strap (5 ft., 3,000 lbs. capacity, 1 each)
Belden Cable (15' , shielded)
5/8 - 18 UNF Bolt (Grade 8, 1 each)
¾ - 16 Bolt with Washer (2 each)
Cotter Clip
Inhibisol Cleaning Solvent or Equivalent
Permatex # 2 or Equivalent
Nike Igniter Spanner Wrench, B-467
Calibrated Torque Wrench (0 - 60 ft. lb.)
Transport Vehicle

P6. SAFETY PRECAUTIONS AND WARNING NOTES

1. Prior to any operation involving ordnance disposal at Wallops Flight Facility, the site designated for hazardous waste disposal shall be inspected to (a) detect any possible deterioration of equipment, (b) verify calibration of monitoring equipment, and (c) inspection of safety and emergency equipment and other devices to be utilized during the operation. Equipment/Site Inspection Log (page 12) must be completed.

2. Prior to commencing static firing operations verify the following:

   a. Notification to Range Control to make an announcement on the public address system that static firing is about to commence.

   b. Notification to all Island Personnel (in the immediate area) and Damage Control that static firing is about to commence.

   c. Damage Control will have personnel available with Haz-Mat training located at the disposal area barricade during the statie firing operations

   d. Operations Safety Supervisor is present witb a Ground Safety Plan

Pad Supervisor

3. A circuit anomaly in some igniter circuit testers make the device capable of initiating the electro-explosive device bridgewire. Before each use of an igniter circuit tester, a confidence test must be performed in accordance with WI-546-8072.1.47, "Igniter Circuit Tester Confidence Test."

4. Wrist-stats, static dissipative clothing, and safety glasses must be worn when checking or handling pyrotechnics.

5. Wrist-stats must be checked for proper resistance prior to use. If wrist-stats are removed, resistance check must be repeated. Acceptable wrist-stat resistance measurement shall be 1 MΩ to 10 MΩ opposite hand or wrist-stat to ground.

6. Hard hats and safety clothing are required for motor lifting.

7. Read precautions in Materials Safety Data Sheets (MSDS) prior to using any chemicals.

8. Safety glasses and rubber gloves must be worn when using cleaning solvents.

9. Safety glasses/visors must be worn during cutting, sanding, or drilling operations

SAFETY/SECURITY ITEMS REQUIRED:

Standby Fire Protection
Standby Emergency First Aid
Haz-Mat Personnel
Barricade
Road Block Stands
2-Way Communications
Warning Signs
Wrist-stats
Wrist-stat checker
Grounding Straps
Safety Coats/Coveralls/Shoes
Safety Glasses/Goggles
Protective Head Gear/Face Shields
Rubber Gloves

P7. TRAINING

On the job training is required to perform this work instruction.

P8. RECORDS

Quality Record Title	Record Custodian	Retention
Completed and Signed- off Procedure	Designated Technician	NRRS 8/5A1 Permanent. Records may be retired to an FRC when 2 years old. Transfer to NARA 15 years after completion of the project or when 25 years old, whichever is sooner.

P9. METRICS

N/A

P10. DEFINITIONS

C.G.- Center of Gravity
VA- Volt-Amp
OSS- Operations Safety Supervisor
mA- Milli-Amperes

INSTRUCTIONS: NIKE STATIC FIRING PROCEDURE

DATE: _____

MOTOR: _____

P/N _____ **S/N** _____
(if available)

REQUESTED BY: _____

REASON FOR DESTROYING: _____

_____

TASK A – QUALITY ASSURANCE

1. Technician will verify that the required procedural steps are accurately performed and complete. To attest that this has been accomplished, the technician will enter their name on each sign off indicating satisfactory completion of each step as performed. Discrepancies will be listed at the end of each task and initialed by the OSS.

2. Verify that all handling and lifting devices have been properly load tested and are within certification due date.

_____
TECHNICIAN

3. Verify that all measuring equipment has a valid calibration certification.

Calibrated Torque Wrench (0 - 100 ft. lb.), Calibration Due Date_____
Calibrated Torque Wrench (0-240 in. lb.), Calibration Due Date_____

4. Verify that all calibrated instrumentation has a valid calibration certification.

Igniter Circuit Tester_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Milliammeter _____
Manufacturer _____
Model No._____
Calibration Due Date_____

Pyro-Voltmeter_____
Manufacturer _____
Model No._____
Calibration Due Date _____

Blasting Galvanometer_____
Manufacturer _____
Model No._____
Calibration Due Date_____

5. Verify no-voltage on crane hook in building.

_____
TECHNICIAN

TASK B - MOTOR INSPECTION AND IGNITER CHECKOUT

The following steps are to be completed at the assembly building prior to transferring the motor to the disposal area.

1. Remove motor from shipping container and place on transport trailer.

2. Verify provider of motor performed modified inspection of motor for disposal.

   Lot Number _____ Date of Manufacturer _____

WARNING: Igniter personnel must wear wrist-stats, verify wrist-stats have been tested (1 to 10 MΩ opposite hand or wrist-stat to ground).

_____
TECHNICIAN

3. Obtain RF Avoidance.

_____
TECHNICIAN

4. Remove igniter from shipping container. Visually inspect igniter for evidence of damage.

   Record Serial Number _____

   Record igniter bridgewire resistance _____

5. Measure and record the resistance of the 15 ft. shielded Belden cable. Provide this measurement to the Firing Console Operator.

   Resistance: _____

6. Connect the Belden cable to the ignition leads. Short and shield the leads opposite igniter.

_____
TECHNICIAN

7. Place igniter back in a metal shipping container for transportation to the disposal area.

8. Release RF Avoidance.

TECHNICIAN

9. Transport motor and igniter to disposal area.

10. Ground motor to the certified grounding rod located near the static firing tube.

TECHNICIAN

WARNING: Wrist-stats and static dissipative clothing must be worn when working igniters or initiators

11. Obtain RF Avoidance.

TECHNICIAN

12. Remove shipping closure from igniter boss. Using Inhibisol cleaning solvent clean igniter boss and igniter threads.

13. Verify, through the presence of FBI paint, that the pressure cap on the forward motor dome has been torqued (45 ± 5 in. lbs.)

TECHNICIAN

14. Visually inspect the igniter boss and igniter threads for evidence of corrosion, burrs, or other defects.

15. Remove igniter from shipping container.

16. Apply a coating of Permatex #2 to igniter boss threads. Screw igniter, hand-tight into igniter boss. Ground the igniter.

TECHNICIAN

17. Secure the igniter using a Nike Igniter Spanner Wrench, B-467.

18. Verify that the igniter is properly seated.

TECHNICIAN

TASK C - PREPARATION AND STATIC FIRING OPERATIONS

1. With motor in horizontal position on trailer, attach headcap ring to the forward end of Nike motor using a grade 8 5/8 - 18 UNF bolt. (Drawing D-50-01142) Tighten bolt for a snug fit so that the headcap ring has no play on motor. (Approximate torque - 5 ft. lbs.)

NOTE: Headcap is required to prevent weight of motor being applied to igniter when motor is placed in static firing tube.

_____
TECHNICIAN

2. Attach a nylon lifting strap to nozzle of motor and lift using a petti-bone crane. Position motor over static firing tube and carefully lower the motor into the tube until the motor rest on the headcap ring. Remove strap.

3. Loosely place two ¾-- 16 bolts (MS20012-66) and two washers into the holes marked for "bolts" on the marked half of the fixture (hold down collar). The bolts should face in the direction indicated by the arrows. (Drawing D-50-01139)

4. Each technician (2) will lift a half (there are two halves) of the collar fixture by the handles and capture the nozzle within the center of each half of the fixture. Push the bolts through the collar fixture and secure with a nut and washer. Torque the nut to 60 ft. lbs., continue tightening the nut until the next slot in the nut is aligned with the hole in the bolt. Secure nut with cotter clip.

_____
TECHNICIAN

5. Slide the hooks from the turnbuckle through the slots in the collar from the bottom with the points of the hooks pointing away from the motor. Secure the hooks in place with the stainless steel pins. Rotate the collar so that a chain assembly is directly above each lug on the tube. Adjust ratchet mechanism on turnbuckle so that it will tighten. Tighten all turnbuckles so that the hooks on the lower end engage the lug welded on the motor tube. Tighten the turnbuckles hand tight and uniformly. Adjust ratchet mechanism so that the handle is not engaged with the turnbuckle.

_____
TECHNICIAN

6. Firing Console Operator will perform VA checks in accordance with established procedures.

7. Confirm RF Avoidance.

_____
TECHNICIAN

8. Pad Supervisor will clear the disposal danger area of all unnecessary personnel.

TECHNICIAN

9. Verify AC portable firing box is disconnected from the firing line and is shorted.

TECHNICIAN

10. Verify firing line is shorted at the barricade.

TECHNICIAN

11. Confirm firing line is shorted and grounded by measuring the resistance from the motor end.

Record Resistance _____

TECHNICIAN

WARNING: Wrist-stats and static dissipative clothing must be worn

12. Using a pyro-voltmeter check for NO VOLTAGE on firing line.

	No-Voltage
Line A to Line B	
Firing Line A to Ground	
Firing Line B to Ground	

TECHNICIAN

13. If NO VOLTAGE is present connect firing cable to the shielded Belden cable, which is connected to the Nike igniter.

TECHNICIAN

14. Pad Supervisor will clear ALL personnel from the disposal danger area and proceed to the barricade.

TECHNICIAN

15. Firing Console Operator will measure total resistance of firing line plus igniter in accordance with established procedures.

16. Release RF Avoidance

TECHNICIAN

17. Pad Supervisor will notify Range Control that the Static Firing is ready to commence.

TECHNICIAN

18. Operations Safety Supervisor shall verify that the disposal area is clear and all personnel are behind the barricade.

OSS

19. Firing Console Operator will perform firing console operation in accordance with established procedures.

20. The Pad Supervisor shall verbally count down from 10 seconds.

21. At T-0 the Firing Console Operator will ignite the igniter.

22. In the event of a NO-FIRE, proceed to TASK C, of this procedure, and notify Range Control that a NO-Fire has occurred.

TECHNICIAN

23. If motor has been successfully static fired, the case must remain in the tube for approximately 1 hour until the case has cooled sufficiently to be removed.

24. Disconnect the firing leads form the portable AC firing box, remove motor from tube.

25. Notify Range Control that the static firing operations are complete.

TECHNICIAN

TASK D - NO FIRE OPERATION

IN THE EVENT OF NO-FIRE, ALL PERSONNEL WILL WAIT 30 MINUTES BEHIND THE BARRICADE

1. From the barricade measure the line resistance to determine if the squibs have been fired.

   Line Resistance _____ _____
   TECHNICIAN

2. If the squibs have not fired, the ignition current should be increased (no more than 2 times the recommended firing current) and a second attempt will be made to fire the squibs.

   Ignition Current _____ _____
   TECHNICIAN

3. If the squibs fail again, all operations will stop. Range Control shall be notified that static firing has been terminated.

   _____
   TECHNICIAN

4. All personnel shall leave the area and road blocks at the barricade will be manned for one hour.

5. After 1 hour, disconnect and short the firing leads from the portable AC firing box.

6. Obtain RF avoidance.

   _____
   TECHNICIAN

7. Proceed to the motor and short the igniter leads (Belden cable).

8. Remove motor from the tube and examine the igniter.

   _____
   TECHNICIAN

FLOW DIAGRAM

N/A

EQUIPMENT/SITE INSPECTION LOG

Equipment/Facility	Condition	Corrective Action	Comments
Facility			
Concrete anchors			
Certified pyrotechnic ground			
Safety/Security			
Grounding straps			
Barricade			
Road block stands			
Warning signs			
2-Way Communications			
Stand-by Fire Protection			
Haz-Mat Specialist			
Stand-by Emergency First Aid			
Wrist-stats			
Safety Coats/Coveralls			
Safety Glasses/Goggles			
Safety Shoes			
Protective head gear			
Face Shields			
Equipment			
Igniter Circuit Tester			
Firing lines			
Pyro-Voltmeter			
Igniter leads			
Pettibone crane			
Lifting Strap			
Torque wrenches			
Miscellaneous			
Weather Conditions			

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	05/04/1999	Initial Release
A	09/03/1999	Added Quality Record Block; Updated location of Wallops Procedure
B	03/22/2002	Removed "(PN 13-1-2)" from title; re-formatted with latest WI template; incorporated instructions for PN 13-1-2 into WI

EXHIBIT II.CC-2

POST BURN OB AREA INSPECTION LOG

EXHIBIT II.CC-2
POST BURN OB AREA INSPECTION LOG

EQUIPMENT/FACILITY	CONDITION	CORRECTIVE ACTION	COMMENTS
Subunits Integrity			
No. 1			
Rain Cap			
No. 2			
Rain Cap			
No.3			
Rain Cap			
Pad Integrity			
Concrete			
Tie-Down Cables			
Tie-Down Anchors			
Berm Integrity			
Concrete			
Pad Cover Integrity			
Roof			
Structure			
Pan Integrity			
Steel			
Residues			

EXHIBIT II.CC-2
POST BURN OB AREA INSPECTION LOG

EQUIPMENT/FACILITY	CONDITION	CORRECTIVE ACTION	COMMENTS
Subunits Integrity			
No. 1			
Rain Cap			
No. 2			
Rain Cap			
No. 4			
Rain Cap			
Pad Integrity			
Concrete			
Tie-Down Cables			
Tie-Down Anchors			
Berm Integrity			
Concrete			
Pad Cover Integrity			
Roof			
Structure			
Pan Integrity			
Steel			
Residues			

POST BURN OB AREA INSPECTION LOG
(continued)

	CONDITION	CORRECTIVE ACTION	COMMENTS
Soil Survey			
Pad Survey			
Other/Miscellaneous			

REMARKS:

_____

_____

_____

_____

_____

OB OPERATIONS: _____

_____

INSPECTED BY: _____ **TITLE:** _____

DATE: _____ **DAY:** _____ **TIME:** _____

ATTACHMENT II.DD

SECURITY PROVISION AND PROCEDURES TO PREVENT HAZARDS

ATTACHMENT II.DD-SECURITY PROVISION AND PROCEDURES TO PREVENT HAZARDS

II.DD.1. Security

Security is provided at the entrance to the Main Base and the Mainland. To enter Wallops Island, security access must be granted at the Main Base. Entrance to Wallops Island operations is through the security gate located at the Mainland, approximately 13 kilometers (8 miles) south of the Main Base, and over the causeway crossing Cat Creek and coastal marshes. Security personnel are under contract to NASA and are trained by a NASA Security Office approved law enforcement program.

II.DD.1.1. Security Procedures and Equipment

Upon entering Wallops Island, NASA has established security systems for rocket motor handlers. These security systems are applicable to the Open Burning (OB) area. Security systems are outlined in RSM 2003 Range Safety Manual. Security procedures include employee and visitor identification procedures, measures for receiving and control, and general security police orders. Physical security includes fencing along land access routes, security patrols, a badge identification system, and employee training certification for rocket motors.

II.DD.1.1.1. 24 Hour Surveillance System

NASA provides 24-hour security for the Wallops Island and Mainland facilities. The security gate is manned with a 24-hour standing and roving patrol, who conduct a visual check on buildings and structures.

II.DD.1.1.2. Barrier and Means to Control Entry

Entry to Wallops Island is by way of a two-lane causeway from the Mainland. The location of the security gate on the Mainland and causeway is shown in Figure II.DD-1. The Atlantic Ocean and several creeks and marshes serve as natural water barriers. Badges are required for all personnel and visitors for admission to the Island. Badges of different types designate the necessity of an employee's presence in a buildings. Buildings/areas are placarded with applicable entry procedures. Regardless of the badge type, all employees who work with rocket motors are under the supervision of the Range Safety Officer, who has complete control of the Range. These employees have passed a range safety training course requiring certification as outlined in Attachment II.EE - Personnel Training.

Warning lights are located on Wallops Island along the access road and at the end of the causeway to control vehicular traffic. A red light requires all vehicles to stop at the designated point. Roadblocks are used to control access to areas within the Island. Unmanned roadblocks are not to be violated under any circumstances and serve as danger warnings.

Warning signs are located on structures to indicate limited access by certified personnel. The signs are in accordance with the procedures outlined in the United Nations document "Transport of Dangerous Goods" and Department of Defense (DoD) 6055.9 "Ammunition and Explosive Safety Standards". The warning signs are located on all visible angles of approach and are classified as follows:

- "Class 1, Division 1" on an international orange, octagonal-shaped sign, denotes the presence of DoD hazard class/division 1.1 explosives, which present a blast hazard primarily and can be expected to mass detonate when involved with fire.

- "Class 1, Division 2" on an international orange, X-shaped sign, denotes the presence of DoD hazard class/division 1.2 explosives, which present both a blast and fragment hazard.

- "Class 1, Division 3" on an international orange, triangular sign, denotes the presence on DoD hazard class/division 1.3 explosives, which present primarily a mass fire hazard.

- "Class 1, Division 4" on an international orange, rectangular sign, denotes the presence of DoD hazard class/division 1.4 explosives, which present primarily a moderate fire hazard.

"Dangerous - Unauthorized Personnel Keep Out" signs are displayed in addition to the explosives warning signs. A "Danger - Unauthorized Personnel Keep Out" sign is also posted at the OB area.

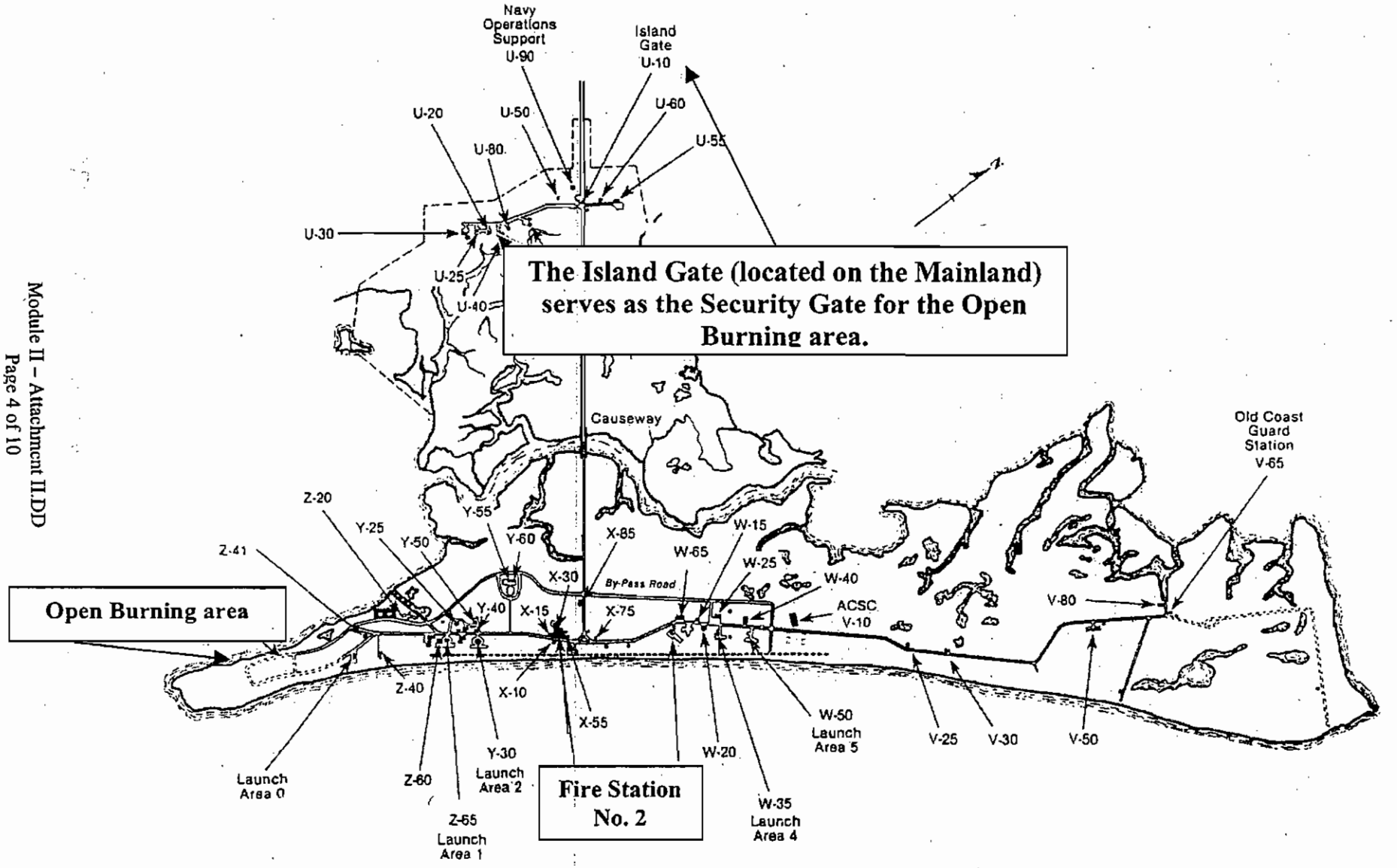


FIGURE II.D-1
Security Gate Location – Wallops Island
Date: December 31, 2003

II.DD.1.2. Waiver

A waiver from the security requirements is not applicable to Permit.

II.DD.2. Inspection Schedule

General inspections are routinely performed on buildings and structures located on Wallops Island. These inspections include the OB area and related facilities. Roving security patrol on the Island check for unauthorized entry onto the facility and report obvious building damage when it is encountered. The fire department performs fire drills and water supply systems inspections on a semi-annual schedule. Unplanned fire drills are also used to ensure proper preparation of fire-fighting capabilities on the Island. Prior to each semiannual OB groundwater monitoring event, the condition of monitoring wells and OB structures are noted in the site field book. In addition, OB subunits and pad assembly are inspected prior to each burn. A Post Burn Inspection is also conducted; refer to Attachment II.CC Inspection Schedule and Exhibit II.CC-2 Post Burn Inspection Log.

II.DD.2.1. Types of Problems

The OB area is located on a remote part of the Island. An inspection of the area is performed prior to OB operations to determine if the subunits are in a vertical position and in sound shape to support the rocket motor with waste propellant. A visual inspection of the pad is also performed. Three subunits and one burn pad are available for OB operation. In the event a subunit is determined unfit for OB, one of the other subunits is used to support the rocket motor. In the event the burn pad is determined unfit for OB, the pad is not used until necessary repairs are made.

Rocket motors are inspected prior to, and after shipping to OB. This ensures that the rocket motor's integrity is not compromised in any way that could lead to an unplanned explosion or other release of waste constituents. The inspection also includes a survey of personal protective equipment, calibration of equipment, malfunctions, and weather conditions.

Groundwater monitoring equipment will be inspected prior to well purging for each groundwater monitoring sampling event.

II.DD.2.2. Frequency of Inspections

An equipment/site inspection log has been incorporated into the work instructions (Exhibit II.CC-1) developed for the static firing of rocket motors. The work instruction identifies equipment associated with the OB process. Prior to any operation involving ordnance disposal at WFF, the site designated for hazardous waste disposal shall be inspected to detect any possible deterioration of equipment. The following will also be inspected (a) rocket motors,

(b) monitoring equipment's calibration, (c) safety and emergency equipment, and (d) other devices to be utilized during the operation. The inspection includes date, weather conditions, notations of any observations, and nature of corrective actions, if any. The Carrier Systems Branch shall maintain the log for a minimum of 3 years, from the date of inspection. A copy of all inspections will be kept at Building X-55 General Services in the OB record storage area.

The frequency of inspections is based upon the number of OB operations. Inspections are made prior to any thermal treatment of rocket motors. Any deterioration or malfunction is corrected prior to thermal treatment.

II.DD.3. Preparedness and Prevention Documentation

A waiver from the requirements of 40 CFR 270.14[b][6] is not part of this Permit. Documentation of NASA's preparedness and prevention requirements for open burning are described in the following sections.

II.DD.3.1. Equipment Requirements

II.DD.3.1.1. Internal Communications

The communication equipment at the OB area consists of hand-held, two-way FM radios, which are on a radio net monitored by the Security Office, the Range Safety Office, the Fire Department, and the Health Unit. A telephone is located at the Multi Function Radar Facility, Building Z-41, approximately 1.6 kilometers (1.0 miles) from the OB barricade.

II.DD.3.1.2. External Communications

A telephone at Building Z-41 serves as the external communication equipment to summon emergency personnel other than the fire department. Access to outside lines is available through this telephone. Hand held radios used at the site have access to the Emergency Console. The Emergency Console will summon emergency personnel from WFF Main Base or off facility emergency units if needed.

II.DD.3.1.3. Emergency Equipment

During open burning operations, the fire department is on stand-by status. As described in Attachment II.FF - Contingency Plan, the fire department for WFF is available for emergency operations. Portable fire extinguishers are located on vehicles used to transfer rocket motors for open burning. WFF also maintains agreements with local police, fire, emergency response, and hospitals. Documentation of arrangements can be found in Attachment II.FF – Contingency Plan.

II.DD.3.1.4. Water for Fire Control

The fire department on Wallops Island consists of two fire trucks with a total capacity of 56,788 liters (1,500 gallons) of water and 227 liters (60 gallons) of foam. On the Island, three water storage towers 56,781,189,270, and 189,279 liters (150,000, 50,000 and 50,000 gallons) provide water to a water hydrant system maintained at 3,785 liters per minute at 1.4 kilograms per square centimeter (1,000 gallons per minute at 20 pounds per square inch). In addition, a 378,541 liter (100,000 gallon) storage tank located on the mainland provides water to the Island. The closest water hydrant to the OB area is located approximately 609 meters (2,000 feet) away at the Virginia Commercial Spaceport. Hydrant flow tests are performed annually by the fire department to ensure the water supply system is functioning properly. Pumper trucks are used at the open burning area. In the event additional capacity is needed, a 26, 498 liter (7,000 gallon) fire truck is available from the Main Base.

II.DD.3.2. Aisle Space Requirement

Aisle space requirements are more than adequate for the outdoor thermal treatment at the OB area. Sufficient space is available between the subunits and burn pad for inspection and maintenance purposes. Emergency equipment may reach the OB area from the access roadway.

II.DD.4. Preventative Procedures, Structures, and Equipment

The following subsections describe the procedures, structures, or equipment used at the Open Burning area to comply with the requirements of 40 CFR 270.14[b][8].

II.DD.4.1. Unloading Operations

NASA vehicles transport rocket motors to the OB area, in original packing containers. Vehicles are required to meet the requirements of DoD Form 626, which requires emergency equipment, suitable transport, and certified drivers. All drivers transporting rocket motors must hold a Commercial Drivers license with Hazardous Materials endorsement. All NASA motor vehicles used for transporting rocket motors to Wallops Island are inspected prior to loading to check for safe mechanical condition. Vehicles are equipped with spark arrestors, have wooden-lined back carriages to prevent accidental ignition, and are properly placarded with their explosive designations.

Large rocket motors (greater that 100 pounds) are transported in wooden crate containers and are handled with a forklift. The motors are unpacked in reverse order of packing in preparation for open burning. Smaller rocket motors are containerized and placed in the wood-lined pickup truck. These are unpacked at the OB area and prepared for OB.

II.DD.4.2. Run off

Migration of contaminants, from the OB area during a rain event, is prevented by covered subunits and pad at the site. The subunits are covered and the pad is protected by a berm and cover.

Following each OB operation, the OB area is inspected for ejected material. Ejected material and residue is reignited on the burn pad. Prior to and following each OB operation, surface soil and water within a 1.2 meters (4 foot) diameter of the subunit or pad are sampled to validate the lack of contamination from OB operations. Surface soil sampling consists of six discrete points, which lie between the OB subunit or pad and a 1.2 meters (4 foot diameter) boundary line. The six discrete points are sampled before and after the OB operation. The six discrete before samples and the six discrete after samples are each composited into one sample (two samples total). One grab surface water sample is taken from the same source both before and after each OB operation. Surface water samples are field tested for pH, conductivity, and temperature. Surface soil samples are analyzed for total and dissolved lead (SW-846 6010B) and energetics (SW-846 8330 modified or 8321). Results are reported semiannually in the OB Groundwater Monitoring report.

Runoff, which should not come in contact with contaminated media, is directed across the access road to the east and north and across vegetation to the south and west. Runoff is not collected and does not impact other drainage structures on the Island. Runoff from the OB area infiltrates into the sandy soil surrounding the units.

Since the OB area will not have a point source or a storm water collection system, a Virginia Pollutant Discharge Elimination System (VPDES) Permit is not required.

The OB area lies west of the Atlantic Ocean at an elevation of +10.0 MSL, limiting high water from reaching the OB area.

II.DD.4.3. Water Supplies

The nearest water supply well is located on the Mainland approximately 4.3 kilometers (2.7 miles) from the OB area. Runoff and infiltration from the site enter the Atlantic Ocean or brackish creeks and marshes surrounding the OB area. This water is not a source of potable water for humans or animals.

II.DD.4.4. Equipment and Power Failure

The OB operations have no permanent power requirements. Electric power failure will have no impact on OB at Wallops Island. OB activities are not

The OB operations have no permanent power requirements. Electric power failure will have no impact on OB at Wallops Island. OB activities are not performed in the event of electrical storms. OB activities in progress are immediately terminated whenever lightening is within 8 kilometers (5 miles) of the OB area. In addition, buildings and areas containing rocket motors are vacated when the 8 kilometers (5 miles) distance is determined. The NASA weather station on the Main Base continuously tracks weather conditions at Wallops Island and notifies the Range Safety Officer when electrical storms are observed on radar.

II.DD.4.5. Personal Protection Equipment

To prevent exposure of personnel to propellant contained in rocket motors, NASA provides personal protective clothing and equipment (PPE) to certified employees. Items available to employees include the following:

- Safety goggles and safety spectacles;
- Safety shoes;
- Non-static producing, fire resistant shop coat, coveralls, and gloves;
- Protective head gear;
- Face shields; and
- Wrist-stats.

Additional protection of employees is provided by the fiberglass barricade located 152 meters (500 feet) from the OB area. The barricade serves as a shield to protect personnel from any potential escaping debris and gases. Ignition of the propellant does not occur until all personnel are located behind the barricade.

II.DD.5. Prevention of Reaction of Ignitable, Reactive, or Incompatible Wastes

The waste propellants have been identified by EPA's hazardous waste identification criteria as reactive wastes. Propellants are reactive and are capable of an explosive reaction if subject to a strong initiating source or if heated under confinement (40 CFR 261.23a[6]). As required by 40 CFR 264.17(c), a source of published documentation that cites the reactivity of these wastes is provided in Dangerous Properties of Industrial Materials.

The WFF takes precautions to prevent the ignition or reaction of ignitable and reactive waste. For example, all storage and support activities for propellants are included in limited access areas at WFF. Information signs warning against smoking, the introduction of matches, and other flame-producing devices are displayed at all normally used limited area entrances. A "No Smoking" sign has been posted.

NASA has several operating procedures aimed at preventing ignition or reaction of the propellants. Sparks are avoided at rocket motor handling facilities by requiring all of the operating personnel to wear non-conductive sboes and wrist-stats when involved with propellant operations. Heat or spark producing, electrically powered, or impact tools required for OB preparation are permitted only with written permission.

These procedures ensure that the waste is separated and protected from sources of ignition or reaction from open flames, static, etc.

II.DD.5.1. No-Fire Operation

In the event of No-Fire, all personnel will remain behind the barricade. Further instructions are found in the Open Burning Procedure Work Instruction found in Attachment II.CC.

ATTACHMENT II.EE

PERSONNEL TRAINING

ATTACHMENT II.EE-PERSONNEL TRAINING

II.EE.1 Outline of Training Program

Personnel training programs for Open Burning (OB) operations include rocket motor handling, contingency plan implementation, emergency response, and hazardous waste management. A major component of the training program is Procedure and Guideline 8715.02 Training and Certification Procedures for Ordnance Handlers at GSFC/WFF (Exhibit II.E.1). This procedure is intended to provide and assist managers and employees in safe OB operation practices and is administered by the Ordnance Training and Certification Committee (OTCC). The procedures set forth the policy for personnel who are assigned duties in handling rocket motors and complies with the requirements of:

- Executive Order 12196, "*Safety and Health Programs*";
- Subpart H of the "*Basic Program Elements for Federal Employees Occupational Safety and Health Programs*" under 29 CFR 1960.59; and

Employees that are certified in ordnance handling are the only individuals permitted to perform work on ordnance and rocket motor devices.

Initial HAZWOPER training is a federally required comprehensive 40-hour course, which instructs students in emergency response safety procedures and protocol during hazardous material releases. HAZWOPER training prepares the individual in emergency response and common work practice situations, which could result in accidental releases or could potentially affect human health and the environment. In conjunction with initial 40-Hour HAZWOPER training, a federally required annual 8-hour HAZWOPER Refresher training is attended every year thereafter. The purpose of the 8-hour refresher training is to maintain a current and thorough knowledge of emergency response and safety procedures. Training also updates the individual's awareness in new technologies and/or response procedures to be used during hazardous material releases.

II.E.1.1 Job Titles and Duties

Personnel certified in the handling of ordnance and rocket motors are the principal individuals involved in the operation of the OB units. Four categories of ordnance training are available and are as follows:

- Category I - All Systems
- Category II - Vehicle Systems
- Category III - Payload Systems
- Category IV – Selective

Operators and technicians handling rocket motors will possess a minimum Category IV certification.

A request for ordnance certification training is initiated by submittal of completed Form NASA WI-1284 "Ordnance Training/Certification." The OTCC assures appropriate course content and delegates individual's certification instruction. The Chairman, OTCC, with recommendations from the OTCC, approves ordnance certification training programs, provides technical direction of the OTCC, and recommends certification of applicants to the Chief, Safety Office. The Chief, Safety Office shall certify applicants based on OTCC recommendations. Ordnance Certification cards (NASA WI-1286) are issued to operators and technicians upon successful completion of the certification program. The Secretary, OTCC is responsible for maintaining records for each individual certified to handle ordnance devices in Building E-107.

II.E.1.2 Training Content, Frequency and Technique

All current and future operators and technicians performing duties for rocket motor handling at the OB area will complete the Ordnance Certification Training. Recertification of ordnance and rocket motor handlers will be required every 3 years. New operators and/or technicians assigned to the facility will be required to complete all training requirements prior to performing work duties in the OB area. Supervisors of OB operators, as well as the OTCC will participate in reviews of the initial and continuing training.

Training will be conducted in three phases: classroom lectures, video presentations, and field experience. The ordnance training manual is included in Exhibit II.EE-1. The videotape presentation will consist of four 1-hour segments on the safe handling of rocket motors. The hands-on experience will involve the refurbishment of rocket motors and instruction on contingency planning and residual material management.

This course will be taught by a Category I certified individual or equivalent. Category I certified personnel must have a minimum of 3 years of varied experience in both vehicle and payload pyrotechnic systems. Personnel must have served as a Pad Supervisor/Pad Chief or an equivalent position. Personnel must

be capable of conducting classroom and/or on-the-job training.

A comprehensive physical and medical health surveillance examinations will also be a part of the certification process conducted in accordance with 29 CFR 1910.120 [f]. Annual physical medical health surveillance examinations will be required each year thereafter. These physical examinations are also intended to determine an employee's fitness for using a respirator in accordance with 29 CFR 1910.134.

The Environmental Office representatives, who support the OB operation, and designated OB personnel are required to complete the initial 40-hour HAZWOPER training program. Eight-hour HAZWOPER Refresher training is required annually every year thereafter.

The initial and annual HAZWOPER course includes:

- Site safety planning – levels of protection
- Hazard recognition
- Toxic effects
- Safe work practices
- Anticipated hazards
- Handling emergencies and self rescue
- Rules and regulations for vehicle use
- Employee rights and responsibilities
- Containerizing and transporting hazardous materials
- Respiratory protection and levels of personal protective equipment
- Use, care and limitations of personal protective equipment
- Personal and equipment decontamination
- Contingency planning and implementation
- Proper sampling techniques and documentation

Certified instructors will teach Hazwoper initial and refresher training.

Resource Conservation and Recovery Act (RCRA) Hazardous Waste classes and Integrated Contingency Plan classes are required to be taken annually by all hazardous waste generators and Treatment , Storage, or Disposal Facility operators at WFF. Environmental Office representatives, who have a minimum of 3 years experience in their field, and who have taken advanced classes in their subject area, give these classes.

The RCRA Hazardous Waste class includes:

- Hazardous waste management procedures
- Emergency procedures
- Contingency plan implementation
- Waste minimization/pollution prevention

II.E.1.3 Program Director

An environmental coordinator will be responsible for oversight and review of environmental activities, training, management of hazardous waste, emergency technical assistance, and compliance. The environmental coordinator is required to be an engineer, with 2 years of environmental management experience or equivalent.

H.1.4 Relevance of Training to Job Position

Employees will receive training within the scope of their specific job positions that will include: site orientation; hazardous waste management; and contingency plan training. Employees responsible for OB activities, including supervisors, will be trained in ordnance and rocket motor handling and in recognizing safety and health hazards in the workplace. Training will include all aspects of handling, transport, ignition or detonation, propellants, igniters, and residuals. Training will be reviewed annually.

H.1.5 Training for Emergency Response

The applicable requirements of this section are the procedures for using, inspecting, repairing and replacing facility emergency and monitoring equipment, response to fires, explosions, sudden and non-sudden releases associated with residuals. The general requirements for these are outlined in Range Safety Manual (RSM-2002) for GSFC/WFF and Wallops Safety Manual (WSM-2002). In addition, the Ground Safety Group prior to any potentially hazardous operation or launch conducted at WFF prepares a Ground Safety Plan. The WFF training programs are designed to promote effective staff response to emergencies through awareness of correct operating procedures, appropriate equipment, emergency systems, communications and alarm systems. Training on procedures is received during the employee's site orientation. Response to fires, explosions and releases will be provided by the WFF fire department, with additional support available from local community volunteer fire departments within the proximity or region of WFF. The WFF fire department personnel are trained as first level emergency responders and are on-site during actual OB activity.

II.E.2 Implementation of Training Program

New employees receive training through lectures and handout materials during orientation. The orientation information is available through the employee's supervisor. Newsletters and other information are distributed to employees on a regular basis. Personnel assigned to OB operations will successfully complete Ordnance Certification and training on contingency planning prior to working in the OB area. Rocket motor handlers cannot work without direct supervision from ordnance trained and certified employees until they are certified. Designated personnel will obtain HAZWOPER certification prior to assignment. All drivers must have commercial drivers licenses with Hazardous materials endorsement before they are allowed to transport rocket motors.

Records and certifications for OB personnel regarding health, safety, and security are maintained in the following locations: Health Office, Building F-160; Safety Office, Building E-107; and Security Office, Building N-222.

EXHIBIT II.EE-1

Training And Certification Procedures For Ordinance Handlers

Procedures and Guidelines

DIRECTIVE NO.	800-PG-8715.0.2	**APPROVED BY Signature:**	*Original Signed By*
EFFECTIVE DATE:	April 5, 2001	**NAME:**	Arnold L. Torres
EXPIRATION DATE:	April 5, 2006	**TITLE:**	Director of Suborbital and Special Orbital Projects

Responsible Office: 803/Safety Office

Title: Training and Certification Procedures for Ordnance Handlers at GSFC/WFF

PREFACE

P1. PURPOSE

Operations are conducted at the Goddard Space Flight Center/Wallops Flight Facility (WFF) which involve handling of pyrotechnic (ordnance) devices. These devices are potentially hazardous if not handled properly. NASA requires personnel handling these devices be trained and certified. This procedure outlines the requirements and procedure by which the WFF Ordnance Training and Certification Committee (OTCC) certifies personnel to handle pyrotechnics in support of projects managed by, or conducted with Code 800 resources.

P2. REFERENCES

NPG 8715.3, NASA Safety Manual
NSS 1740.12, NASA Standard for Explosives, Propellants, and Pyrotechnics
GPD 8715.1, Goddard Space Flight Center Safety Policy
800-FORM-0002, Request for Ordnance Training/Certification

P3. SCOPE

This procedure is applicable to all personnel, including contractors, that are required to handle ordnance devices in execution of their work duties at WFF or at off-site locations while supporting Code 800/Suborbital and Special Orbital Projects Directorate's (SSOPD) programs, projects, and reimbursable activities. This procedure identifies the process by which personnel become certified by the WFF Ordnance Training and Certification Committee (OTCC).

Personnel coming to WFF to conduct projects must either submit satisfactory evidence of the required skills and knowledge to the OTCC or become certified by the OTCC. Ordnance handling certifications from other ranges or facilities are an acceptable demonstration of the required skills and knowledge. Uniformed DOD personnel, explosive ordnance disposal personnel, and law enforcement personnel are exempt when qualified by formal training or certifications.

P4. DEFINITIONS

a. Ordnance Training and Certification Committee (OTCC) - The WFF OTCC is appointed by the Director of SSOPD. The OTCC's function is to evaluate and approve/reject applicants applying for ordnance handler certification, as well as, developing or approving training programs for ordnance handlers.

b. Ordnance Certification Program - Program which includes as a minimum a WFF OTCC approved formal training program and a demonstration of applicants proficiency in handling ordnance devices in a safe and reliable manner. Ordnance Certification consists of various levels:

(1) Category I Certification - Personnel must have a minimum of three years of varied experience in both vehicle and payload pyrotechnic systems. Personnel must have served as a Pad Supervisor/Pad Chief or an equivalent position. Personnel must be capable of conducting classroom and/or on-the-job training.

(2) Category II Certification - Personnel must be fully knowledgeable of, and shall be restricted to, launch vehicle pyrotechnic/ordnance systems.

(3) Category III Certification - Personnel must be fully knowledgeable of, and shall be restricted to, payload pyrotechnic/ordnance systems.

(4) Category IV Certification - Personnel shall be restricted to specific devices and/or systems that shall be defined on their certificate and ordnance card. Newly certified personnel who require supervision during ordnance handling operations will also be assigned to Category IV.

(5) Trainee Certification - Personnel having completed classroom instruction but have not completed the hands-on portion of training. Trainees must have a person with a Category III Certification or higher present at all times when they are handling pyrotechnics.

P5. AUTHORITIES AND RESPONSIBILITIES

a. Chairman, OTCC - Responsible for technical direction of the OTCC and for recommending certification of applicants to the Chief, Safety Office. The Chairman, with recommendations from the OTCC, shall approve ordnance certification training programs.

b. Chief, Safety Office - Shall certify applicants based on OTCC recommendations and other knowledge that he/she may possess.

c. Secretary, OTCC - Responsible for maintaining records for each individual certified to handle ordnance devices. The Secretary is also responsible for advising the ordnance handler's immediate supervisor when certification is about to expire (90-day certification renewal notice).

d. Immediate Supervisor - The Applicant's immediate supervisor is responsible for initiating the Request for Ordnance Training/Certification and for certifying the accuracy of the data provided.

e. Approving Official - The Applicant's approving official is responsible for approving submittal of the Request for Ordnance Training/Certification (800-FORM-0002) to the OTCC. The Approving Official will be at the Branch or Office Chief level.

P6. CANCELLATION

Ordnance Certification Plan for WFF, dated 1982

P7. QUALITY RECORDS

Quality Record Title	Record Custodian	Retention
Request for Ordnance Training/Certification form (completed by applicant)	OTCC Secretary	NRRS 1/14 B2. Destroy when 3 years old or when no longer needed for reference, whichever is sooner
Applicant's resume of ordnance handling experience	OTCC Secretary	NRRS 1/14 B2
Applicant's ordnance handling course data and test results	OTCC Secretary	NRRS 1/14 B2
90-day Certification Renewal Notice (copy)	OTCC Secretary	NRRS 1/14 B2

IMPLEMENTATION

1. CERTIFICATION REQUIREMENTS

To obtain ordnance handler certification through the OTCC, all personnel must:

1.1 Demonstrate a need to handle pyrotechnics in the execution of their job duties.

1.2 Complete the Request for Ordnance Training/Certification form (800-FORM-0002). The data contained on this form will be used by the OTCC to determine whether or not the candidate has satisfied the certification requirements.

1.3 Be properly trained in standard pyrotechnics handling safety practices. The OTCC shall approve pyrotechnics safety training courses or conduct the courses with OTCC members. The supervisor may request training from the OTCC for new ordnance handlers. The Safety Office normally schedules one course per year. The OTCC shall ensure that a written/oral exam covering the

course items (a through e below) is conducted. Seventy-five percent correct is considered passing.

a. Basic Principles of Explosives Safety
b. Transportation and Storage Requirements
c. Radio Frequency Hazards
d. Electro-Static Discharge Hazards
e. Basic Initiator Circuits

1.4 Have knowledge of the systems and procedures they are required to use. The supervisor or system engineer's statement of training will be used to evaluate this element.

1.5 Have demonstrated through on-the-job training, direct experience, or by "classroom demonstration" that they are proficient in pyrotechnic handling techniques. For personnel requesting recertification, direct pyrotechnic handling experience or refresher training must occur within 6 months prior to request. Before the OTCC will complete the evaluation, a certified ordnance handler (Category I, II or III) must sign-off on demonstrations of hands-on experience.

1.6 Demonstrate that they posses no disqualifying health problems. The possession of a valid State drivers license shall be acceptable unless counsel from medical personnel determines otherwise. Personnel who do not possess a valid drivers license shall present a statement from a licensed Medical Doctor verifying that they have no disqualifying medical conditions to handle dangerous materials. The OTCC reserves the right to request a medical evaluation. Minimums include acceptable vision without color blindness, acceptable hearing, hand-eye-coordination, and free of medical conditions such as addictions, mental illness, etc.

For personnel who have demonstrated a need to handle pyrotechnic devices in execution of their normal duties (item 1.1) and who cannot satisfy all of the remaining requirements (items 1.3 through 1.5) a Trainee Certification may be issued after completion of items 1.3 (a through e). Trainee Certifications will restrict the applicant to handling specific pyrotechnic devices under direct supervision of a Category I, II, or III certified ordnance handler.

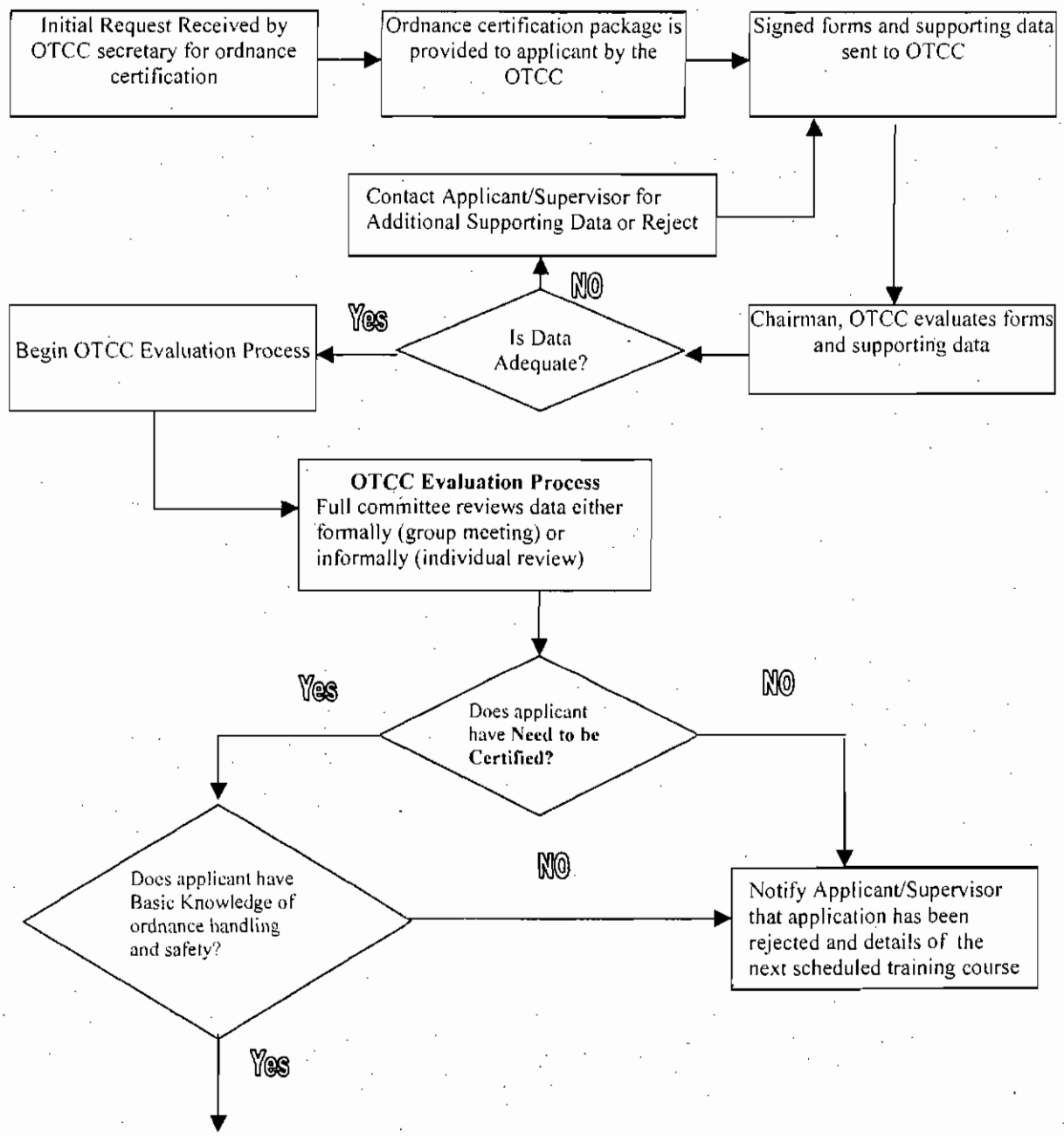
Personnel desiring to upgrade or remove restrictions from their certification may due so at any time during their certification period by completing and submitting the Request for Ordnance Training/Certification Form (800-FORM-0002) with appropriate justification for the request.

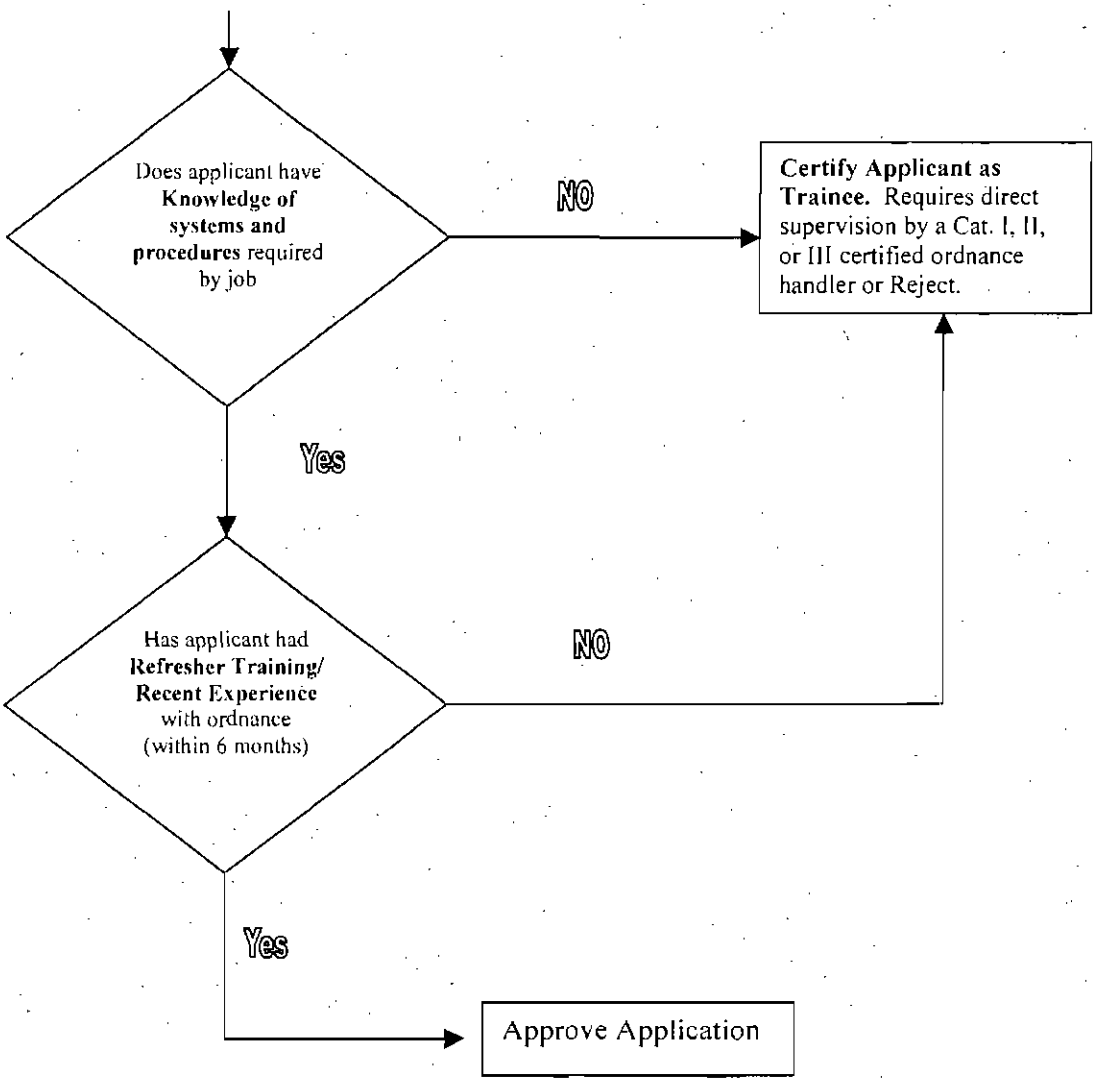
2. CERTIFICATION PERIOD

Ordnance handler certification is valid for a period of 3-years from the date of certification.

3. FLOW DIAGRAM OF CERTIFICATION PROCESS

The following flow diagram depicts the process employed by the OTCC to evaluate and certify personnel to handle ordnance devices:




Does applicant have **Knowledge of systems and procedures** required by job
NO
Certify Applicant as Trainee. Requires direct supervision by a Cat. I, II, or III certified ordnance handler or Reject.
Yes
Has applicant had **Refresher Training/ Recent Experience** with ordnance (within 6 months)
NO
Yes
Approve Application

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	April 5, 2001	Initial Release

ORDNANCE TRAINING

(Handling, Safety, and Circuitry)

NASA Sounding Rocket Operations Contract
Wallops Flight Facility
Wallops Island, Virginia

September 2001 (Original Release)
June 2003 (Revision D)

COURSE OBJECTIVES

- To familiarize each participant with the risk, safety and hazards involved with ordnance handling. This objective includes the circuitry involved and every aspect of ordnance handling and safety.
- All participants are involved with ordnance in some respect. This includes handling, checking out, installing and connecting ordnance devices. These applications are the employee's job resposibility.
- To lay the groundwork for submission to the Ordnance Training Certification Committee, OTCC, a request for "Trainee" status in terms of Ordnance card.

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Chapter 1: BASIC EXPLOSIVES

In one sense, explosive compounds are fuels since they liberate energy in the form of heat and gas due to chemical decomposition. This is similar to oil, gasoline, butane, and coal. The major difference between materials classified as explosives and normal fuels are these:

- The explosive material contains its own oxygen and does not require atmospheric oxygen for combustion whereas normal fuels such as coal require large amounts of oxygen in order to provide combustion. For example, to burn one pound of coal requires enough air to provide two pounds of oxygen. On the other hand, a smokeless rifle powder will burn in a vacuum as well as in the air.

- The rate of combustion of explosive materials is much faster than normal fuels. Once initiated under proper conditions, combustion or decomposition of an explosive takes place in millionths of a second, whereas an equal weight of a fuel such as coal may take many minutes to complete its burning. Whether normal fuel or explosive, the ability to perform work is based on the liberation of gas at high temperatures, this produces pressure. In the case of explosives, this pressure effect is often aided by the rapidity of the action, which may also produce shock phenomena.

Explosives can be classified into three basic types: Priming Materials, Propellant Type Materials, and High Explosives.

A. Priming Materials

Priming materials are often called "First Fire" materials since they are the first materials initiated in an explosive train. Typical primers include lead styphnate, HOLEX #1 (a zirconium base pyrotechnic) and lead azide. This latter compound is more often used as a high explosive booster. All priming materials have certain common characteristics:

- There is a high degree of sensitivity to initiation from high temperature, shock, friction or electric spark.

- There is the ability to release very high temperatures or flame upon decomposition.

Since primers are usually initiated by raising their temperature by means of an electrically heated wire (bridgewire) or by shock such as the striking of the primer by a firing pin in a rifle cartridge, a high sensitivity is required. Since primers are usually poor producers of gas, their main function is to initiate a second, more

stable, but better power producing explosive compound, which requires an even higher temperature from the primer to be initiated. This points up one of the oddities of explosives which is **"THE MORE POWERFUL THE EXPLOSIVE, THE MORE DIFFICULT IT IS TO INITIATE."** Nitro-glycerine is an exception to this rule. Therefore, an efficient explosive train usually requires a minimum of two elements:

- A priming material to permit ready and reliable initiation
- A main explosive charge of higher power output for performing desired work.

B. Propellants

Propellants have the following characteristics:

- Propellants are good gas producers.
- Propellants burn or deflagrate rather than detonate.
- The rate of burning of propellant powders, although very rapid compared to fuels, is nevertheless controlled by the pressure surrounding the propellant.
- Propellants are generally more stable and, therefore, more difficult to ignite than are the priming compounds discussed earlier.

One major difference between propellants and high explosives is in their respective methods of burning. Propellants burn in a manner, which is scientifically, called "deflagration", while high explosives "detonate"

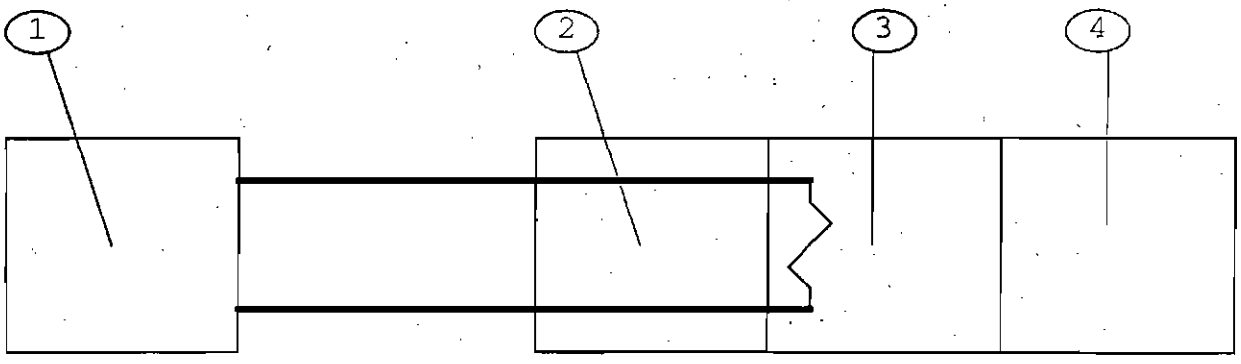
Two very important points characterize deflagration:

- The propellant burns evenly and at a uniform rate on all ignited surfaces.
- The gases and other combustion products flow away from the burning surfaces.

Note: CATEGORIES CAN OVERLAP

Example – Ammonium Nitrate is a chemical, which can be packaged in Several Different Forms. One Method uses the Chemical Coated with Talc, an Inert Material used for Anti-caking. And this Packaging allows the Chemical to be sold as Fertilizer (FGAN). It can also be packaged in a Prilled Form, in which Small Pellets of Uniform Size and Shape are Manufactured and Coated with a thin Layer of Wax to Produce Explosive Grade Ammonium Nitrate (EGAN). Ammonium Nitrate has been commonly employed as an Oxidizer in Rocket Propellants.

ELECTRO-EXPLOSIVE DEVICE (EED)



(1) On the input side is the electrical circuit made up of a power source, switches, connectors and cables. The circuit must be considered as a part of the EED and it is here that many hazards occur.

(2) The electric transducer consists of a plug with two pins ending in a bridgewire. Instead of pins, there may be wires and instead of the hot bridgewire (perhaps the most common type), there may be an exploding bridgewire (EBW), a graphite film or some less common mechanism.

(3) A sensitive explosive charge is heated by the electric energy.

(4) The output charge is critical when considering safety. If there is nothing in the box, we have an electric match or squib that results in a small flame (a test squib). If the box is full of high explosive, the EED becomes a detonator or blasting cap whose output will produce a shock wave to create a high explosive effect. Alternatively, the box could contain a grain or propellant to result in the family of actuators or propellant actuated devices. This family includes the motors, switches, cutters, valves, bolts and automotive air bags.

Figure 1.B-1

When burning times of 1 second or longer are required, the reaction time of the pressure cartridge using rifle type smokeless powders is too fast and a gas generator is needed. The propellant in a gas generator is very similar to that used in a rocket engine and is much slower burning than the smokeless powders. It is, however, still a propellant with all of the basic propellant characteristics.

Therefore, we can use this type of propellant to give burning times of many seconds. As might be suspected, propellants for gas generator applications are even more difficult to ignite than smokeless powders and most will not sustain combustion unless they are maintained at relatively high pressures and temperatures.

C. High Explosives

The family of high explosives includes TNT, Nitroglycerine, TETRYL, Pentaerythrite Tetranitrate (PETN), and Cyclotrimethylenetrinitramine (RDX). While high explosives produce some gas and high temperatures as a result of explosive decomposition, their main source of power is due to shock or shattering force rather than pressure as was the case with low explosives such as propellants.

The two most commonly used high explosives used at HOLEX are RDX and PETN. They cannot be normally initiated by spark, heat or flame. This does not mean that they will not burn if set on fire. In fact, burning is one means of disposal, but it does mean that they WILL NOT decompose with their maximum energy under these conditions. To obtain true HIGH ORDER detonation, these materials must be subjected to shock impact of 3000 to 5000 meters per second, which is obtainable only from another explosive. This is the reason that items using RDX and PETN as a main charge usually have a 3 unit explosive train consisting of a primer, a booster charge and finally, the main charge of high explosive.

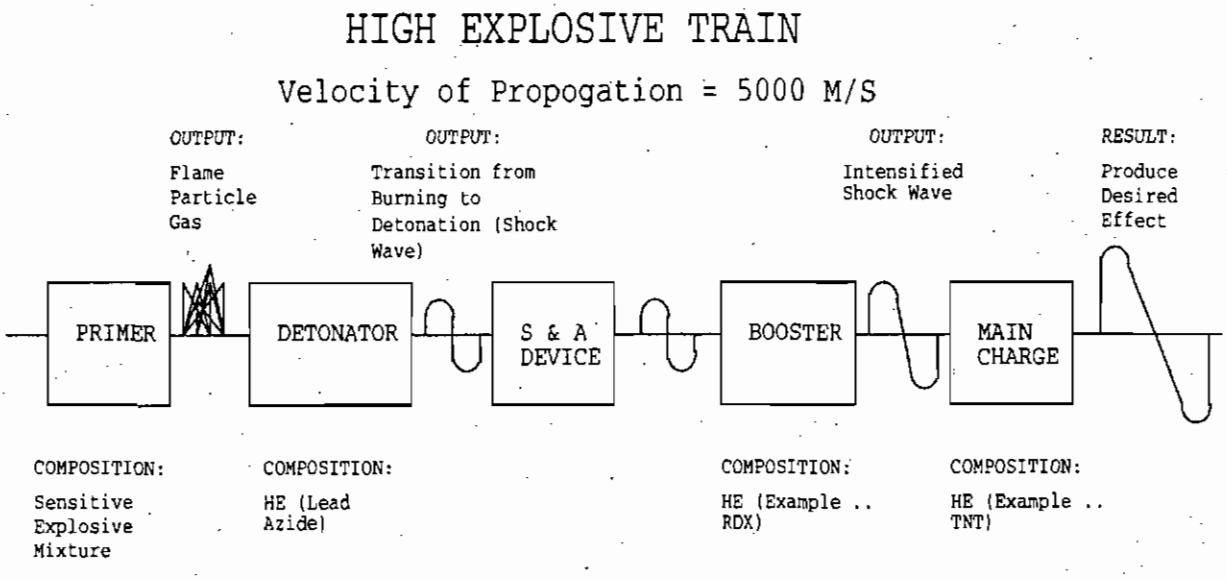


Figure 1.C-1

Now let us examine what HIGH ORDER DETONATION means. For purposes of simplicity, let us imagine a cylinder of RDX one foot in diameter and three feet long. Against the left end of this cylinder we will now set off an explosive charge of lead azide. The shock from the decomposition of the azide is sufficient to cause decomposition of the face of the RDX cylinder, which occurs, with release of gas and increase in temperature. This is called the zone of decomposition and it travels to the right down the length of the cylinder at tremendous speed. This speed is called the detonation rate and is constant for each type of explosive. For example, in RDX pressed to a density of 1.6 grams per cubic centimeter the detonation rate is 8,200

meters per second or over 18,000 miles per hour!! Therefore, the entire time required for the decomposition to travel from end to end of the three foot long cylinder will be about 0.0001seconds. With decomposition proceeding at this rate, there is no opportunity for the by-products of gas and particles to escape from the decomposition area, which results in tremendous shock pressures being generated. In fact, the gases and particulates actually follow the detonation wave from left to right as it proceeds through the cylinder in a manner similar to the dust clouds that whip up and trail a speeding truck on a dirt road. As the decomposition zone reaches the end of the cylinder it not only is traveling at 18,000 miles per hour but it has also developed a peak shock pressure of 4,000,000 pounds per square inch. It is this combination of velocity and shock that gives high explosives their tremendous shattering effect. It is this ability to shatter that is used to break bolts, shear steel plates and deform heavy metal sections by means of detonating high explosive charges.

Summary/Highlights of Basic Explosives

Explosives are fuels, although a special type of fuel that contains its own oxygen

Primers are the most sensitive explosives and are the first unit in the explosive train.

Propellants, including primers, deflagrate or burn rather than detonate and use pressure from hot gases for accomplishing work.

High explosives detonate rather than deflagrate and use their extreme detonation velocity and shock pressure to produce shattering rather than pressure effects.

All explosives, primers, propellants, and high explosives are unstable compounds by their very nature and, while safe to handle and process under controlled conditions, must always be treated and handled with the respect their latent power deserves.

D. Low Explosive Train

The low explosive train is comprised of:

- An explosive chemical mixture that is highly sensitive to ignition by high temperature, shock, friction, or electric spark. This mixture is called the primer. We use an electrically heated bridgewire to ignite the primer by means of high temperature. Ignition by shock can be accomplished by a firing pin in a rifle or by an exploding bridgewire (EBW). A wooden match is a good example of ignition by friction, and an electric spark and black powder or even the action of the old flintlock rifle and black powder demonstrates the other means of ignition

of what we call primers. The flame is used to set off the next element in the explosive train.

- The second element in a low explosive train depends mostly on the kind of work to be performed. The second element is not as sensitive to ignition as the primer material, and sometimes we may have to insert a booster material between the primer and the second element. If we want to produce gas and pressure to accomplish work, we would use a propellant as the second element in the train. Propellants deflagrate or burn rather than detonate, and their output is flame, gas and particles. The decomposition rate or velocity of propagation of a propellant is very slow, in the area of 5 feet per second, or less. Having a propellant as the second element in a low explosive train results in a family of actuators or propellant activated devices. This family includes the motors, switches, valves, bolts, and even automotive air bags.

A low explosive train is comprised of a highly sensitive explosive material called a **primer** and a second element that is less sensitive and is called **a propellant**.

Propellants, including primers, deflagrate or burn rather than detonate.

The output of low explosive train is flame, gas, and particles.

The decomposition rate of a low explosive train is 5 feet per second, or less.

The low explosive train uses pressure from the hot gases to accomplish work.

E. High Explosive Train

Essential elements of a high explosive train are:

- A primary or low explosive charge, contained in a suitable housing, that is capable of (1) being activated by a relatively small stimulus (mechanical or electrical) and (2) producing a self-propagating reaction. The output of this initial charge consists principally of relatively low velocity hot gases and particles. **(The primer)**

- An intermediate charge of primary high explosive (most commonly lead azide) in which the transition from burning to detonation takes place. **(The detonator)**

- A secondary high explosive charge (for example RDX) that intensifies the shock output from the previous charge. **(The booster)**

- A main charge consisting of a secondary high explosive (for example TNT) that has a sufficiently high enough output to produce the desired effect. **(The main charge)**

The output from a high explosive train is an amplified detonation wave and the effects of that wave are blast, shock and fragmentation.

Blast is the effect from high explosives in air. Shock is the effect from high explosives in a solid. Fragmentation is the effect of breaking up a solid, i.e. hand grenade

Blast is the result of overpressure and is used for destruction (overpressure of 3 PSI can knock over a brick wall.... overpressure of 9 PSI will cause brain damage).

Auxiliary elements that are usually included in a high explosive train for convenience and safety purposes are:

- Leads to transmit explosive reactions between spatially separated elements.
- Safe and arming devices that must provide both electrical and mechanical interruption of the detonation of the high explosive train.

Chapter 2: ELECTRO-EXPLOSIVE DEVICES (EEDs)

A. Types of EEDs

- **Pressure Cartridges:**

Pressure cartridges, in general, consist of an ignition primer and a main charge encased in a single cartridge. The primer ignites the main propellant charge, which then produces gas in the required quantity and temperature. The gas thus produced may be used for any number of useful work-producing applications, such as, pushing pistons, breaking diaphragms, filling flotation devices, air bags, etc. We can see by these applications and components of the pressure cartridge that it belongs to the category of Low Explosive Train.

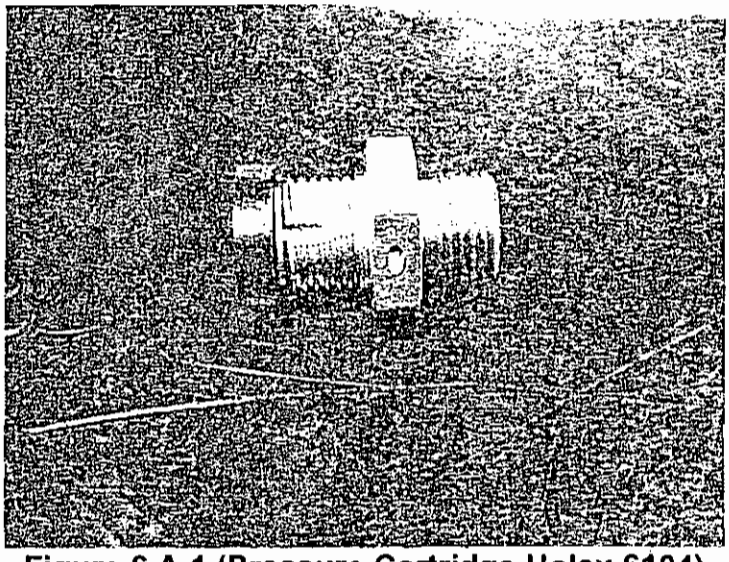


Figure 6.A-1 (Pressure Cartridge Holex 6104)

- **Igniters:**

Ignition cartridges generally fall into one of three categories: Ignition Primer, Integrated Ignition Primer and Booster Combination, and Complete igniter consisting of Primer, Booster and Main Sustainer Charge

Ignition primers, in general, are electrically initiated cartridges loaded with a heat-sensitive material, which, when initiated, produce high temperature gas and flame. Initiation is caused by the passage of an electric current through a resistive wire (bridgewire), which heats the wire to a temperature above the auto-ignition temperature of the surrounding priming material. This decomposes very rapidly, producing flame and high-temperature gases. This flame and gas output is used to ignite a secondary explosive material. The nature of the secondary charge will depend upon the final application. For example, it may consist of a pyrotechnic mixture used to raise the ignition

chamber of a solid propellant rocket motor to the pressure and temperature required for sustained ignition. Since the ignition primer is the first and most complex element in an explosive train, its reliability becomes the basic or limiting element of the entire train. Usually ignition primers are small in physical size and, as such, are limited with respect to energy output.

LOW EXPLOSIVE DEVICES

OUTPUT: FLAME (HEAT), PARTICLE AND GAS

SIZE: LARGE

ROCKET MOTORS, GAS GENERATORS AND FLARES

SMALL

IGNITERS, ACTUATORS SUCH AS GULLOTINES, PIN PULLERS, DIMPLE MOTOR, BELLOWS MOTOR

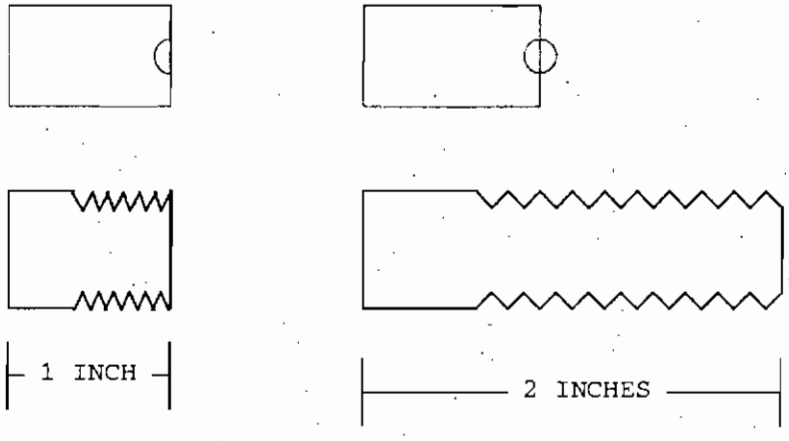


Figure 6.A-2

Note: Commercial Examples:

Automotive Air Bags (CO_2 and gas generator)

Sylvania Magic Cube (percussion activated-primer hit by spring)

Seldom is the ignition primer capable of directly igniting large solid propellant grains, such as those common to rocket motors or large gas generators, without the assistance of an intermediate booster or sustainer charge. In the

case of the gas generators, HOLEX combines the required intermediate booster or sustainer charge with the ignition primer material in a single integrated cartridge assembly; in many cases, the prime material acts as the pressure producing mix as well. The booster or sustainer portion of such cartridges usually consists of a pyrotechnic material installed in a manner, which permits the unit to deliver a more sustained flame-heat output than that provided, by the primer alone.

The term "igniter" is frequently defined as any type of ignition cartridge, which is designed to ignite a secondary charge. This definition would apply to both of the basic types of ignition cartridges discussed above. However, the term "igniter" in the case of solid propellant rocket motors, normally describes a three or more component igniter assembly, which includes the thread-in ignition primer, a pyrotechnic booster or transfer charge, and a sustainer charge of pyrotechnic pellets or a single large progressively burning pyrotechnic propellant.

- **Initiators:**

  An initiator is also a primer, just as is an igniter, however, the term initiator is more commonly used in conjunction with high explosive applications.

- **Cartridge Activated Devices:**

  The cartridge-actuated devices group consists of cable cutters or guillotines, bolt-cutters, actuators, thrusters, and pin pullers. These are not the only cartridge-activated devices manufactured but are representative of the more common types. Piston-activated separation bolts, pressure-activated release nuts and numerous other specific application devices could also be included in this category.

  Cable cutter and bolt cutters are used where a fast reliable separation of mechanical parts is required. In the sounding rocket business we use the cable cutters to release the Despin weights just prior to payload separation and boom deployments within payloads.

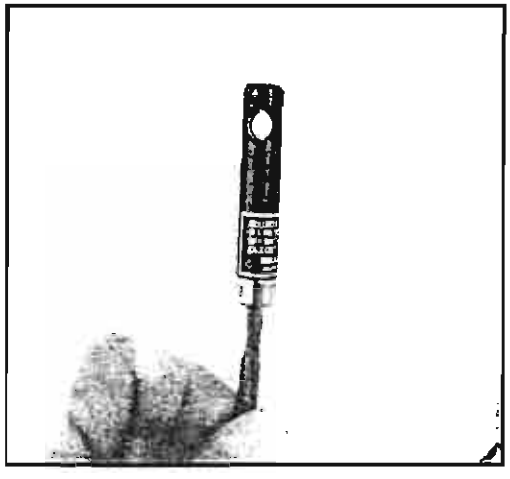


Figure 6..A-3 (Guillotine Cutter Holex 2800)

Actuators and thrusters are similar in design and manufacture. In general, a thruster is considered a slower, less shock-inducing mechanism used to accomplish work, i.e., moving a latch or ejecting another device. The actuator is a faster moving piston generally used to penetrate another device, such as a pressure bottle burst disk.

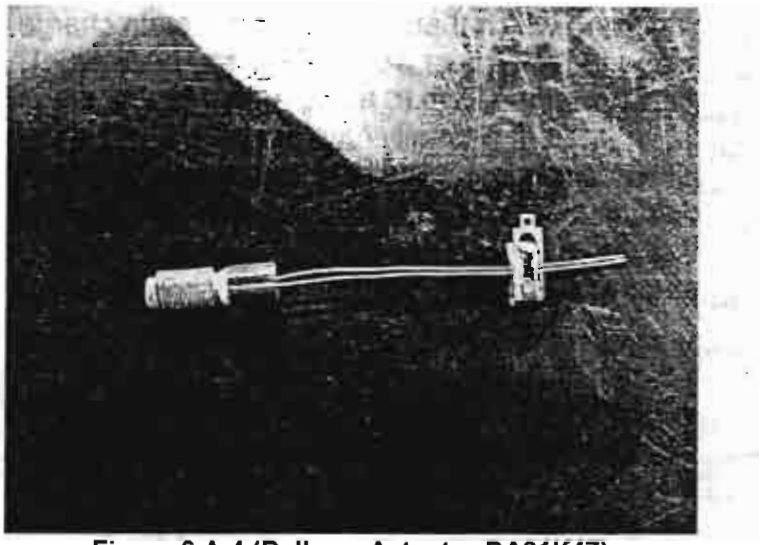


Figure 6.A-4 (Bellows Actuator BA31K47)

Pin pullers are usually employed where relatively little shock is desired. Typically, a pin puller is used in conjunction with a spring separation, or perhaps where gravity will supply the energy of separation, such as in rocket stage separation.

Figure 6.A-5 (Pin Puller Atlas 228-50000 / 1MT18CC)

- **Detonators:**

  A detonator is most commonly used for the detonation of high explosives. It uses a filament wire, which is covered with a sensitive ignition mix or prime. The prime will not detonate but ignites a booster charge, which will transfer the deflagration (burning) to a detonation (shock wave advancing ahead of the burning front) which then detonates the main charge or load. The load is sized according to the type of work it needs to perform. This can vary from a simple pressed cylindrical form to a shape charge, which will direct the shock front. A shape charge will normally have an optimum distance from its target where the greatest shock is achieved due to overlapping shock waves. A detonator will be found in a high explosive train.

- **Detonating Cord (Det Cord):**

  Detonating cord has a core of PETN or RDX in a reinforced plastic and fabric-coated covering. It will transmit a detonating wave from one point to another at a rate between 20,000 and 24,000 feet per second. It is used to prime or detonate other explosive charges. It can also be used as an explosive item by itself; several wraps around a tree will cut a tree on a line as clean as a whistle. Although it does not lose its explosive properties by exposure to low temperatures, the covering becomes stiff and cracks when bent. Great care is required in using detonating cord primers in arctic conditions.

B. Safety of the EED

There are four separate and distinct aspects of safety with respect to the handling and functioning of electro-explosive devices. This has to do with the premature operation of the device, which is generally concerned with the following factors:

- Protection against accidental actuation during normal continuity checks and physical handling
- Protections against accidental initiation from electro-magnetic radiation whether power line or radio frequency or radar
- Protection against premature initiation from static buildup or static discharge
- Protection against premature initiation from elevated temperatures or mechanical shock.

Definitive action leading to the reduction of the first two hazards listed above has been taken in the form of the requirement for a 1 watt, 1 ampere NO FIRE characteristic for electro-explosive devices. This 1-watt, 1 ampere NO FIRE characteristic has become the National Standard for all squibs in use today. The squibs today can survive the application of 1 ampere of current for a duration of 5

minutes without "cooking" up to a high enough temperature to initiate the primer material of the squib. Further, most of the squibs that we use today have an ALL FIRE current rating of 3 Amps, with a recommended fire current of 4 or 5 Amps.

Now, let us look at the "NO FIRE" amperage and voltage with respect to the possibility of accidental initiation due to continuity testing, bridgewire resistance measurements, etc. In this case special "squib checkers" used throughout the industry are usually limited to a maximum output of 5 milliamperes at short-circuit conditions. These are the "Alinco Igniter Testers" or "Blasting Galvanometers". There are a few digital volt-ohmmeters that have been approved for bridgewire resistance readings, but these should not have a short-circuit output of more than 50 milliamperes.

Static Electricity

Let us now look at the problem of static electricity and its relationship to accidental initiation of electro-explosive devices. First of all, we must refer to that mythological creature, call the "standard man" who is theoretically capable of building up a static charge on his body which will be equivalent to a 500 mmf capacitor charged to a potential of 18,000 volts. This provides our man with an energy capacity of 810,000 ergs, which is far from an insignificant amount with respect to the initiation of explosive devices. This last statement is particularly true if it is also considered that this energy can be discharged from an initial peak potential of 18,000 volts. It is also significant to note that the Smithsonian physical tables state that a steady or DC potential difference of 13,050 volts will produce a spark or arc in air over a length of 5.0 centimeters. In practical terms, this means that a man charged to the theoretical limit of 18,000 volts could move his finger or other parts of his body or a tool in his hands within two inches of an electro-explosive device sitting on a grounded surface and produce an arc discharge containing about 800,000 ergs of energy. This is both theoretically and practically possible, since there are many authenticated cases of an electro-static discharge from the human body.

The problem of initiation from electrostatics varies slightly from that considered for electromagnetic radiation hazards. In Electro-Magnetic Radiation (EMR), it is assumed that the voltage is induced in a closed loop system causing a current to flow through the bridgewire, thereby raising the temperature of the priming material above its auto-ignition point. In the case of static discharge, the actuation phenomena usually consists of an arc which occurs between the bridgewire and the outer case of the part and which does not result in any thermal heating of the bridgewire circuit. One recent example occurred when an executive of a company located in the Midwest went to the explosive magazine and picked up an electrically actuated pressure cartridge by its leads. Carefully holding the four shunted leads together, he walked from the magazine, through the plant, and into his office where he deposited the part on top of a radiator cover. As soon as the case of the part touched the cover of the radiator, it fired. The causes are evident.

Holding the part only by the shunting leads, his body and the bridgewire circuit became one side of the plate of the capacitor. In his walk through the plant and over his carpeted floor, he built up an electrostatic charge. This charge had nowhere to discharge until the case touched the well-grounded radiator cover. At this instant, the full potential difference, which could amount to 18,000 volts immediately, existed between the bridgewire circuit and the part case, resulting in an arc through the priming material.

It is a basic characteristic of the majority of explosive compounds that they will initiate when an electric arc is passed through them, even though the current in such an arc may be of very small magnitude. To the best of the writer's knowledge, there is no positive explanation for this, although one theory states that the initiation actually occurs by positive ion bombardment of the crystals in the path of the arc. Regardless of the reasons, it is safe to say that when a condition occurs which results in an electric arc through an explosive prime that an explosion will result.

The problem of protection against static electricity is far and away the most critical in the field of electro-explosive devices. Static charges can and are present in almost every conceivable environment, and where not present, they can be readily induced. Based on several years of investigation and many conferences with people also concerned with the safety problem, it appears to be an established fact that there have been hundreds of so called "incidents" which can be directly attributed to premature actuation of an electro-explosive device by static for every one which can even be remotely attributed to electromagnetic radiation. Despite this overwhelming body of fact, there has apparently been little agitation or outcry in the industry for amelioration of this phenomenon. This in itself is remarkable, particularly when contrasted to the massive and many times misdirected efforts, which have been directed toward the solution of the far less critical problem of electromagnetic radiation.

At this point it appears that a most obvious answer would be to enclose the bridgewire circuit in a material of sufficient dielectric strength to prevent an arc occurring from bridgewire to case. This, unfortunately, is not as easy to do in practice as in principle. First of all, there is not only the problem of bridgewire to case arcing; there is the companion problem of an arc occurring between bridgewire circuits in dual bridgewire circuit parts. There are also the limitations on the dielectric strengths of available priming material, and even more rigid limitations on the total space envelope, which severely limits the physical spacing between bridgewire circuits, and the outer case of the part.

Manufacturers are striving to produce the standard 1-ohm, 1-watt, 1-ampere NO FIRE capability, but also a squib that will withstand very high potential differences between the case and the bridgewires and reducing the chance of inducing an arc. Truly the explosive circuits and components that we use are getting safer all the time.

Electro-Magnetic Radiation

Next we will consider protection against premature ignition from electro-magnetic induction from radar and communications equipment and/or basic AC power lines. Here the establishment of safe values is less clear-cut than in the previous cases, but is still capable of reasonable analysis. In the case of parts having an integral connector such as many that we use in the sounding rocket program, the problem can be greatly reduced by placing a short across the bridgewire as close to the bridgewire as possible. This reduces the length of the closed loop bridgewire circuit and reduces the length of the lines that can pick up radiated energy. A further safety precaution is to have a bleed resistor of not less than 10k ohms from one side of the closed loop to chassis ground (to bleed off any induced energy in the closed loop circuit).

The personnel hazard electro-magnetic radiation level has been set at .01 watt/cm2. In a typical sounding rocket with a 10-Watt transmitter, the dangerous area around an antenna extends to approximately 2.5 inches from the antenna. In practicality, unless you are sitting on the antenna, it provides little or no radiation danger to an individual. Besides, when the antennas are radiating, anyone moving around the antennas, will cause dropouts at the ground station, so close proximity to antennas is discouraged. (See worksheets at back of book for examples of how to calculate safe radiation distances, and amount of induced voltage from parallel running lines)

Temperature and Shock

The risk of premature actuation of ordnance due to high environmental temperatures, is not nearly so serious as the preceding three. In general, most existing electro-explosive devices will withstand temperatures up to 450 degrees F without either detonation or deterioration of their later function. Special cartridges can be made available which will go up to 600 degrees F and there is some possibility of attaining even higher temperatures for limited time periods. The major problems with respect to safety of EEDs and temperature are those, which would occur, should a missile malfunction on the launch pad, causing a detonation of fuel and/or other cause of fire. Here, the temperatures could very well run to 1500 degrees F or higher, and the safety problem is to prevent any secondary casualty, such as warhead actuation, due to initiation of EED's by the high external temperatures.

Essentially this is a problem of system design rather than cartridge design, since there is obviously an upper temperature limit for electro-explosive devices which no known present technology will raise.

The greatest threat to exposure of the rocket to shock is during handling operations. Unsafe practices, faulty equipment, could contribute to the possibility of dropping the rocket motor and causing initiation.

Summary / Safety of EED's

The present electro-explosive device is truly remarkable in its reliability and reproducibility of operation. It can readily achieve reliabilities of 99.99% at 95% confidence level for practically every required parameter.

In addition to reliability, electro-explosive devices require little or no preventive maintenance and are capable of long-term storage life without deterioration.

The existing capability of such devices to meet a 5 minute dissipation of 1 watt per bridgewire circuit without subsequent deterioration or danger of accidental initiation makes them safe to handle under any current or anticipated fields of electromagnetic radiation.

The coming developments that will permit electrically actuated cartridges to be subjected to high voltages between pins and case and between bridgewire circuits without deterioration in performance or accidental initiation will eliminate the major remaining hazard with respect to initiation.

The analysis of the above has indicated that a combination of a 1.0-ampere "NO FIRE" with a bridgewire resistance of 1.0 ohm appears to be the optimum design for safety from accidental initiation from the hazards covered.

Semiconductor Bridge Technologies (SCB's)

Quantic Industries is the manufacturer of most of the squibs that we use and is working on the perfection of Semiconductor Bridge devices to initiate the explosive train. These devices would add greater safety in the prevention of accidental initiation from the hazards mentioned above. They are developing a type called the Junction Diode Semiconductor Bridge, which will make the device totally immune to the effects of electro-magnetic radiation (EMR) from radars, AC lines, or transmitted RF.

Thiokol Propulsion is developing an all-electronic safe-and-arm (ESA) device that uses semiconductor bridge (SCB) technology to initiate the propellant powder.

Arm and Fire sequence requirements

- Dual safing features
- High and low side switch protection to isolate the SCB from stray energy.

Chapter 3: FUNDAMENTALS OF ROCKET MOTORS

A rocket motor is basically an engine that produces a thrust, i.e., a forward force, by generating a high velocity efflux without using any of the constituents of the "atmosphere" in which the rocket is operating. The thrust is produced because the exhaust from the rocket has a high velocity and therefore a high momentum. The rocket engine must, therefore, have exerted a force on the exhaust material and an equal and opposite force, the thrust, is exerted on the rocket.

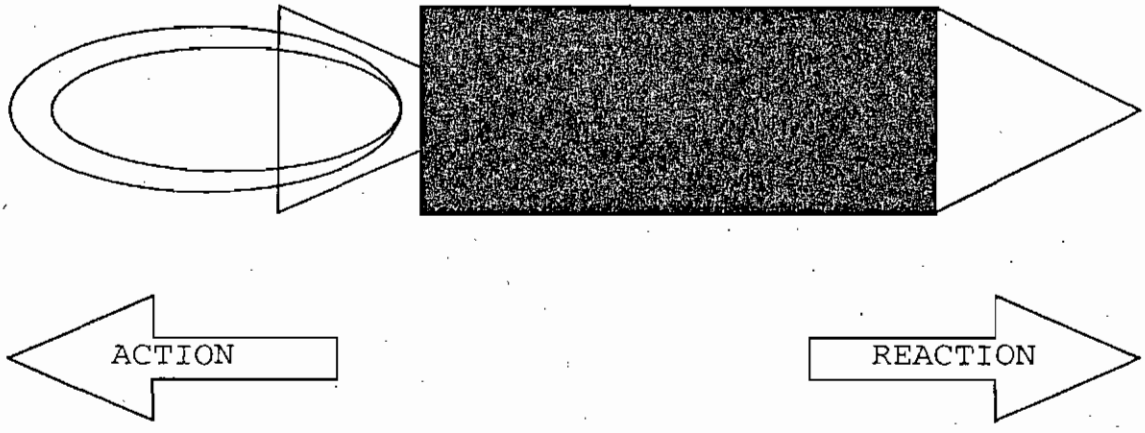


Figure 7-1

The basic principle driving a rocket engine is the famous Newtonian principle that "to every action there is an equal and opposite reaction". If you have ever shot a shotgun, especially a big 12-gauge shotgun, then you know that it has a lot of "kick". That is, when you shoot the gun it "kicks" your shoulder back with a great deal of force. That kick is a reaction. A shotgun is shooting approximately an ounce of metal in one direction at close to 700 miles per hour. Therefore your shoulder gets hit with the reaction. If you were wearing roller skates or standing on a skateboard when you shot the gun, you would be propelled backwards by the reaction.

If you have ever seen a big fire hose spraying water, you may have noticed that it takes a lot of strength to hold the hose (sometimes you will see two or three firemen holding the hose). The hose is acting like a rocket engine. The hose is throwing water in one direction, and the firemen are using their strength and weight to counteract the reaction.

When you blow up a balloon and let it go, it flies all over the room before running out of air, you have created a rocket engine.

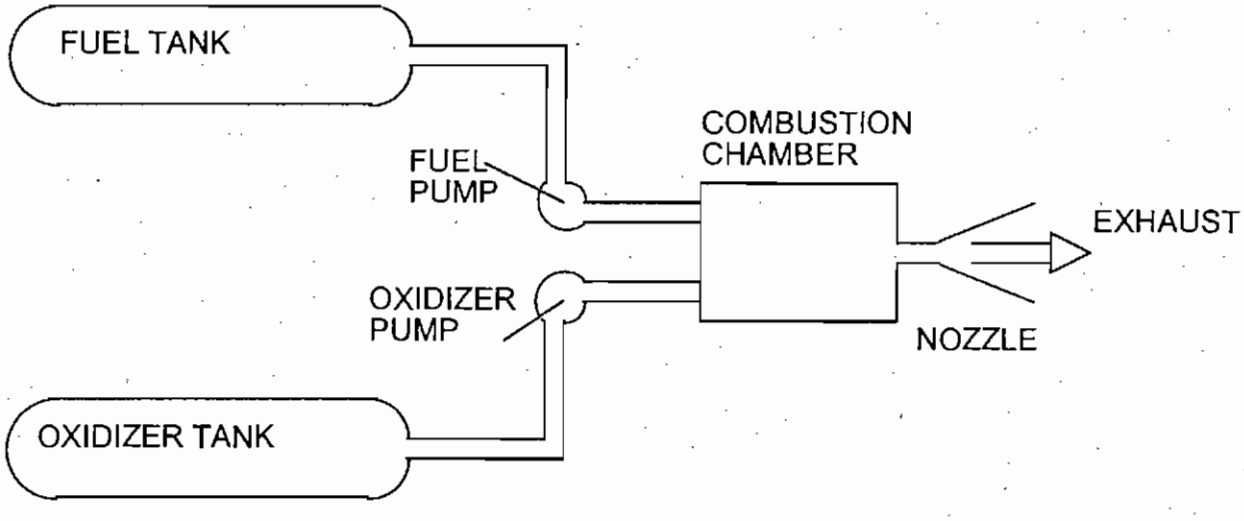
Because a rocket engine utilizes a propellant that contains its own oxygen, means that it can operate in any part of the atmosphere and outside the atmosphere, which makes it ideal for space propulsion.

There are two basic types of rocket engines:

- Chemical Rockets
  - Liquid Propellant Rockets
  - Solid Propellant Rockets

- Non-chemical Rockets

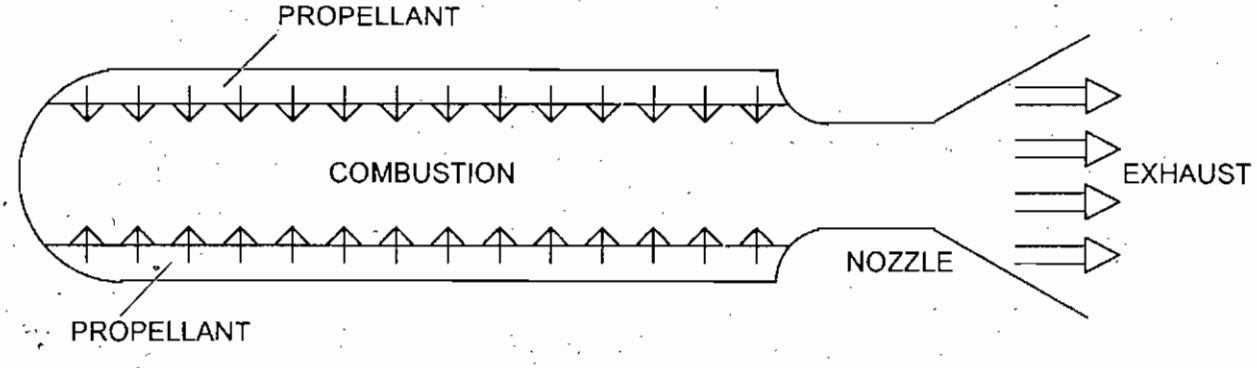
In a liquid propellant rocket, the fuel and oxidizer are stored in the rocket in liquid form and pumped into the combustion chamber.



BASIC ARRANGEMENT of LIQUID PROPELLANT ROCKET

Figure 7-2

In a solid propellant rocket, the fuel and oxidizer are in solid form and they are usually mixed together to form the propellant. This propellant is carried within the combustion chamber.



BASIC ARRANGEMENT of SOLID PROPELLANT ROCKET

Figure 7-3

In a non-chemical rocket, the high efflux velocity from the rocket is generated without any chemical reaction-taking place. For example, a gas could be heated to high pressure and temperature by passing it through a nuclear reactor and it could then be expanded through a nozzle to give a high efflux velocity.

The discussion of space propulsion systems given here is at a very basic level. The references listed at the end of this chapter should be consulted for more detailed information about these systems.

A. Liquid Propellant Rockets

As discussed before, in a liquid propellant rocket engine, the fuel and oxidizer are stored in liquid form and pumped into the combustion chamber. In a monopropellant liquid –fueled rocket, a single liquid is used, the chemical reaction required to produce the high temperature, high-pressure gas often being induced by the use of a catalyst. An example of a monopropellant is hydrogen peroxide. In the more common bi-propellant rocket engine, the liquid fuel and liquid oxidizer are separate and two storage tanks are required.

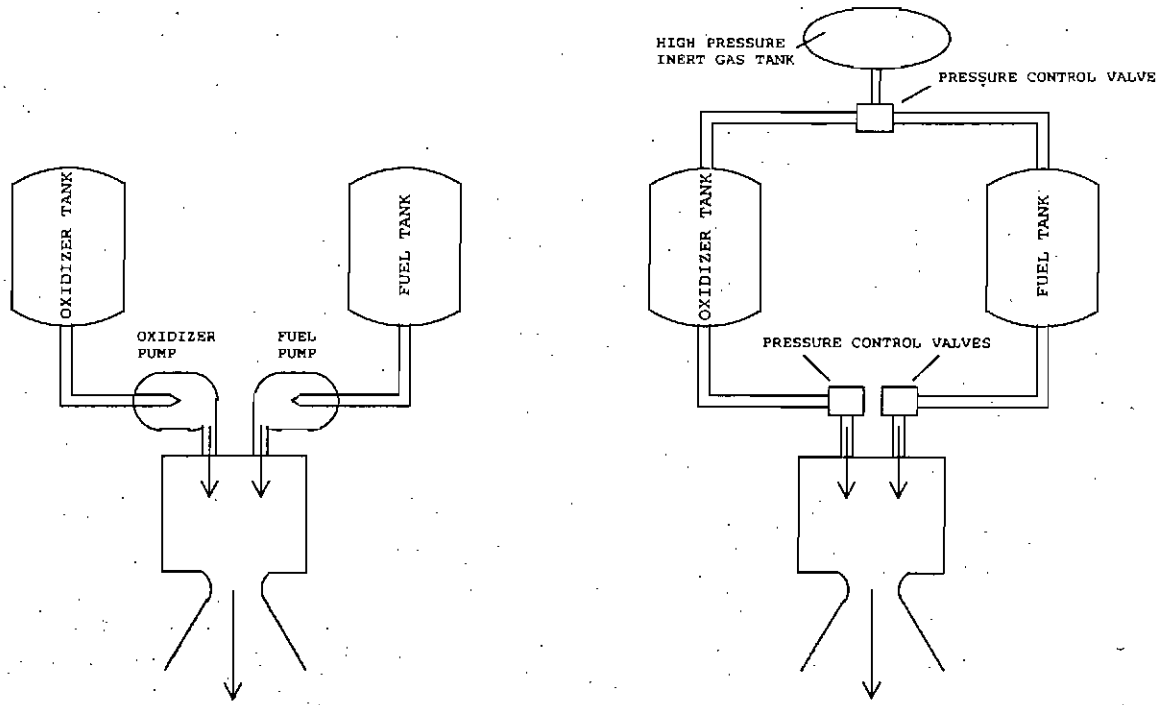
There are five major components in a liquid-propellant rocket, they are:

- The liquid propellants
- The propellant flow controls
- The combustion chamber and nozzle
- The supporting structure including the tanks and hull
- The guidance mechanisms

The fuel and oxidizer must be fed into the combustion chamber at the high pressure that exists in this chamber. Using centrifugal pumps, which are often driven by a turbine that is itself driven by an expanding gas, can do this. Alternately, the propellants can be forced into the combustion chamber by pressurizing the tanks with an inert gas that is light in weight and not soluble in the propellant. These two systems are illustrated schematically in Figure 7.A-1 on the following page.

Both methods allow the rate at which the propellants are delivered to the combustion chamber to be controlled thus allowing the thrust to be controlled. They also, allow the engine to be shut down.

The fuel and oxidizer are fed into the combustion chamber through an injector whose purpose is to thoroughly mix the propellants before ignition. The size of the combustion chamber must be large enough to ensure complete combustion. One of the most difficult problems in the design of the combustion chamber is ensuring that despite very high temperatures in the combustion chamber, these being typically of the order of 3000 degrees C., failure of the wall of the chamber does



METHODS OF DELIVERING LIQUID PROPELLANTS TO THE COMBUSTION CHAMBER

Figure 7.A-1

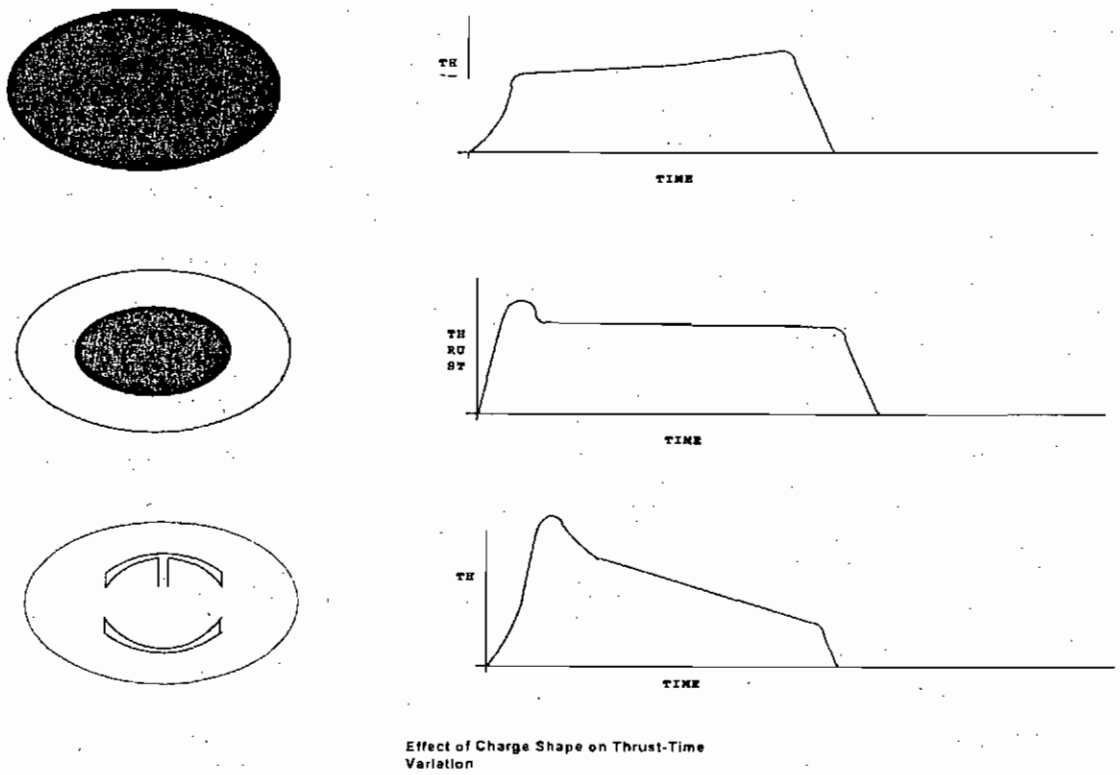
not occur. Lining the combustion chamber with a ceramic or other high temperature material helps but cooling of the wall usually has to be provided. This can be done by circulating the cool fuel from the fuel tank before it is injected into the combustion chamber through a cooling jacket or cooling coils around the combustion chamber. This serves also to preheat the fuel prior to combustion. It is relatively easy to mount the combustion chamber nozzle assembly on gimbals, which allows it to be pointed in different directions thus allowing the thrust direction to be controlled.

B. Solid Propellant Rockets

As discussed before, in a solid propellant rocket the fuel and oxidizer are both in solid form and are thoroughly mixed during manufacture. This propellant or charge is placed directly in what is effectively the combustion chamber of the rocket engine. The engine then consists, basically, of nothing more than a cylindrical chamber, packed with the fuel-oxidizer mixture, which is closed at one end and open at the other end with a convergent-divergent nozzle fitted to the open end.

A solid propellant rocket is essentially a single unit and it is therefore, difficult to steer the rocket by changing the direction of the thrust. As a consequence, solid-propellant rockets are more commonly steered by mounting controllable deflector plates or rings in the exhaust path. These devices must, of course, be made from materials that can resist the high temperatures and velocities that exist in the exhaust flow.

It is also proved to be very difficult to control the thrust from a solid-propellant rocket engine. However, using a shaped charge, i.e. by shaping the face of the propellant on which combustion occurs, can vary the variation of thrust versus time.



Effect of Charge Shape on Thrust-Time Variation

Figure 7.B-1

There is another common shape that is used in solid propellant rocket engines, mostly in military applications, and that is the "Star Pattern". A sample design configuration is shown below:

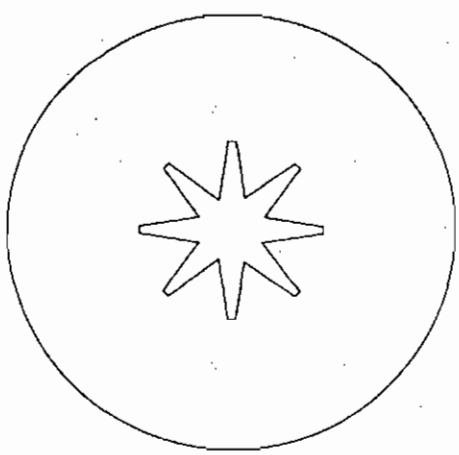


Figure 7.B-2

What kind of a thrust variation do you think it would produce?

Property	Liquid Propellant	Solid Propellant
Specific Impulse:	250 – 400 seconds	250 – 300 seconds
Propellant Density:	Low to Moderate	165 – 25% > liquids
Mass Ratio:	8 – 10	As high as 20
Handling:	Seldom packaged; Often requires cryogenic equipment	Prepackaged and ready to fire
Thrust-Magnitude Control:	Throttled by regulating fluid flow rate to combustion chamber	Difficult to control and shut down
Thrust-Direction Control:	Combustion chamber mounted on gimbals although deflecting vanes and rings can be used	Difficult to mount on gimbals so usually steered using exhaust deflecting vanes and rings
Operating Conditions:	Long burning times with moderate combustion chamber pressure & temperature	Short burning times with high rocket acceleration and high combustion chamber pressure and temperature
Manufacture & Construction:	Often intrinsic and expensive	Usually relatively simple & inexpensive
Cost	High	Low

C. Hybrid Rockets

In a hybrid rocket the fuel is solid, often a plastic, and the oxidizer is a liquid, either liquid oxygen or, sometimes, nitric acid. The liquid is carried in a pressurized container above the fuel, which burns outward from a central hole. This system combines the advantages of the solid propellant (easy handling) with the advantages of liquid propellants, which include, regulating the rate of burning, and the ability to stop the engine by shutting off the flow of the liquid. It appears likely that hybrid systems will be used mainly for steering purposes or for making corrections in velocity. It should be noted that not only can you shut off a hybrid engine, but also you can restart the engine by starting the flow of the liquid again. The fuel and the liquid oxidizer are hypergolic, which means that they will combust on contact with each other.

Chapter 4: STATIC ELECTRICITY/ESD CONTROL

This section covers static electricity characterization and methods for the control of electrostatic discharge (ESD for the purpose of eliminating or mitigating its fire and explosion hazard). The generation of static electricity is not in itself a hazard. The hazard arises when static is allowed to accumulate, subsequently discharging as a spark across an air gap in the presence of highly flammable materials or energetic materials such as explosives, ordnance or propellants.

A. Definitions

Static Electricity is an electrical charge at rest. More specifically, static electricity is the imbalance of positive and negative charges. The movement of static electricity is the transfer of electrons from one object to another at different potentials caused by direct contact or induced by a charged field. The magnitude of the charge is dependent on the size, shape, composition, and electrical properties that make up the object. This charge can transfer electrons within an object (polarization) or from one object to another (conductive charging). When this occurs the static electricity is quickly released known as an Electrostatic Discharge (ESD) resulting in the form of a spark. Electro-explosive devices (EED's), ordnance systems, flammable vapor mixtures, explosive materials, and other explosive components can be ignited by ESD.

Static buildup or generation can be developed in many ways. Two of the most common are friction charging and induction charging. The **prime** method of generating static electricity is by rubbing or separating materials, commonly known as the **triboelectric method**. The term "triboelectric" comes from the Greek word "tribo" which means to rub. A triboelectric charge is defined as an electrical charge generated by frictional movement, or a separation of two surfaces. Triboelectrification of materials occurs anytime two dissimilar materials are in contact with each other. The outer atoms of one material will strip some of the electrons from the other. The additional energy of rubbing will cause a larger exchange of electrons, creating a greater charge.

Thunderstorms create electrostatic charges whenever warm, moist air masses collide with cold, dry air masses. The warm air rises above the cold air and the upward and downward movement of air causes a charge of electricity to build-up on clouds that are formed. When the charge on the clouds gets large enough, discharge takes place and we see "lightening". The same process takes place anytime we move. If conditions are right, a simple act of people moving can generate a static charge of up to **35,000 volts**. Simple, movement of a worker at a workbench can generate up to a **6,000 volts** static charge on their clothing and body. When the workers body is fully charged any contact with an object with a difference in potential or a grounded item the static electricity is discharged causing a spark to jump. In terms of static electricity generation with rocket motors, the movement of a motor that is not in a shipping container to the launch pad on an air-log dolly, which has rubber tires, through the air currents creates

static electricity of significant proportions. The "first touch rule" should be applied as ESD control when the motor is grounded at the pad to certified ordnance grounds.

Triboelectric generation is not limited to personnel movement. Machinery moving parts, equipment operating the flow of fluids or gases can also generate substantial electrostatic voltages. Table 3.A-1 shows some typical electrostatic voltages for various types of products and activities. The shows a comparison between high and low relative humidity levels. The more moisture content in the air, the easier it is for electrons to dissipate through it. Relative humidity levels between 30% and 70% decrease the potential for static buildup.

Table 3.A-1: Typical Electrostatic Voltages for Products & Activities

Means of Static Dissipation	Voltages 10-30 % Relative Humidity	Voltages 30-70 % Relative Humidity	Voltages 70-90 % Relative Humidity
Walking across carpet	35,000	7,500	1,500
Walking across vinyl floor	12,000	3,000	250
Worker at bench	6,000	400	100
Vinyl envelops for work instructions	7,000	1,500	600
Common plastic bag picked up from bench	20,000	6,500	1,200
Work chair padded with polyurethane foam	18,000	5,000	1,500

The Triboelectric series on the following page (Figure 3.A-2) defines some types of materials which become positively / negatively charged in the relation to the others. When any two substances in the list contact another and are separated, the substance highest on the list loses electrons and assumes a positive charge. The further apart the two materials are in the series; the greater the voltage the two materials can develop. The degree of voltage depends on many factors such as cleanliness, relative humidity, temperature, pressure of contact, speed of rubbing and size of the surface area rubbed.

Another method of charging is called the **Induction Method**. Unlike the Triboelectric method, the induction method of charging does not require actual contact between two objects. Anytime an object becomes charged, or anytime a current flows, invisible electromagnetic fields of force develop around the charged object or around the current-carrying conductor. These electromagnetic fields are

similar to the field or lines of flux of a magnet. As the charge on an object increases, or as the current flow increases, the electromagnetic fields increase in strength and dimension. When a conductor is moved through the field, or the field is moved through a conductor, a voltage is induced in the conductor. Anytime an object is charged, even if an insulator, it emits an electromagnetic field. When a conductor is exposed to an

TRIBOELECTRIC SERIES

	Air	
	Human Hands	
	Rabbit Fur	
	Plexiglas	**Increasing Positive (+)**
	Mica	
	Human Hair	
	Nylon	
Wool	Fur	
	Lead	
	Silk	
	Aluminium	
Paper	Cotton	
	Steel	
	Wood	
Amber	Sealing Wax	
	Hard Rubber	
	Nickel	
	Copper	
	Brass	
	Silver	
	Gold	**Decreasing Negative (-)**
	Platinum	
	Celluloid	
	Polyurethane	
	PVC	
	Silicon	
	Teflon	

Figure 3.A-1

electrostatic field, some of its electrons will become mobile and either moves toward or away from the field, depending on the polarity. The movement of electrons constitutes an electrical current. However, if the field and the conductor are both stationary, a phenomenon known as polarization occurs on the conductor.

The materials that are listed in the triboelectric electric series chart, Figure 3.A-1), have a unique surface sensitivity. The surface resistivity of these materials is referred to as conductive, static dissipative, and insulative.

Conductive materials are defined as having a surface sensitivity 10^5 ohms per square or less, while static dissipative materials are defined as those having are defined as those materials having surface resistivity between 10^5 ohms and 10^12 ohms per square. Surface resistivity greater than 10^12 ohms per square are considered and insulator.

Conductive materials redistribute the electrical charge rapidly, thus preventing a buildup of charges, static dissipative materials distributes the charges at a slower rate, and insulating materials hold static charge and prevent the charge from flowing. When we charge something with static electricity, no electrons are made or destroyed. No new protons appear or disappear. Electrons are just moved from one place to another. The net, or total, electric charge stays the same. This principle is called the **Conservation of Charge**.

Explosive industries are primarily concerned with the sparks associated with static electricity discharge. These sparks can trigger a fire or explosion during certain stages of the process. Current flow through bridgewires or sensitive electrical components is of equal concern.

B. Sensitivity To ESD

Clothing is one of the greatest producers of static electricity. Polyester, nylon, rayon, wool and silk can produce high levels of static electricity. Also undergarments made of these materials present less of a hazard but still should be avoided. Loose clothing should also be avoided. The movement of the clothing on a person's body can produce static electricity. Explosive handler's clothing should be made from 100% cotton, a cotton-synthetic blend, or a polystat blend, which contains 1% stainless steel for static dissipation.

Some electronic parts have been known to fail at charges of 15 volts. Many electronic parts are damaged below levels of 2000 volts. Personnel do not typically feel these low voltages when discharged. Human sensitivity levels usually occurs around 3500 volts. It is very important for individuals to remember when handling sensitive pyrotechnic devices that even though you may not feel a static discharge the device still could be initiated depending on the sensitivity of the pyrotechnic device.

The Human Body Model (HBM) device sensitivity to ESD is as follows:

- ESD Class 0-1c (0 to 9000 volts): Damage caused that one will not feel.
- ESD Class 2 (2000 to 3,999 volts): Damage caused that one might feel.
- ESD Class 3A-3B: (4,000 to 15,999 volts): Damage you will detect as a spark with your own body.

C. Control Program Requirements

Electro explosive devices that are designed to function when an electric current is applied can be initiated by ESD. Electric primers, squibs, blasting caps, detonators and igniters are devices that are susceptible to ESD. NSROC and NASA / Safety shall conduct all operations involving explosive devices and / or propellants using controlled procedures that have been approved. Maintaining proper controls of procedures as well as maintaining proper protection levels of materials is essential to an ESD control program. A control program should focus on proactive prevention rather than reactive detection and damage control. The following elements are required to provide proper controls.

- Verify conformance of protected areas to NASA requirements. An initial survey is required of the area to determine types of explosive devices that are used, types of testing is performed, expiration dates, maintenance, reliability of test equipment and if the proper PPE and other safety equipment to safely perform the hazardous test is available.

- Proper clothing for employees has been issued to prevent static charge generation.

- Purchasing the proper handling and test equipment with the required training and technical assistance for the correct uses of that equipment is essential.

- Training shall be provided to all employees involved with handling of ordnance devices are essential. All personnel shall be given proper training involving associated with their duties, on the PPE that is issued, and certified on the most recent requirements of and techniques of ESD.

- Safety and performance audits should be periodically performed in all work areas where hazardous activities are performed. If a deficiency is detected the findings will be documented on the NSROC CATS system for corrective and preventative disposition.

- Although shipping and receiving of ordnance devices is controlled by certified personnel, ESD precautions needs to be labeled on the packages or shipping containers to prevent an inadvertent event causing a static discharge and perhaps injury to personnel or damage to equipment.

- An approved list of all explosive devices needs to prepared and constantly maintained as explosive quantities are received and shipped. All ordnance devices and shipping or storage containers will be identified with the proper explosive symbol and stamped ESD sensitive.

D. Types Of ESD Controls

Personnel, pyrotechnics, ordnance devises, motors, GSE, and other equipment present during explosive operations must be handled with each individual and / or component at the same electrical potential to eliminate discharge of electrical energy that could cause an explosion. Several types of controls include grounding and bonding, shielding, neutralization, ESD packing symbols.

- **Grounding and Bonding**: The most effective method of dissipating static electricity is to provide a continuous path to a common ground. In the case of the explosives an independent **certified ordnance ground** is required and periodically tested to assure adequate protection. To ensure static discharge protection, a continuous wire of AWG N0.8 or braided ground straps of equal conductivity are used to bridge potential breaks. Be aware that paint, rust, and/or other surface conditions may cause a break in the continuity resulting in an inadequate ground. Equipment that is merely touching the conductive table or floor is not considered sufficiently grounded without an independent ground strap attached resulting in the equipment and the conductive surface both being at the same electrical potential. Examples of grounding devices are removable clip type ground connectors, bonded straps between explosive components that will eventually be mated, conductive coats and cotton clothing, wrist straps / associated tester, foot grounders / associated testers, conductive work surfaces, and / or conductive floors connected to a certified ordnance ground.

- **Wiring Shielding and Faraday Shielding**: Electro-explosive and their components shall be designed to prevent inadvertent arming, actuation, or initiation due to operator error, short circuits, radio frequency transients, or other unexpected failure modes. Two designs are using faraday cage shielded wiring and EED faraday cap shields. Firing circuit shielding shall provide a minimum of 20db safety margin below the rated function current of the system initiator (max NO-FIRE current for EED's) and provide a minimum of 85% coverage. A solid shield rather than a mesh would provide 100% coverage. Shielding shall be continuous and terminated to the shell of connectors and / or components. The shield shall be electrically joined to the shell of the connector / component around the full 360 degrees of the shield. The shell of connectors/components shall provide attenuation at least equal to that of the shield. The EED should have a faraday cap that will short the leads, shield the connector from RF or static electricity, and also be grounded to the ordnance ground.

- **Other controls**: Monitoring static buildup with electrostatic meters and static alarms. Special conductive coatings and antistatic wax for floors, glass, acrylic, etc. Establishing constraints for temperature, wind, humidity, for internal and external operations. Design considerations and prohibition of introduction of

static generators (tape, adhesives, foam devices, food bags, etc.) and Electromagnetic field generators (radios, transmitters, radars, electronic devices, etc.). Training, lighting detection system, and test equipment calibration.

E. Hazards Associated With Explosive Devices

Hazards associated with ESD discharge during handling of explosives for the NSROC program are not always easily identifiable or understood. Some are very obvious and other not so obvious. In many cases the actual planning and implementation of the operations can be a first step in a potentially hazardous situation. The list noted below identifies and offers an explanation on how the risk associated with ESD is minimized for the NSROC program.

- **Electrical Storms:** A visible lightning strike can produce as much as 20 to 50 million volts. Enough to certainly kill an individual. Also during an electrical storm small electrical discharges are prevalent and can initiate an explosive device. Explosive devices that are ESD sensitive have a rated electrostatic sensitivity of .1 joule or less. These explosive are mostly primers, igniters, tracers, explosive bolts, explosive cutters, and other pyrotechnic devices. Whenever an electrical storm approaches an ordnance facility, the facility should be secure by a shutdown procedure and everyone in the facility should evacuate as quickly as possible.

- **Electrostatic Buildup:** As discussed previously the simple task of walking across a carpeted surface on a in a dry environment can produce 30-40 thousand volts of static and when one touches a doorknob a spark is produce. Individuals do not feel a static discharge until it reaches to about 3,500 volts. It takes approximately 4,000 volts to see a spark in a dark room and approximately 5,000 to hear it crackle. An electrostatic discharge that is not perceived can initiate a pyrotechnic device. A standard blasting cap is ignited at around .036 to .064 joules. An individual can easily store approximately .156 joules of energy, enough to ignite sensitive explosives.
- **Inadequate Wrist Straps:** All wrist straps shall contain a current limiting safety resistor of 1 Meg ohm. The 1 Meg ohm resistor protects from a rapid discharge of electrons that could cause increased current levels and also a spark. The wrist strap should be tested after the strap is installed. As with the wrist strap testers in the M-area do not pick the tester up to check the wrist strap for use. One will get a false reading.
- **Not Using Calibrated Ordnance Test Equipment:** On the NSROC program the ordnance handlers are required to use only test equipment that has been calibrated, certified along with a proper calibration sticker with expiration dates included, and they are required to perform a operational test before use. If this

procedure is not followed the program and employee safety is placed in a high risks and dangerous situation.

- **Not Using Authorized Standard Operating Procedures:** During operations that involve handling, testing, and processing explosive devices and systems, it is imperative that all operations will use authorized and approved procedures to accomplish these tasks. The procedure will be developed by a qualified NSROC employee, forwarded to a group of experienced NSROC individuals (safety, quality, ordnance handler's, engineering, and management) as required for a thorough review, the group will be assembled for a table top discussion which will approve changes to the procedure, final signature approval and release. No operation will be performed on explosive systems without an approved and signed procedure. Any deviation after to the procedure required to complete the operation will be documented on a NCR and require MRB approval before authorization to proceed is granted.

- **Transporting the Motor to the Launch Pad:** In order to transport the motor to the launch pad from one of the vehicle processing facilities using the motor dollies, the motor braided ground must be disconnected from the ordnance ground. Do not disconnect the ground from the motor. Leave the braided ground attached to the motor. The motor will be subjected to a substantial amount static electric buildup during transport especially is the humidity is below 35%. It is very important to remember that the first operation that you perform at the pad is to connect the motor braided ground to the ordnance ground. Do not connect the ground to the section that you will be mating.
- **Other hazards:** Checking for stray voltage when using an overhead crane, ungrounded ordnance components, propellant removal operations, pressurization of motor cases, low humidity, igniter or initiator removal/installation, nozzle removal tasks, handling and storage of pyrotechnic devices, periodic inspection, etc.

F. Prevention

The information in this section includes some additional safety tips for preventing static induced hazards in an explosive area. Ordnance handlers should utilize their training and judgment when determining a facility, operation, or situation is unsafe and be prepared to cease an operation until such time as the operation is deemed safe.

- When entering a facility make sure you take proper precautions and observe the types and quantity of explosives, number of hazardous operations being performed at one time, and the number of people in the area. Make sure you are aware of the emergency exit routes and if the routes are clear.
- Always keep the ordnance handler and the ordnance device at the same potential. When removing a pyrotechnic device from storage or shipping container, if possible, place device on a static dissipative surface and connect a

ground lead to the packing material before you take the device out of the packing.

- Verify that the "buddy system" is being followed. Check the humidity levels and see if the relative humidity has fallen below 35%. Ask questions. Find out about the transmission of different radio frequencies being transmitted from radars, radios, etc. Make sure there is a frequency authorization safety board that regulates the use of various transmitters.
- Make sure that proper ordnance grounds are installed and have been previously tested and records are kept. Verify the proper shielding is being used. Check how the grounding has been implemented for the various types of explosive devices. Verify the explosives are properly stored.
- Verify the wrist straps, and other PPE is operating properly and is tested at a minimum on a daily basis.
- Make sure that all test equipment has a current calibration certification decal or label. If not red tag the device until such time as the unit is calibrated.
- Find out if a lighting detection system and if so find out how the lines of communication are established in order for everyone to be notified.

Chapter Summary

When handling motors, pyrotechnic devices, igniters, initiators, prima-cord, destruct charges, FCDCA cord, hypergolic or oxidizer fuels, or any other explosive substance extreme care must the given to the buildup and discharge of static electricity. There are a few simple rules that an ordnance handler should at all times keep cognizant of.:

1. The first is the "contamination or charged rule". The explosive handler should at all times consider themselves as being charged and contaminated with a substantial amount of static electricity and this charge is ready to be discharge.

2. The second is the "first touch rule". Now if you consider that you are a charged object at all times and ready to discharge one must consider where the discharge is going to take place by considering the handler's first touch. Always avoid making the "first touch" or connection to the explosive device first. Try to always seek the same potential by touching other grounded devices at the same potential that are not directly in contact with the explosive device.

These two basic rules and the information presented will elevate the handler's awareness and hopefully provide a safe environment when working directly with explosive devices.

Chapter 5: TEXT HIGHLIGHTS FOR RANGE SAFETY MANUAL (RSM-2002)

This chapter contains excerpts from *The Range Safety Manual* which are appropriate to Ordnance Training. The primary objectives of Range Safety Manual are:

- To identify Wallops Flight Facility (WFF) range requirements to implement safety policies and criteria defined in *NASA Procedures & Guidelines* (NPG) *8715.3*
- To define specific design requirements, restrictions, operational procedures, and support requirements
- To identify data requirements necessary for WFF to perform appropriate safety analyses and grant approval to conduct operations
- To acquaint range users with the range safety organization at WFF.

The Range Safety Manual is applicable to all Programmatic Operations and specific aircraft operations conducted at or managed by WFF. It is applicable to all NASA personnel, NASA contractors, tenants, experimenters, and range users. It is the responsibility of all personnel to acquaint themselves with the requirements set forth in this document, NPG 8715.3 and GMI 1300.2 (Reference a).

For aircraft operations, the Manual is applicable for hazardous systems incorporated within or attached to aircraft platforms, operations conducted on the GSFC's WFF test range, and operations which expose the public to risk greater than that incurred by normal aircraft operations. Aircraft operational requirements for the WFF airfield are defined in the Aircraft Operations Manual for Wallops Flight Facility (Reference b).

For WFF managed operations conducted at other ranges, the requirements established by this document shall be used as a minimum unless requirements of the host range are more stringent, in which case the more stringent requirements will apply. More stringent safety requirements will be considered by GSFC's WFF if requested by the range users, experimenters, or tenants.

WFF Policy dictates that all operations be conducted within the risk levels specified by NPG 8715.3. The Range Safety Manual defines the specific requirements, which must be met to fully implement this policy. In cases where requirements cannot be satisfied, a safety analysis report approved by the Director of Suborbital and Special Orbital Projects is required.

A. Ground Safety

The ground safety goal of GSFC's WFF is to minimize the risks to personnel and property involved in conducting operations at GSFC's WFF and to prevent mishaps that would result in embarrassment to NASA or the United States Government.

It is required that all systems be designed such that a minimum of two independent unlikely failures shall occur in order to expose personnel to a hazard.

Hazard Control

The methods employed by WFF to protect personnel and property and to minimize the risk in conducting potentially hazardous operations are:

- Identify all the known hazards associated with the program.
- Implement safety design criteria.
- Minimize exposure of personnel to hazardous systems.
- Establish safe operating procedures.
- Plan for contingencies

Limits (exposure and personnel)

The cardinal principle to be observed in any location or operation involving explosives, severe fire hazards, high pressure systems, or other hazardous materials, shall be to limit the exposure to a minimum number of personnel, to a minimum time, and to a minimum number of potential hazards, consistent with safe and efficient operations. Operations shall be arranged such that, should an incident occur, it will cause the least possible injury to personnel and damage to facilities or surrounding property. Operations shall be conducted in a manner such that the distance a person is from a hazardous system increases as the possibility of actuating the system increases.

Personnel Limits

Only active essential personnel (no less than 2 and no more than 12) shall be permitted on launch pads, in explosives handling areas, or other hazardous areas. This limit includes supervisors, range users, and others determined necessary by the OSS. The Chief, Safety Office may grant exceptions following review of formal requests.

The OSS (or other NASA official in charge of the operation) shall assure that the number of personnel performing potentially hazardous tasks is kept to a minimum.

For off-range operations, WFF employees (NASA and/or contractor) shall abide by the requirements of the launch range conducting the operation(s) if that range has requirements or limits more stringent than WFF.

The WFF OSS shall determine the number of personnel necessary to perform each task through writing and submission to the range safety office.

Requirements regarding official visitors or guests, tours, etc. are as follows:

- Early notification of an impending visit or tour shall be given to the OSS responsible for the operations prior to the individual or group arrival. Potentially hazardous operations or tasks shall be brought to a safe stopping place (Category "B" state) and all work on hazardous systems will cease while the tour is in progress.

- If the hazardous system cannot be placed in a Category "B" status (e.g., pad arming has already occurred), and it has been determined by the Chief, Range and Mission Management Office (or his designee) that the visit is necessary, the OSS and the RSO shall determine the most convenient time and duration for the visit.

- For operations at other ranges (mobile or permanent), the GSFC's WFF lead manager (Campaign Manager, Program Manager, or Project Manager), in conjunction with the local safety official(s) shall determine the necessity of the visit or tour and will determine the most convenient time, consistent with safety policies/requirements for the visit to occur.

- Tour groups will be accompanied by a person of authority such as the OSS and will consist of no more than twelve (12) people. The twelve-(12) people will include the Tour Guide (Supervisor, Campaign Manager, Payload Manager, Project Manager, or their designee). If the group is larger than twelve (12), it will be split into as many smaller groups as are necessary to maintain the limit.

- Members of the tour group shall not be permitted to touch or handle any ordnance or other hazardous hardware.

All area-specific safety requirements shall be enforced (i.e., safety glasses, hard hats grounding, clothing, etc.). The person of authority shall determine the necessity of wearing static dissipative garments when in the vicinity of explosives or other static sensitive materials.

Ground Safety Plan

The Ground Safety Group (GSG) will prepare a Ground Safety Plan prior to any potentially hazardous operation or launch conducted at GSFC/WFF. This plan will identify the potential hazards and describe the system designs and methods employed to control the hazards. This plan shall also establish controls to protect high value property, as required.

For launch or other potentially hazardous ground operations conducted at other ranges, this information shall be provided in a Ground Safety Plan or Ground Safety Data Package.

Where applicable, a general Ground Safety Plan may be prepared for repetitive operations/ programs which shall identify safety planning for all potential hazards. This plan may be augmented for mission operations by a mission specific Ground Safety Plan.

Hazard Categories

Hazard categories are established to differentiate between hazardous and non-hazardous systems. Each system is analyzed and categorized as either Category "A," Category "B," or Category "A/B." All hazardous systems shall be considered Category "A" until Category "B" conditions have been determined and approved.

Category "A" systems are those systems which meet all the following:

(1) Initiation of the system could lead to a chain of events which result in injury or death to personnel or damage to property,
(2) Sufficient potential energy exists to initiate the device, and
(3) The energy output of the system is not controlled by approved mechanical restraints or other safety devices.

Category "B" systems are those systems which

(1) Are highly improbable of being initiated,
(2) Shall not cause injury to personnel or damage to property by either the expenditure of their own energy or the chain of events they initiate, and
(3) Contain a minimum of two independent safety devices, which prevent an inadvertent actuation.

Category "A/B" systems are those systems which change from Category "B" to Category "A" during the various stages of processing. The change in hazard category is accomplished by utilizing approved out-of-line SAFE/ARM devices, mechanical restraining devices, employing the man-rated design requirements defined in 5.3.4.4.5 or 5.3.11, or by other approved means which reduce the effects of an inadvertent actuation to a non-hazardous condition or reduces the probability of occurrence to acceptable levels. The Category "A" or Category "B" requirements shall apply as appropriate.

The classification of each system, the devices or means of reducing the classification level, the danger area, restrictions, and list of responsible persons shall be identified in the Ground Safety Plan or Ground Safety Data Package for each program.

Multiple Operations

Multiple unrelated operations shall not be conducted simultaneously within a single operational danger area unless the operations are reviewed and specifically approved by the WFF RSO or his designee. When such approval is granted, the operations shall not exceed personnel limits established in 5.2.3.

Specific Policies and Criteria / Categorization

All hazardous systems, including electrical, chemical, pressure etc., shall be categorized into either hazard category "A," "B," or "A/B."

Hazardous systems shall be assumed Category "A" until conditions have been met which shall permit a change to Category "B." Category "A" systems can be categorized Category "A/B" when any of the following conditions exist:

Approved restraining devices are employed to reduce the effects of an inadvertent actuation to a non-hazardous condition.

The hazardous system is installed but not connected to its controlling electrical circuit. Hazardous ordnance systems shall also have their Electro-explosive Devices (EED's) shorted, grounded, and shielded.

Ordnance systems employ an approved mechanical or electromechanical SAFE/ARM device, which provides an out-of-line feature in the SAFE position.

Systems employ the man-rated circuit design requirements established in 5.3.4.4.5

For hazardous chemical systems, the system is closed, contains two independent verifiable safeties in the flow path, and leak integrity is verified.

For pressure systems, the pressure is steady state and less than or equal to the Maximum Allowable Working Pressure (MAWP). The MAWP is defined as the maximum pressure to which personnel may be exposed, and is synonymous with Maximum Expected Operating Pressure (MEOP) as defined in MIL-STD 1522A (Reference o).

For Category "A/B" systems, the change from Category "B" to a Category "A" shall be performed as late as possible in the processing sequence.

Danger Areas

For all hazardous systems, a danger area shall be defined which will adequately contain the hazard and protect personnel should an inadvertent actuation occur. Restrictions shall be established to prohibit access into the danger area when the possibility of initiating the hazardous system exists.

Prelaunch and Launch Danger Areas shall be defined in the Ground Safety Plan/Data Package for each mission.

Mission-specific danger areas for chemical, pressure, radiation, or other hazardous subsystems shall be defined on a case-by-case basis and shall be identified in the Ground Safety Plan/Data Package for that mission.

Flight control danger areas and their implementation shall be defined in the Ground Safety Plan/Ground Safety Data Package when applicable.

Operations/Design Considerations

This document allows range users to utilize various acceptable design techniques defined in 5.3.4. Prelaunch operational requirements should be a factor in selecting a specific design because operations that require personnel to be located inside danger areas during power switching, power on, and RF transmissions can only be performed if:

(1) The system is in a Category "B" condition, or
(2) The man-rated design defined by 5.3.4.4.5 is employed.

Category "A" systems may be converted to a Category "B" state by implementing any of the requirements cited in paragraph 5.2.5.3.

All Category "A" danger areas shall be cleared of personnel for operations which require power switching, power ON, or RF transmissions, except as identified in 5.3.3.8.

Personnel may be allowed in the danger area of Category "A" system whenever there are no power switching, power ON, or RF transmissions occurring and two independent inhibits are verified in place.

No personnel shall be allowed within the danger area of a Category "A" system if the system has been reduced to only one inhibit.

Prior to switching Ground Support Equipment (i.e., vacuum systems, heaters, etc.) ON for the first time, the applicable danger area will be cleared of all personnel regardless of the system status. Prior to making an electrical change on a non-hazardous (Category "B") system, all personnel in the vicinity shall be notified of the impending event.

Personnel may be allowed in danger areas to perform work external to the vehicle when power is supplied to a Category "A" system and no power switching is occurring. This operation shall be specifically approved by the WFF RSO or his designee and can only occur after power has been cycled several times and has remained ON in a steady state condition for a reasonable amount of time.

Hazardous Circuit Design Requirements

All circuits that initiate ordnance devices or initiate other hazardous systems shall be approved by the GSG prior to granting approval for use at GSFC's WFF.

Category "B" systems shall contain a minimum of two independent safety devices which prevent an inadvertent actuation.

The electrical circuit shall contain a minimum of two independent open contacts between the power source and the system initiator.

The system shall be designed such that the conversion from Category "B" to Category "A" shall minimize personnel exposure to the hazard. The final conversion to Category "A" shall occur during arming operations.

The Chief, Safety Office or his designee shall approve mechanical restraint designs.

All circuits initiating Category "A" devices or systems shall satisfy the circuit design criteria identified below.

All EED's shall meet a 1 amp/1 watt NO FIRE requirement and be 100% qualified with a 500 VDC megohmmeter test for 5 seconds from bridgewire to case (and bridgewire to bridgewire if dual bridgewires are used) unless an exemption is granted by the Chief, Safety Office or his designee.

Electrical wiring and power source shall be completely independent and isolated from all other systems; they shall not share common cables, terminals, power sources, tie points, or connectors with any other system.

All circuit wiring shall be twisted and shielded and independent of all other systems. When not physically possible to maintain the shield throughout the entire electrical circuit, as a minimum the wiring shall be twisted and shielded from the system initiator to the point of the first short circuit condition. This requirement is applicable both before and after installation of SAFE/ARM type connectors. The use of single wire firing lines, with the shield as the return, is prohibited.

Shielding shall provide a minimum of 20 dB safety margin below the minimum rated function current of the system initiator (max NO-FIRE current for EED's) and provide a minimum of 85% optical coverage. (A solid shield rather than a mesh would provide 100% optical coverage.)

Shielding shall be continuous and terminated to the shell of connectors and/or components. The shield shall be electrically joined to the shell of the connector/component around the full 360 degrees of the shield. The shell of connectors/components shall provide attenuation at least equal to that of the shield.

The electrical circuit to which the system EED is connected shall be isolated from vehicle ground by no less than 10K ohms.

All circuits shall be designed with a minimum of two independent safety devices. Any time personnel are exposed to a hazardous system, a minimum of two independent safety devices are required to be in place.

The system EED shall be provided with an electrical short until its programmed actuation unless the Chief, Safety Office, grants an exemption. This requirement does not negate the use of solid-state switches.

Any electrical relay or switch, which is electrically adjacent to the system initiator (either in the power or return leg of the electrical circuit), shall not have voltage applied to the switching coil (or the enable/disable circuit for solid state relays/switches) until the programmed initiation event.

Charged ("Hot") batteries may be installed into Category "A" circuits only if at least one of the following design approaches is utilized. Otherwise, the battery shall be charged at the latest feasible point in the countdown process with no personnel in the defined danger area.

The system is designed with a mechanical or electromechanical SAFE/ARM device, which shall adequately contain the output of the system or its initiator when in the SAFE position.

The system is designed to meet Capacitive Discharge Ignition (CDI) circuit criteria as defined in Paragraph 5.3.4.4.4.

The system is designed to meet man-rated circuit requirements as defined in Paragraph 5.3.4.4.5.

The system is designed to meet Exploding Bridgewire (EBW) circuit requirements as defined in Paragraph 5.3.4.4.6.

Category "A" circuits shall be designed such that the following operations can be accomplished:

Mechanical installation and electrical connection of the system initiators can be performed at the latest possible time in the assembly process, consistent with other assembly operations.

Prior to connecting an EED to its electrical circuit, it shall be shorted, shielded, and grounded. Connect EED's to chassis ground and the chassis to a single-point earth ground.

Prior to connecting system initiators to their electrical circuit, voltage checks shall be made between each leg of the circuit and from each leg to ground to ensure no voltage is present.

CDI Circuit Design Requirements

CDI circuit shall meet the requirements in paragraph in 5.3.4.4 through 5.3.4.4.3.3 and the following additional requirements.

The charging battery shall be current limited such that it shall not exceed 10% of the minimum rated function current of the system initiator (max NO-FIRE current for EED's).

The firing capacitor shall be provided with an electrical short (when the circuit is in the SAFE condition) and a means of remotely monitoring capacitor voltage. Whenever personnel are exposed to the system, the firing capacitor shall be shorted.

There shall be a minimum of two independent open switches between the power source and the system initiator.

Man-Rated Circuit Design Requirements

Man-rated circuit shall meet the requirements in paragraph in 5.3.4.4 through 5.3.4.4.3.3 and the following additional requirements.

The system initiator shall be both physically and electrically isolated from the power source by a minimum of three independent safety devices. This requirement is applicable both before and after installation of SAFE/ARM type connectors. Electromechanical out-of-line SAFE/ARM devices that can be both Armed and Disarmed remotely shall be counted as two safety devices.

Switches in both the power and return legs shall electrically isolate the system initiator. The wiring between the initiator and the switch in both the power and return legs shall have the following additional features:

The wiring shall be in a separate cable, which is twisted, shielded, double insulated, and independent of all other systems. Shielded wiring shall meet the requirements of 5.3.4.4.1.4 and 5.3.4.4.1.5.

Protection by use of physical barriers or by physical location of components shall be employed such that short circuits to other power systems are impossible, even assuming loose or broken wires.

A Failure Mode and Effects Analysis (FMEA) shall be performed to ensure a minimum of three independent failures is required for a premature actuation to occur. The detail level of the FMEA shall be established by the WFF RSO and shall be based on factors such as type of system, system design, and level of hazard.

A Quality Assurance Program shall verify compliance with all requirements and certify the "as built" configuration.

Exploding Bridgewire (EBW) Circuit Design Requirements

A means of continuously monitoring the firing capacitor voltage shall be provided.

Two separate electrical paths to discharge the firing capacitor shall be provided. This can be provided either through the EBW circuit or through the Ground Support Equipment.

A positive means of interrupting the capacitor charging circuit shall be provided.

A positive means of interrupting the EBW triggering circuit shall be provided.

A time delay of several seconds between application of the arming signal and application of the trigger signal for the EBW to fire shall be provided.

Ground Support Equipment (GSE)

The Chief, Safety Office or his designee shall approve the design of GSE used to make measurements on or provide control of hazardous devices, systems, or circuits.

All electrical meters or test equipment used to make measurements of hazardous systems shall be current limited to 50 ma.

All GSE used in, or to obtain measurements of, hazardous systems (electrical meters, pressure gages, slings, scales, etc.) shall be calibrated/certified and may not be used beyond the certification period. Certifications shall be performed at GSFC's WFF unless approval for certifications performed at other sites/facilities is obtained from the Chief, Safety Office.

All meters that are used to measure resistance of ordnance devices are required to be tested for proper operation immediately prior to starting the procedure.

All lifting devices, fixtures, and equipment shall conform to the standards and regulations of NSS/GO-1740.9 and GMI 1710.6.

Electrically operated GSE (vacuum systems, heaters, pumps, etc.) used on Category "A" systems shall meet the following design criteria and restrictions.

All GSE shall be designed such that the system can be remotely switched ON/OFF.

No personnel shall be permitted to be within Danger Areas defined in safety plans while power is being supplied to its GSE.
GSE shall be switched OFF prior to system arming operations. After arming operations are complete, the GSE may be switched ON provided items 5.3.5.6.1 and 5.3.5.6.2 above are satisfied.

The design of GSE should consider the impact of the above restrictions on operations. Flyaway connectors should be used to permit system operation late in the countdown process. For vacuum systems, a remotely operated valve is recommended to maintain vacuum integrity when power is switched OFF.

Electrostatic Discharge (ESD) Hazards

Precautions shall be taken to eliminate or reduce the risk of electrostatic discharge during potentially hazardous operations. The method used to eliminate or reduce static electricity is to provide an electrically continuous path to ground. All conductive objects (including personnel) shall be electrically connected to a common ground.

Grounding straps shall be used to bridge locations where electrical continuity may be broken by grease, paint, or rust. Equipment in contact with conductive floors or tabletops is not considered adequately grounded.

Wire used, as a static ground conductor shall be large enough to withstand mechanical damage and shall not be less than American Wire Gauge (AWG) No. 8 or a braided cable of equal conductivity.

Connection of static ground conductor shall be made to a certified grounding point. Grounding point certification shall be performed semiannually.

When performing potentially hazardous operations on electrostatic sensitive systems, personnel shall comply with the following:

- Wrist straps shall be worn and connected to a certified ground when handling EED's or when working on exposed rocket motor grain.

- Outer garments (e.g. lab coats or overalls) that dissipate static charges shall be worn. Under special circumstances, the WFF RSO, or his designee may waive the use of static dissipative outer garments.

- Personnel are required to touch the ground system upon entering an ordnance work area. This grounding requirement applies even when wearing protective clothing.

Ionizers may be used for static neutralization in ordnance work areas, only with specific approval from the Chief, Safety Office. Use of these instruments shall be allowed only when other means of static neutralization are not effective and may never be used directly on ordnance items.

Electrical Storm Criteria

When an electrical storm is detected within 15 nautical miles or the potential for an electrical storm is forecast within 10 nautical miles of potentially hazardous work areas, a warning shall be issued to bring operations to an appropriate stopping point.

When the storm is detected within 10 nautical miles or the potential for an electrical storm is forecast within 5 nautical miles of potentially hazardous work areas, the area shall be evacuated regardless of the status of the operations.

If a warning system is not available to determine the approach of an electrical storm, the potentially hazardous work area shall be cleared upon hearing thunder or observing weather conditions, which have the potential of producing electrical storms.

Radiation Systems

Radiation shall be adequately controlled during all operational phases to assure the protection of personnel, facilities and equipment and compliance with applicable federal, state, and NASA regulations. Such sources include radio-frequency/microwave emitters, radioactive materials, x-ray devices, lasers, and optical emitters.

The Wallops Frequency Utilization Management Working Group shall approve the RF-radiation sources used at WFF.

All operations involving the use of RF transmitters shall be coordinated through the Range Control Center (5.4.2.2) and conform to the standards and regulations specified in IEEE (Institute for Electronic and Electrical Engineers) C95.1-1991 and GHB 1860.2.

Mission-specific descriptions of RF transmitters and restrictions shall be provided in the Ground Safety Plans/Data Packages.

RF radiation into areas where ordnance operations are conducted shall be controlled to assure insufficient energy exists to cause premature initiation of ordnance.

The RF avoidance times shall be established in operational plans for all transmitters capable of producing a potential hazard to any ordnance operation. The RF avoidance is defined as no radiation within ±20 degrees (azimuth and elevation) of the ordnance site. The WFF RSO or his designee shall approve any deviation of this requirement.

The GSFC Radiation Safety Committee shall jointly define personnel and ordnance hazard distances for all transmitters.

Ionizing Radiation Controls

All operations involving the use of radioactive sources shall conform to the standards and regulations of the Nuclear Regulatory Commission, GHB 1860.1, and regulations of the host range.

The range user is responsible for obtaining all licenses for radioactive materials.

Procedures for the use, handling, and storage of radioactive sources shall be designed to minimize the exposure of personnel.

Range users shall identify all radioactive sources and provide Material Safety Data Sheets (MSDS) for each radioactive source to be used. This includes calibration sources as well as test sources.

Range users shall provide GSFC/WFF with detailed operating procedures for use, handling, and storage of non-exempt radioactive sources (as defined in 10 CFR, 19 & 20) while on the range. Specific data requirements are listed in Section 8.0 and GHB 1860.3.

The range user at the end of the program shall remove ionizing radiation sources from the range.

Man-Rated Liquid Propulsion Systems

A man-rated propulsion system shall be employed when the following two conditions exist: (1) a leak or spill of the propellant poses a catastrophic hazard and (2) the propulsion system may be placed in a condition whereby spill response is not possible. 5.3.11.1.2. The propulsion system's primary leak path (i.e., from the propellant tank through the thrusters) shall contain a minimum of three mechanically independent safeties in series. If the mechanical safeties are electrically controlled, the electrical controls shall be independent of each other. A pyrotechnically actuated isolation valve with two fault tolerant electrical safeties immediately downstream from the liquid propellant tank shall be considered equivalent to two flow control safeties.

Secondary leak paths (i.e., through or around wetted fittings to the ambient environment) shall contain a minimum of two safeties in series to prevent a catastrophic leak/spill past a wetted fitting. A fitting that has been sealed by welding shall be considered equivalent to two mechanical seals. Metal-to-metal fittings (e.g., Swagelok and AN fittings) shall be considered equivalent to two safeties.

Prior to a launch, flow control devices within the liquid propulsion system shall not be operated under condition(s) that preclude spill/leak response.

Electrical Hardware

The electrical circuit(s) that operates the liquid propellant flow control devices shall be man-rated (i.e., two faults tolerant). At least two of the three electrical inhibits shall be remotely monitored when conditions preclude spill/leak response.

Electrical circuit(s) that operates components whose failure may cause the liquid propellant to catastrophically overheat (thus causing either propellant decomposition or propellant tank over pressurization) shall be man-rated.

Personal Protective Equipment

Safety glasses, safety shoes, hard hats, arctic clothing, shop coats, etc., are required to be used by GSFC's WFF employees, contractors, experimenters, and range users when exposed to certain hazardous conditions.

All personnel shall wear static-dissipating clothing in processing areas for ordnance or other hazardous systems, which are susceptible to electrostatic discharge. Ordnance handlers shall not wear static producing clothing (i.e., wool, rayon, nylon, polyester, etc.).

During operations involving EED or exposed grain, all personnel are required to wear approved, grounded wrist-straps. Approved leg-stats may be used in place of wrist-straps for specific operations approved by the Chief, Safety Office.

Safety glasses or face shields are required for operations where an ocular hazard may exists.

Hard hats are required for operations where personnel work on multiple levels.

Operations involving chemicals that pose a health risk require that personnel wear protective equipment (identified on a case-by-case basis in the specific operational procedure) that shall provide respiratory and/or full body protection during:

Operational Security, Controls, and Procedures

The WFF has established operational safety controls with which all persons at WFF shall comply. These controls include:

- Badges - Special badges are required of all personnel for admission to Wallops Island and other restricted areas. Work areas, launch areas and facilities are restricted and placarded to identify the presence of hazardous materials/operations and to warn against unauthorized entry. Admittance to such restricted areas is limited to personnel displaying the proper badges.

- **ALL-HAZ** – All hazards – wearer is authorized unescorted access to all areas where potentially hazardous operations are occurring. OSS approval is required prior to entering an area where a hazardous operation is occurring. ALL-HAZ badges are normally issued to GSFC/WFF-based personnel associated with facility infrastructure.

- **SPEC-HAZ** – Mission Specific Hazards- identifies visiting, mission-specific essential personnel who, with the Operations Safety Supervisor's permission, are permitted in areas where potentially hazardous operations (of their mission) are occurring. Chief of the Safety Office must approve ALL-HAZ and SPEC-HAZ badges.

- **NON-HAZ** – No hazards – (default badge class) Identifies personnel not associated with potentially hazardous operations, e.g. Radar, Navy, custodial, project administrative, etc. Wearer is permitted entrance only to areas of non-hazardous (Category "B") operations. Wearers of this badge are allowed access to a hazardous area only when escorted by someone wearing an ALL-HAZ or a SPEC-HAZ badge.

- **NONE** – No NASA areas – Issued to Navy personnel granting them access to navy facilities on Wallops Island

- Danger Area Access - the Danger Area Warning System and roadblocks control Access into operational danger areas at GSFC/WFF. The Operations Safety Supervisor always controls admittance into the Danger Area.

- Danger Area Warning System - GSFC/WFF Danger Area warning systems involve the use of lights, sirens, signs, and/or roadblocks to alert personnel of the potential hazards present in certain areas and/or to prevent personnel from entering these areas. Under no circumstances shall personnel pass through an active danger area warning system without first obtaining permission from the Operations Safety Supervisor or his designee.

- Launch Pad Warning System - GSFC/WFF Launch Pad Warning Systems involve the use of lights and exterior public address systems to advise personnel during Danger Time I, Danger Time II, Caution Time, and All Clear status changes, or other hazardous periods. Hazard warning lights are visible from all angles of approach. These systems are operated to indicate the following conditions:

  - Danger Time II - Flashing red light at launch pad. No personnel are permitted access to the pad. (Example: Payload power switching after motor ignition ARM plug installation, Launch operations, etc.)
  - Danger Time I - Flashing amber light at pad. Only active essential personnel performing specific tasks, which are approved by the OSS, are permitted access to the pad. (Example: Staging Rocket Motors and booster arming operations, etc.)
  - Caution Time - Flashing amber light at pad. Only essential personnel performing specific tasks are permitted access to the pad. (Example: Rigging launcher cables, heater checks, etc. after the motors are on the pad)
  - All Clear - No warning lights at pad or Pre-launch Roadblock. All personnel are permitted access to the pad. (Example: No ordnance systems on the launch pad)

- Launch Pad Roadblocks - In addition to the warning systems, manned and/or unmanned roadblocks are established at various places and times. The unmanned roadblocks are equipped with flashing red lights indicating Pre-launch Danger Area status. Unmanned roadblocks shall be equipped with communications equipment and a sign directing action. Under no circumstances shall personnel pass through a roadblock without permission from the OSS or his designee.

- Explosives Signs and/or Symbols - Based on procedures of the U. N. document (Transportation of Dangerous Goods) documented in NSS/GO-1740.9, 8719.9 and DOD 6055.9, the GSFC's WFF utilizes four symbols to denote different classes of ordnance. These symbols are prominently displayed on International Orange signs at each magazine and refer to the most hazardous material stored within.

  - Class 1, Division 1: an octagonal-shaped sign displaying the numeral "1" in the center denotes the presence of DOD Hazard Class/Division 1.1 explosives, which present a blast and fragmentation hazard and can be expected to mass detonate when exposed to fire.
  - Class 1, Division 2: an X-shaped sign displaying the numeral "2" in the center denotes the presence of DOD Hazard Class/Division 1.2 explosives, which present a fragmentation hazard.
  - Class 1, Division 3: an inverted triangular sign displaying the numeral "3" in the center, denotes the presence of DOD Hazard Class/Division 1.3 explosives, which present a mass fire hazard.
  - Class 1, Division 4, on a diamond-shaped sign displaying the numeral "4" in the center denotes the presence of DOD Hazard Class/Division 1.4 explosives, which present a moderate fire hazard.

RF Radiation Controls

Operational Restrictions - All RF emitters used at GSFC's WFF shall be periodically analyzed to determine whether or not they pose a potential hazard to personnel or ordnance. When a potential hazard exists, operational restrictions and/or controls shall be established to protect personnel and/or ordnance systems.

Barricades/Signs - In areas where RF hazards to personnel exist, signs and/or barricades shall be erected to prevent personnel from entering the potential hazard area. 5.4.1.4.3.

Warning Lights - On high power RF emitters such as Radar Systems, red and blue warning lights shall be utilized to warn personnel of the potential RF hazard. A red flashing light shall be illuminated whenever power is supplied to the system. A blue flashing light shall be illuminated whenever the emitter is radiating.

Operational Controls

For all potentially hazardous operations at GSFC's WFF, the Test Director, Assistant Test Director, RSO, and OSS exercise control over all personnel associated with the operation. For off-range operations, Section 2.5 establishes the hierarchy for operational control.

All NASA personnel, NASA contractors, experimenters, range users, and tenants are responsible for:

- Adhering to the requirements established in this document.
- Adhering to the directions issued by the Test Director, RSO, and/or OSS.
- Reviewing vehicle and payload operations with the OSS.
- Obtaining permission from the OSS before conducting any operation in assembly, test, or launch areas.
- Identifying active essential personnel for each operation to assure maximum personnel limits are not exceeded.

All RF radiation on WFF is controlled through the Range Control Center, to assure that RF limits (5.3.8.1) are not exceeded and to preclude possible interference with other transmitters. Range users shall obtain permission through the OSS before any RF transmitters can be switched ON.

The Ground Safety Plan/Data Package defines Danger Area clearance requirements and personnel restrictions for all potentially hazardous operations. All personnel at GSFC's WFF are responsible for complying with these restrictions.

All personnel performing potentially hazardous operations (explosives handling, chemical transfer, etc.) shall be trained and experienced. These personnel are required to be certified or directly supervised by certified personnel when performing these operations. The GSFC's WFF will approve all personnel certifications or may approve certifications established by user programs. Range users shall provide documentation that supports training, experience, or certification of their personnel.

Operational Procedures

Range users are responsible for submitting to GSFC's WFF comprehensive handling, assembly, and/or checkout procedures for all hazardous systems for review and approval. Operations shall not be conducted until the Safety Office has approved these assembly and test procedures.

Under no circumstances shall a potentially hazardous operation begin without prior approval from the OSS.

The GSFC's WFF requires that no unrelated tasks be conducted simultaneously, within overlapping Danger Areas, on hazardous systems. It is the responsibility of all supervisory personnel to prepare work schedules to comply with this requirement.

Instruments used to measure the resistance of EED's shall (a) contain a certification sticker and (b) be checked, immediately prior to use, to assure the short circuit current is less than 50mA.

Range users shall obtain permission from the OSS prior to making a power switch on any vehicle/payload or ground support system.

Emergency Procedures - Prior to conducting an operation, GSFC's WFF shall establish emergency procedures and an emergency response team in the event of launch abort or recovery. Range Users shall identify personnel as required by the GSFC/WFF to participate on any emergency or recovery team.

For off-range operations, permission to perform the above operations shall be granted by the hierarchy defined in Section 2.5.

B. Flight Safety

The flight safety goal is to protect the public, range participants, and property from the risk created by conducting potentially hazardous operations at WFF and to prevent mishaps that would result in embarrassment to NASA or the United States Government. Although these risks can never be completely eliminated, the flight should be carefully planned to minimize the risks involved while enhancing the probability for attaining the mission objectives.

The WFF is responsible for flight safety until all flight components have reached impact or have achieved orbital insertion. A Flight Safety Program shall be implemented to protect the public and participating personnel for all WFF launch operations and operations conducted by WFF at mobile ranges established at remote sites. For operations conducted at other established ranges, WFF is responsible for assuring that NASA personnel, contractors, and experimenters are not exposed to risk greater than the acceptable risks established by this document.

Flight safety is generally associated with the containment of vehicle flight within approved operational areas and impacts (spent stages, payloads, balloons, payload/parachutes, etc.) within planned impact areas. Since the entire set of variables (vehicle aerodynamic/ballistic capabilities; azimuth and elevation angles; wind, air and sea traffic, and proposed impact areas) are unique, flight safety analysis shall be performed for each mission. The GO&SSG personnel to certify the flight-worthiness of the launch vehicle shall review vehicle design, reliability, performance, and error predictions for each flight case.

Flight safety data shall be prepared by the FSG of GSFC's WFF prior to any launch operations where GSFC's WFF has flight safety responsibilities. This data

shall be published in a Flight Safety Plan and shall describe the proposed vehicle flight and the means to contain it safely. For operations at other established ranges, any special flight safety restrictions or requirements shall be documented in a Flight Safety Data Package for that operation. For NSBF balloon operations, any special flight safety restrictions or requirements shall be documented in a program SAR or an individual mission Risk Analysis document.

The FSG shall certify the flight worthiness of all rockets, missiles, drones, and other similar vehicles.

Flight Safety for aircraft operations shall assure that public exposure to risk does not exceed the limits defined in Section 6.2.

Risk Criteria

All mission activities shall be conducted such that the risk shall not exceed the following unless a complete analysis and review are conducted and results are documented in an approved SAR (Safety Analysis Report). Risk controls for protecting landmasses shall be implemented by establishing casualty expectation limits and risk controls for protecting ships and aircraft shall be implemented by establishing maximum hit probabilities.

Public and Personnel Risk

The casualty expectation, for all mission activities, shall be less than 30×10^{-5}.

The probability of hitting a ship shall be less than 3×10^{-5} for each impact area.

The probability of hitting an aircraft shall be less than 10×10^{-7} for each impact area. The minimum aircraft hazard area shall be 2 sigma.

Exemptions

A mission where the risk exceeds one or more of the above criteria may be conducted provided:

Formal government or private agreements allow the use of the area for flight and impact, or

A SAR documenting the mission risk level is prepared and approved.

Flight Termination

Flight termination systems are required to meet design features as specified in the Range Commanders Council Document "Flight Termination Systems Commonality Standard," Standard 319-99.

Flight termination may consist of command destruct, thrust termination, auto-destruct, recovery initiation, command fire system, or command no-fire systems.

Requirements for rockets, missiles, drones, and other similar vehicles:

- A flight termination system is required in every stage (each motor) of a launch vehicle, unless it is shown that the maximum range of the vehicle is less than the range to all protected areas, or a risk analysis shows that all of the mission risk criteria specified in Section 6.2 are satisfied, or the vehicle is inherently safe.

- An operation is considered inherently safe if the predicted flight is based solely on launch and dispersion parameters and known system errors. The Chief, Safety Office or his designee, is responsible for determining if an operation is inherently safe and for approving the type and design of the flight termination system.

- Operations are considered inherently safe if all of the following conditions are true:

- The vehicle does not contain a guidance or control system.

- The vehicle can be accurately wind weighted to provide an acceptable impact location.

Launch limits, as stated in section 6.4.1.4.1 and 6.4.1.4.2, are met.

Launch Vehicle and Payload Description Data

Hazardous Electrical Circuits - Range users shall provide the GSFC's WFF Range Support Manager with two readily distinguishable copies of schematic and wiring diagrams of all pyrotechnic and other circuits, which initiate hazardous systems. The Safety Office shall be promptly notified of any changes to hazardous electrical circuits.

Mechanical Systems - Range users shall provide a description, including technical details and precautions, for all hazardous mechanical systems. Scale drawings shall be supplied showing the location of these and all other hazardous systems (ordnance, pressure, etc.).

Ordnance Devices - For each EED, data sheets shall be provided listing the minimum all fire current, maximum no-fire current, recommended firing current, normal resistance, pin-to-case resistance, and, if available, the RF sensitivity characteristics. A technical description of all SAFE/ARM type devices (out-of-line S/A, S/A connectors, mechanical restraints, etc.) employed shall be provided. For ordnance devices such as: rocket motors, shape charges, detonating cord, etc. data sheets shall be provided which identify the DOD explosive classification,

normal output characteristics, composition, or any other relevant information needed to perform safety analyses.

Chemicals - The range user shall provide a description and schematic diagram of the system. All hardware "plumbing," components (tanks, fittings, valves), and system safety features shall be defined. A MSDS for each chemical used on the project shall also be provided.

Pressure Systems - The range user shall provide a description of all pressure systems used on the program. Technical characteristics, including design burst, proof, and MAWP pressures, internal volume, and materials of construction shall be provided.

Radiation Sources

Non-Ionizing (RF) Sources - The range user shall provide data on all non-ionizing emitters including frequency, type of emission, type of radiating antenna, and radiated power (both peak and average).

Ionizing Sources - The range user shall provide data on all ionizing sources as required by Reference I, GHB 1860.1, Radiation Protection -- Ionizing Radiation.

Optical Sources - The range user shall provide data on all hazardous optical emitter (e.g., lasers) including wavelength, pulse width, pulse repetition frequency, divergence angle, and power output.

Ground Support Equipment (GSE) - Range users shall provide schematics, drawings, operational description, technical details, and documentation of certification for all GSE used to support hazardous systems or operations. This includes but is not limited to pyrotechnic checkout meters, breakout boxes, calibration sources, pressure systems, chemical service modules, and lifting and handling devices. This requirement is in addition to the requirements of 5.3.5.

Hazardous Systems

Detailed procedures for handling, assembly, and checkout for all hazardous systems (ordnance, mechanical, pressure, chemical, etc.) shall be provided to GSFC's WFF prior to beginning operations.

Recovery

For recovery operations, procedures shall be provided which provide a description of the items to be recovered, reasons for recovery, hazards involved, and any recovery aids and their characteristics. These procedures shall describe the methods employed to verify that all hazardous systems are in a SAFE condition during recovery operations. A list of recovery aids such as chaff (frequency, quantity), locator beacons (frequency, power output, period of operation), dye

marker (color persistence, time of deployment), flashing light (color, frequency, duration, candle power, directional characteristics), smoke (color, duration, time of deployment), radar reflective parachute (when deployed, size), or any other aids used should be included. Also, provide the desired period of recovery operations and the disposition of the recovered items.

Contingencies

Contingency procedures shall be provided prior to beginning operations. These contingency procedures include steps to be taken in the event of launch postponement, launch cancellation (including destaging), hold or abort, booster ignition failure, unintentional land impact, emergency response, chemical spill cleanup, or any other contingency, which may endanger personnel or property.

Approval

The Safety Office prior to use at GSFC's WFF shall approve all procedures for handling, assembly, and checkout of hazardous systems. Approvals shall be obtained prior to performing any potentially hazardous operation.

Waivers

The range user shall provide a copy of any waiver for the launch vehicle or payload granted by another range.

Reviews

It is highly recommended GSFC's WFF Safety Office personnel participate in Design and Mission Readiness Reviews for each mission. The Range User should Safety Office personnel through the GSFC's WFF Range Support Manager at least ten days prior to conducting such reviews. Safety participation in such reviews may prevent costly engineering changes and scheduling delays.

Should GSFC's WFF not be represented at Design and Mission Readiness Reviews, a copy of the review material shall be submitted to GSFC's WFF as early as possible following the review.

Chapter 6:. EXPLOSIVE SHIPPING AND HANDLING

Shipping and Receiving Hazardous material, especially explosives, requires formal training and certification. Depending on the specific type of shipment, the laws are varied. Personnel certified on Wallops Flight Facility are Bob Holston (NSROC), Ernie Cornwell (NSROC), Renay Taylor, and Michele Estrada (CORTEZ III). Wallops shipping are certified to ship by truck in the continental United States. As a general rule, for any shipment outside the continental United States, permission must be obtained for explosives or explosive material from International Trade in Arms Regulations (ITAR) control.

The following general rules do apply when assisting in packaging or labeling.

- Ensure your material is safe to ship. Some materials (most 1.4 pyro's) are not allowed on Passenger aircraft. Some (1.3C rocket motors) are not allowed on any commercial aircraft.

- Choose a suitable container. The rules for Performance Oriented Packaging apply.

- Make sure your container has **only** the information that applies. Remember:

  - Old FED-EX Tracking Stickers may confuse the current shipment.
  - The address that sent the box to Wallops should be removed or covered. What you send out could be shipped here.
  - Check with shipping to find specific rules for packing material inside the box, for type of container, etc.
  - Make sure the labeling on the outside of the box describes exactly what is inside the box, nothing else
  - Allow enough time to ship the material. During one recent shipment, the difference between routine delivery date and overnight was over 3,000.00.

A. Inert Procedures

All reactive material used within the magazine area, once expended as designed, maintains characteristics of the original item. Certain guidelines are used to positively identify the empty casings for further use or disposal.

Spent or fired ordnance has the opportunity to continue life as a training aid, to fit check hardware, or for other purposes deemed appropriate. The following serve as guidelines:

- All material must be clearly identified as inert. A stencil or otherwise clear marking on the device performs this.

- All material must remain segregated from active material.

- All material must be cleaned to the greatest extent possible to remove reactive residue.

- All material must be clearly de-milled to avoid possible re-filling with reactive material. Where practical, drill two holes at 180 degrees apart, so as not to interfere with end usage of the device.

- All material identified as inert must be recorded in some inert record. This record will indicate location of the device, and at least three unique pieces (nomenclature, lot number, serial number) of information to positively identify that particular item.

- This log will indicate the date inerted, and the authorized inerting authority. Only those personnel designated in writing by Magazine Management will certify inert items.

- This inert sheet will accompany the item, if shipped.

Spent or fired ordnance to be disposed as scrap must be certified as inert. The below listed guidelines apply to material being turned over for disposal.

All material must be positively identified. No coverall documentation with "xx number of items", or "xx number of pounds" will apply, and every effort must be made to completely identify the item in question. A bill of lading must be created for each disposal.

Every effort must be made to completely remove all traces of residue of reactive material. This includes but is not limited to inspection of the item, pressure washing the item, soaking, and burning the item in an approved open burn/open detonation area.

Only those personnel designated in writing by Magazine Management will certify inert items.

The bill of lading must include the following statement: " The undersigned official has surveyed the listed material, and certifies it/them as inert. Only the material listed on this document applies.

B. Magazine In-Brief

A magazine in brief is provided to all unescorted workers doing work within the magazine area at Wallops Flight Facility. it is not required for escorted visitors. The "in Brief" includes the following information:

- A Welcome to Wallops Magazine (The WFF Magazine is owned by NASA WFF and operated by the NASA Sounding Rocket Operations (NSROC) Team under terms of the NSROC contract.

- A Description of Storage Capabilities, to include: Five Earth Covered Bunkers, four small bunkers, and four explosive storage facilities. Storage of wide variety of Military ordnance and commercial explosives. Explosive Limit of over 1 million Pounds. 12 Personnel working in the magazine.

The following are covered under operations within the magazine:

- Capabilities and Customers.

- Capabilities of personnel and operations.

- Customers including NSROC, NASA, Department of Transportation, Department of Defense, etc.

- Current and future operations within the magazine.

The following concerns personnel within the magazine:

- Identification of key personnel.
  - Personnel Supervisor- (Chris Bradley 757-824-1689).
  - Magazine Manager- (Ernest Cornwell 757-824-2548).
  - Facilities Operation (FOM) Manager and Alternate (Frank Lau 757-824-1396) alternate Ernest Cornwell (757-824-2548).
  - Escort (as assigned). Briefly describe that escort is responsible for visitor control and safety.

- Only personnel trained and qualified will handle hazardous material. Ask for assistance. Training available through NSROC Safety.

- Only personnel trained and qualified will operate Material Handling Equipment (Forklifts, etc) and Cranes. Training is available through NSROC Safety.

The following safety policies are in place within the magazine area:

- Smoking Policy. No Smoking within the magazine area. Smoking is allowed at M-24, the Loading Dock as long as no hazardous material is being loaded or unloaded.

- With the exception of personnel authorized by Base Security, NO FIREARMS ALLOWED. This is a base requirement.
- The speed limit within the magazine area is 20 miles per hour. Be aware of wildlife within the magazine area, deer, turkey, fox, etc. No hunting of any kind is allowed, and will be criminally prosecuted.

- Magazine Vehicles are the Property of Litton/PRC and only personnel authorized by Litton/PRC are allowed to use them

- Parking is available on the side of M-15, in front of M-16, and other designated areas. At no time will any vehicle without exhaust filters be allowed within the fire lane of any magazine or bunker.

- In addition to the speed limit, give right away to any explosive laden vehicle. These vehicles will have an orange diamond visible on the sides, front and back, or in the case of Material handling Equipment, large containers will be visible with small orange diamonds.

- TWO Way communications within the magazine area. No cellular phones, walkie-talkies, etc, within the magazine area. Cellular coverage is extremely limited at the loading dock. Phones are available in M-15, M-16, and M-22, as well as at the entrance to the magazine area.

- During certain sensitive operations in M-15, gates leading to M-15 will be closed. Follow directions for access to M-15

- For escorted personnel, stay with escort. DO NOT TOUCH ANYTHING without asking your escort. Stay at least one meter from any reactive material. If in doubt, stay away.

- All operations will be briefed prior to start. All personnel within the magazine area will be made aware of major operations, including ordnance movement, major repairs, sensitive non-destructive testing, including dates, times, and locations.

- TWO Man Rule applies for any operation involving explosives. If involved in explosive operations, wear appropriate Personnel Protective (PPE) Equipment. Static wristbands to dissipate static, lab coats to protect against spills, etc.

- When involved in heavy equipment operations, spotter required when driver visibility is reduced, when load is uneven, or during hazardous material movement.

- When involved in heavy equipment operations, approved eyewear, Steel Toe shoes, work gloves, etc.

- During lightning storms, all explosive operations will cease. All storage areas will be evacuated, with the exception of M-16. The entrance gate to the magazine will be closed, and not opened until base weather personnel provide the all clear.

- During the event of weather related base shutdown, the magazine area will be closed. No operations will take place.

In case of an emergency, the following information is needed:

- Any emergency, contact **911** for assistance. This includes fire, medical, or environmental:

- For non-emergency medical, during working hours, nearest medical location is Atlantic Community Health Center, 8034 Lankford Highway, Oak Hall, and Virginia. Telephone number is 757-824-5676. Directions are as follows: Through the Main Gate, travel straight to the stop sign, approximately 2 miles. Right turn onto Chincoteague Road, Rt. 676. Approximately 3 miles east on Chincoteague Road to Route 13 ("T"s Corner). Left (South) on Route 13 (Lankford Highway). Approximately 1 mile on right.

- At any time, if you hear a fire alarm, if time permits, contact the fire department at 1333, and report the situation. If the fire is out of control, evacuate the area, and re-locate to the primary evacuation point, the Loading Dock, M-24, and report to your escort, so he can account for all personnel. If impractical or dangerous to use the M-24, report to the South Side of Building F-10, the secondary evacuation point.

- Various locations throughout the magazine area have Emergency Operating Sirens. These red push buttons are the last resort when the situation becomes out of control. PUSH THESE BUTTONS ON YOUR WAY OUT OF THE MAGAZINE AREA. This will cause an Air Raid style siren to sound though out the magazine area. This is an immediate evacuation of all personnel alarm. As stated before, report to the primary (Loading Dock) or secondary (South parking lot of F-10) evacuation point.

Chapter 7: RESPONSIBILITIES OF THE OPERATIONAL SAFETY SUPERVISOR

Within the Sub-Orbital / Sounding Rocket environment, there exist Operations Safety Supervisors (OSS) for hazardous operations both for the vehicle as well as the payload. Hazardous operations include NASA sounding rocket launch operations, Navy missile exercises, ELV launch operations (e.g., Pegasus and Conestoga) and normal ordnance handling and connection. The tasks performed by either the payload or the vehicle OSS are summarized, as follows:

Vehicle / Pad OSS: (Pad Supervisor)

- Coordinate the implementation of the Ground Safety Plan (GSP) with the Range Safety Officer (RSO), the rest of the Safety Team, the Pad Supervisor, and Test Director (TD).

- Control the hazardous area locations, which includes identifying when personnel may be in a hazardous area, when power switching on the vehicle and/or payload occurs, and when hazardous area Radio Frequency (RF) avoidance shall be implemented. This also includes controlling the number of personnel involved in a hazardous operation.

- Supervise hazardous chemical transfer operations. Monitor all aspects of destruct system including inspection, installation and connection of EEDs.

- Verify that approved procedures and properly calibrated test equipment are used in the hazardous area.

- Approve (or disapprove) redline(s) / changes to procedures at the hazardous area location.

- Implement contingency procedure(s) as required in the event of an emergency, and coordinate with the appropriate personnel (e.g. Fire Department, ordnance handlers, the RSO, and TD) to implement the contingency procedures.

Payload OSS:

- Coordinate the implementation of the Ground Safety Plan (GSP) with the payload project team involving any hazardous payload operations.

- Control the hazard area locations involving payload operations. This includes identifying essential personnel needed in a hazardous area and when hazard area RF avoidance shall be implemented.

- Verify that approved procedures and properly calibrated test equipment are used in the hazardous area.

- Approve (or disapprove) redline(s) / changes to procedures at the hazardous area location.

- Implement contingency procedure(s) as required in the event of an emergency, and coordinate with the appropriate personnel (e.g. Fire Department, ordnance handlers and the RSO) to implement the contingency procedures.

Chapter 8: PRESSURE SYSTEMS SAFETY

A. Operations / Design Considerations

The Pressure Vessels used in GNC, Guidance & Navigation Control, systems are designed to hold sufficient gas energy to support a mission. The safety factors used on these vessels are lower than Department of Transportation (DOT) / American Standards for Mechanical Engineers (ASME) standards, so as to save weight for flight. Therefore there is an inherent risk associated with the use of these vessels.

The greatest potential for harm, which can occur with a pneumatic system, would be an explosive failure of pneumatic components especially pressure vessels.

Proper pressure vessel designs allows for vessels.to yield without fragmenting, if fractured or flawed. Simply put, this means a split, hole or some other fracture can occur and most of the pressure vessel material will stay intact or connected. So in the event of failure, fragmentation should be minimized, which will result in few projectiles.

B. Hazard Zones, Related Safety And Health Risks

- **Hazard Zones**

  The primary hazard zone is an area that is radial outward from the Pneumatics system itself, which includes the Pressure Vessel. The size of these danger zones is dependant on factors such as Vessel design, material, size and stored pressure.

- **Risk times**

  Highest times of risk are after pressurization to Maximum Allowable Working Pressure (MAWP), until the hot gases cool and are considered more stable, (usually 1 to 2 hours). Procedures and provisions are made for remote pressurization of the systems.
  - Initial testing of these pressure vessels is done in restricted, barricaded areas or a test cell.
  - See excerpt from RSM-93 (pages 17 & 18) for NASA Guidelines at the end of this Document

- **Integration Testing**
  - High Risk = hearing impairment from gas blowing.
  - Relative Risk = Possible injury from foreign object blown from nozzles.
  - Little to NO Risk = Explosive forces; providing the Pressure Vessel is maintained a man safe pressure.

- **Protective Gear and Practices**
  - Hearing protection should be used when personnel are in the area of testing and pumping operations.
  - Eye protection is recommended if personnel are to be in the area of gas jets venting.
  - Unnecessary personnel should avoid test areas.

- **Ground Support Equipment (GSE)**

  The GNC group uses a Pneumatic Boost pump, sometimes called the PAGE, Pneumatics Aerospace Ground support Equipment, pump. The safety factor on this pump far exceeds the requirements of either ASME boiler codes or DOT safety standards. However there is some risk involved in using these pumps that technicians or engineers working in the area must be aware of. These include the following:

  - Noise is the most obvious hazard, because of the venting that occurs while the pump is operating or the Lines are being vented.
  - Blowing pressure is also a risk because pressures as high as 5000 PSI are being vented from the lines.
  - Only trained technicians and engineers should be allowed to set up and operate these pumps, because of potential problems that may occur from improper field assembly.
  - O2 deficiency is also a major concern since these pumps are often operated in enclosed structures.

WARNING: TO AVOID THIS OCCURRENCE, THE FACILITY SHOULD BE VENTILATED TO OPEN AIR, BEFORE PERSONNEL ENTER! NO UNTRAINED PERSONNEL MUST EVER BE ALLOWED TO REMAIN IN THE FACULTY WHILE PUMP IS OPERATING.

C. Operational Controls And Procedural Guidelines

All of the controls listed below are mandated by GNC applicable procedures and NASA published operational guidelines.

- During integration testing GNC technicians and engineers are required to warn all personnel working in the area that the system is pressurized and/or the possible occurrence of gas venting

- During initial pressurizations or pressure leak testing the system is located in a barricaded remote area or a pressure test cell.

- During flight pressurizations the PAGE boost pump is operated remotely from the Blockhouse and the launch pad is closed to personnel access.

- During countdown operations, only essential personnel are allowed access in the vicinity of the Flight Pneumatics Systems and then **only after the system is considered stabilized**.

- Should the payload or Pneumatics System have to be removed from the launch rail for any reason, the system must be depressurized remotely to a Man Safe pressure. This is accomplished by using the PAGE venting system, while the Launch pad is again closed to personnel access.

D. RSM-2002 Excerpt

The following are excerpts taken from the *GSFC WFF RSM-2002* (Pages 17 and 18). These include specific guidelines for Pressure Systems and general Safety.

- **Pressure Systems**

  - All ground support pressure systems shall meet ASME Boiler and Pressure Vessel Codes (Reference n) or GMI 1710.4 (Reference o).
  - Unrestricted access shall be granted for all airborne pressure systems (gaseous and liquid) that are certified to the ASME Boiler and Pressure Vessel Codes (Reference n) or have stored energy levels less than l00k Joules (75k ft-lbs) and operating pressure less than 150 psi for gases and 1500 psi for liquids. Systems that contain fluids that are toxic and/or flammable shall also meet requirements of sections 5.3.9, 5.3.10, or 5.3.11 as applicable.
  - If the airborne pressure system does not meet 5.3.12.2, then it shall be remotely pressurized for any of the following:

    ⇒ During the initial pressurization of the system, following system assembly or refurbishment, initial pressurization shall certify system integrity up to 25% of design burst pressure.
    ⇒ After the pressure system has been exposed to excessive vibration or shock or it has been transported in an unknown environment.
    ⇒ During pressurization above 25% of the design burst pressure.

All airborne systems shall comply with the design requirements of MIL STD 1522A (Reference p).

Restricted access is permitted for airborne pressure systems designed to the requirements of MIL-STD-1522A.

Restricted access shall be permitted when the system steady state pressure is less than the MAWP.

Whenever the system pressure exceeds the MAWP, personnel shall be separated from the pressure vessel(s) by a barrier designed to protect against blast and fragmentation, or personnel shall be outside the pressure vessel danger area. The pressure vessel danger area shall be defined in the Ground Safety Plan / Data Package for that mission.

Flight pressure systems shall be re-certified by inspection, testing, or analysis prior to being re-flown. The method of re-certification shall be documented in an approved plan for each pressure vessel.

If a pressure relief device is employed, it shall be set and certified by tagging at no greater than 10% above MOP. This pressure level is defined as the Maximum Design Operating Pressure (MDOP), and may not exceed the proof pressure.

E. Personal Protective Equipment

- Safety glasses, safety shoes, hard hats, arctic clothing, shop coats, etc., are required to be used by GSFC / WFF employees, contractors, experimenters and range users when exposed to certain hazardous conditions.

- All personnel shall wear static-dissipating clothing in processing areas for ordnance or other hazardous systems, which are susceptible to electrostatic discharge. Ordnance handlers shall not wear static producing clothing (i.e. wool, rayon, nylon, polyester, etc.).

- During operations involving PPD or exposed grain, all personnel are required to wear approved grounded wrist-straps. Approved leg-stats may be used, in place of wrist-straps for specific operations approved by the Head, Safety and Quality Assurance Engineering Branch.

- Safety glasses or face shields are required for operations that an ocular hazard may exists.

- Hard hats are required for operations where personnel work on multiple levels.

- Operations involving chemicals that pose a health risk require that personnel wear protective equipment (identified on a case-by-case basis in the specific operational procedure) that shall provide respiratory and / or full body protection.

Chapter 9: ALINCO IGNITER TESTERS

The Alinco Igniter Circuit Tester was developed by the Allegany Company in 1956, and since 1965 been manufactured by MB Electronics. The models that are currently being used by NSROC are a stable, precision instrument designed primarily for the preflight testing of solid-fuel rocket engine igniter bridge-wires for open or short-circuit conditions.

Its use extends to the testing of various other detonators with low-resistance bridge–wire characteristics, such as Quantic 3702 or 6104 pyrotechnic initiator, which play a vital role when utilized to separate sustainer stages from science payloads after rocket launching. This tester is mounted in a weatherproof case, which provides complete portability. The years of successful service by this tester have been proven its safety and reliability in testing all rocket and payload systems utilized by NSROC. The circuit of this instrument is a modified version of the well-known Wheat Stone Bridge. This circuit assures the continued stability and reliability realized in the past for this resistance-measuring instrument.

Two specific accidents involving the use of Alinco Igniter Testers have recently come to our attention. One of these accidents caused death and injury to those people in close-proximity to the scene. Both accidents involved faulty Igniter Testers that had been "assumed" safe because they had just recently been returned from the manufacturer who had repaired and "recertified" those units. In both cases, the current-limiting resistor (that limits the maximum output current to .005 Amps or 5 milliamperes) was **NOT** replaced after repairs had been made to the unit. The certification sheets that accompanied each Igniter Tester stated that all function and output tests had been performed and that the maximum current output from the tester was 5 milliamperes. In both cases, the actual current output was in excess of 1 ampere.

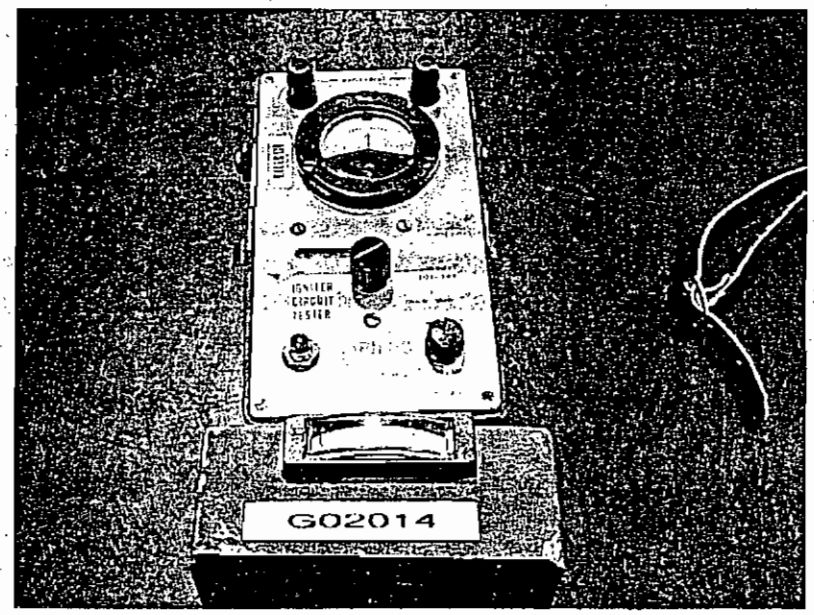
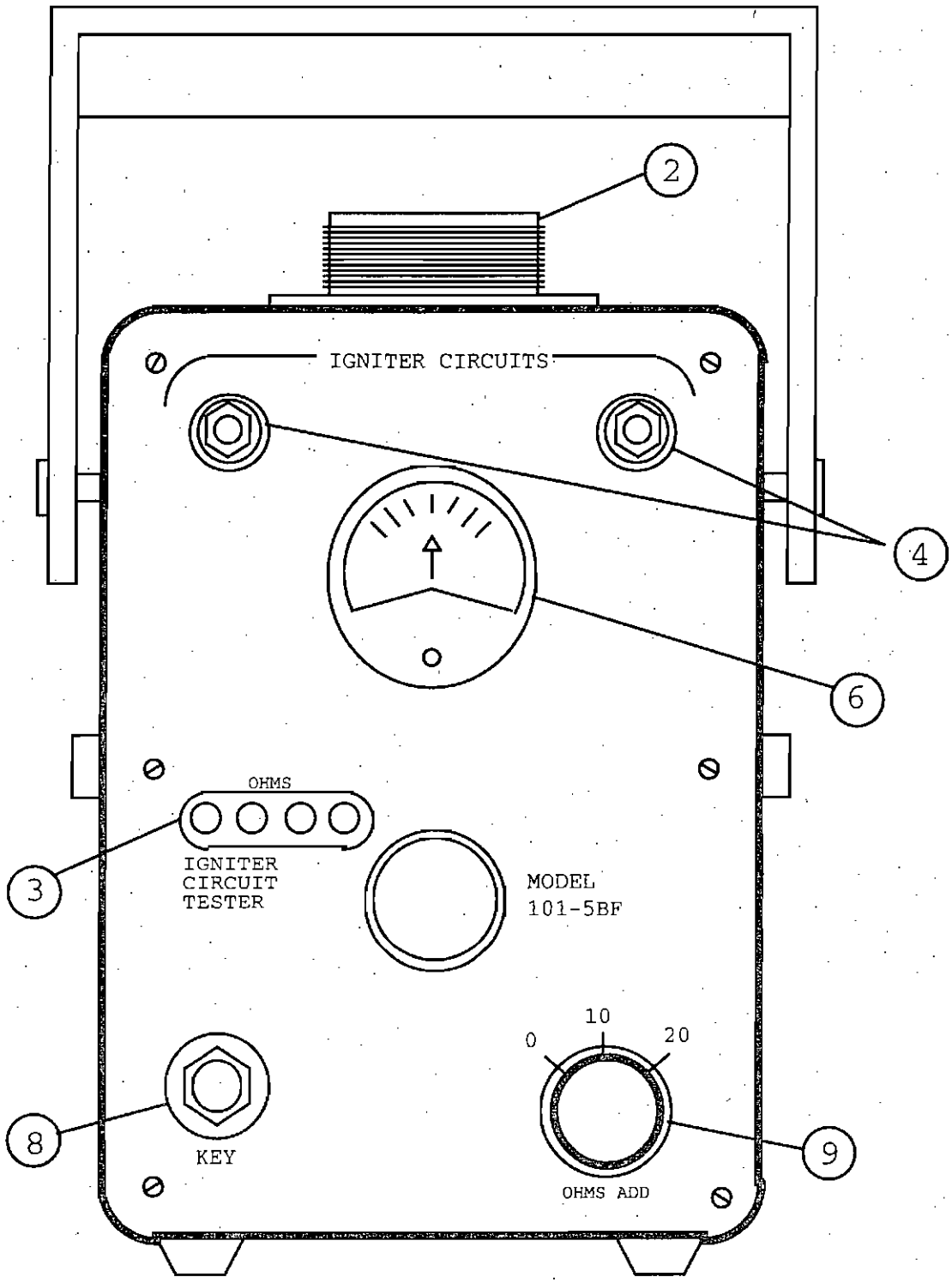


Figure 9-1

One accident occurred at the NASA Poker Flat Rocket Range near Fairbanks, Alaska when technicians were using an Alinco Igniter Tester to read the bridge wire resistance of a Test Rocket Flare, Model MK-13. The tester leads were connected to the flare and when the "Read" button was pressed, the flare ignited. Fortunately, the personnel were able to exit the bunker without injury and the flare failed to ignite the test rocket.

The second and most recent accident occurred at Esrange, Sweden on 27 February 1993. The accident occurred during the final preparation of an Orion rocket motor, which was intended to carry a STRAFAM payload up to 64 km altitude for atmospheric measurements. The vehicle, including the payload, was assemble on the launcher in the MRL building, and the personnel involved were checking the bridge wire resistance of the installed igniter, when the rocket went off. The four persons involved were all standing close to the rocket. The rocket went through the front door off the building and then about 1000 yards away hit the Skylark building, where the rocket exploded. Post-accident investigations discovered that the current limiting resistor R-7 was missing in the Igniter Tester after the unit had been sent to the manufacturer for repairs and replacement of the battery holder.



THE ALINCO IGNITER TESTER, MODEL 101-5BF

Figure 9-2

SCHEMATIC DIAGRAM OF THE ALINCO IGNITER TESTER

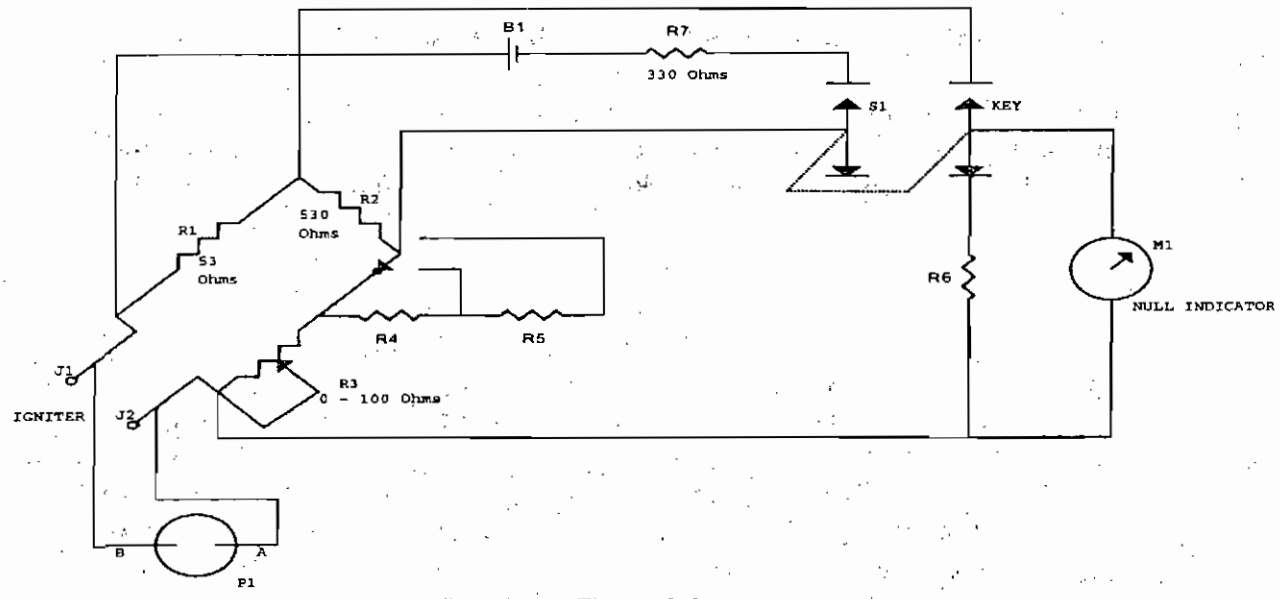


Figure 9-3

A. Circuit Description

The basic circuit of model 101-5BF Igniter Circuit Tester is a modified Wheatstone bridge. The igniter circuit to be measured forms the unknown arm of the bridge, while resistors R3, R4, and R5 form the following arm. Bridge arms R1 and R2 are in the ratio of one to ten, therefore, the igniter circuit is one-tenth the resistance value of that in the balancing arm when a balanced state of the Wheatstone bridge has been affected. OHMS and OHMS ADD, indicate the igniter circuit resistance value directly in ohms, which is their cumulative value. The Alinco has several features including accuracy, safety, reliability, stability and portability.

This schematic diagram shows circuit details of the instrument. With an igniter circuit connected to the measuring arm of the bridge, J1 and J2, depressing switch S1 applies excitation voltage from B1 to the bridge input and places the galvanometer M1 across its output. Adjusting S2 and R3 for the null voltage indication of the galvanometer balances the bridge and presents a front panel indication of the igniter circuit resistance on the OHMS and OHMS ADD dials. Shunt resistor R6 protects the galvanometer from damage by damping the coil when it is disconnected from the circuit. R7 limits the bridge current and in turn the igniter current to 5 milliamperes. The importance of current limiting resistor R7 needs to be emphasized to the utmost.

Letter from NASA, WFF, Flight Safety Office

SAFETY REQUIREMENTS FOR THE USE OF ALINCO TESTERS

As a result of the Poker Flat incident on March 3, 1989, and the recent accident that occurred at Esrange, Sweden, with Alinco testers; NASA, WFF, Flight Safety personnel have reviewed the use of pyrotechnic check-out meters and established the following requirements:

> **"ALL METERS USED BY WFF PERSONNEL TO MEASURE PYROTECHNIC BRIDGEWIRE RESISTANCE, FIRING LINE RESISTANCE, OR ANY OTHER RELATED TASK INVOLVING THE USE OF SUCH METERS, WHETHER THE METER IS WFF PROPERTY OR OTHER SAID METER, MUST BE TESTED TO VERIFY THAT THE MAXIMUM AVAILABLE OUTPUT CURRENT (SHORT CIRCUIT CONDITION) DOES NOT EXCEED 5 MILLIAMPERES, OR THE DESIGNED MAXIMUM OUTPUT CURRENT, DEPENDING ON THE MODEL ALINCO TESTER BEING USED. THE VERIFICATION TEST MUST BE PERFORMED IMMEDIATELY PRIOR TO USING THE METER."**

It is highly recommended that all users adopt the safety requirement listed above, and to take necessary action to implement the verification tests immediately prior to use of the Igniter Tester.

B. Operation

The only connection required for the operation of the Alinco Igniter Circuit Tester is that of the igniter circuit to the binding posts labeled IGNITER CIRCUIT. Optional connection can be made To P-1, the two-pin AN connector on the end of the tester case. Igniter leads from this connector are terminated at the same points in the tester circuit as those from the binding posts.

The controls on the Alinco are as follows: **CAUTION: ALWAYS CHECK THE CURRENT OUTPUT OF ANY IGNITER CIRCUIT TESTER.**

- **Mechanical Zero:** Screwdriver adjustment on the galvanometer face for obtaining mechanical zero of the needle on the scale.
- **OHMS ADD:** Rotary switch to change resistance measurements in 10-ohms increments to 20-ohms.
- **OHMS:** Ten-turn potentiometer with digital indication to change resistance measurement continuously from 0-100 ohms.

- **Keys:** Pushbutton switch to engage self-contained battery and galvanometer for normal resistance measurements.

The operation of the Alinco is as follows:

- Check the galvanometer for mechanical zero.

- If the needle to the galvanometer does not rest on zero graduation of the scale, rotate the zero adjustment located below the face of the meter in the appropriate direction to effect zero indication.

- Remove the shorting bar from the input binding post if your model requires it.

- Connect the igniter circuit lines to the input receptacle or binding posts of the tester.

- Set the cumulative OHMS dial and OHMS ADD control value for the igniter resistance expected.

- Depress the operating key and rotate the OHMS ADD control until the galvanometer needle indicates zero. **Note:** If the needle deflects to the right, the resistance setting of the dials is too high and must be changed in the direction of lower resistance (counterclockwise). In turn, if the needle deflects to the left, the resistance setting of the dials should be increased (clockwise).

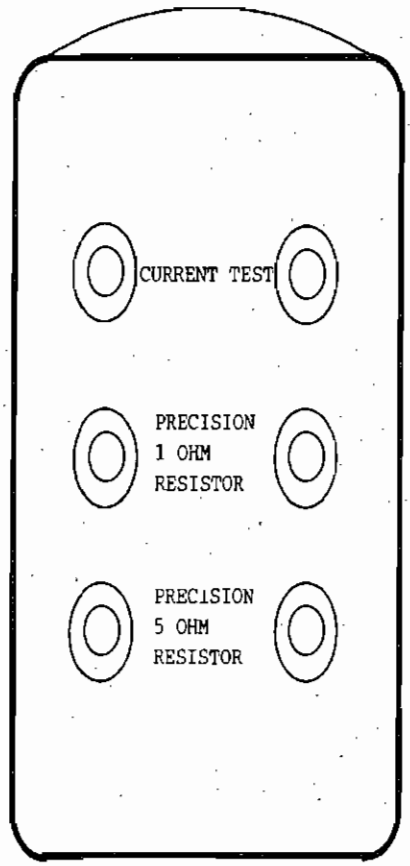
- CAUTION: The life of the digital indicator will be shortened if it is rotated at an excessive rate of speed in order to overcome extreme off-resistance conditions.

- The value of the resistance measured by the igniter circuit tester is indicated as the sum of the OHMS and OHMS ADD dial. For example, if the OHM dial setting is 1.25 and the OHMS ADD dial setting is 10, then the resistance of the circuit measured is 10 + 1.25 or 11.25 OHMS.

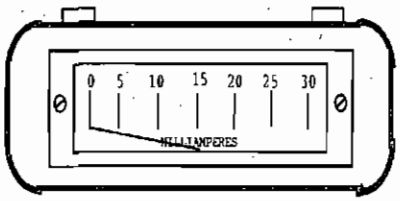
- The resistance of the squib or igniter grid proper is calculated by subtracting the igniter circuit line resistance from the value obtained in the section 7. Shortening the line at the igniter end and measuring its value with the Alinco Igniter Circuit Tester readily determine the igniter circuit line resistance.

- Anytime an igniter circuit tester is not performing properly stop the operation by safe the system or pyrotechnic in accordance with WFF RSM02. Then place the tester in the hands of the certified personnel (WFF NASA CALIBRATION LABORTORY) for repair.

MODIFIED ALINCO IGNITER TESTER 101-5BF WITH MILLIAMMETER AND PRECESION RESISTORS BUILT INTO THE ALINCO REMOVEABLE LID



IGNITER COVER - TOP VIEW



IGNITER COVER - END VIEW

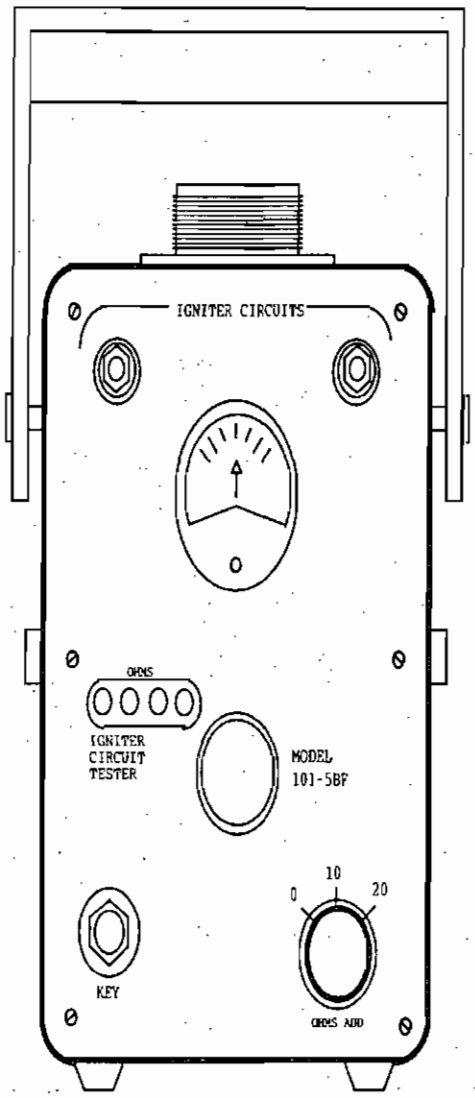


Figure 9.B-1

C. Other Equipment

There is other equipment used in the checkout of ordnance and ordnance circuitry. This includes blasting galvonometers, pyrotechnic voltmeters and Valhalla meters. The blasting galvonometer is used to measure continuity. It is normally used to measure the short back through the ordnance circuitry. This short enables the ordnance to remain in a safe configuration by keeping the pyrotechnic shorted. A drawing of the galvonometer is shown below.

Figure 9.C-1

The pyrotechnic voltmeter is used to perform no voltage checks on ordnance connectors within the ordnance circuitry. A drawing is shown below.

Figure 9.C-2

The Valhalla Igniter Circuit Tester (MODEL 4314A/B) is designed specifically to test the igniters used to detonate charges in explosive devices. The manufacture designed this tester with one objective: to make it absolutely fail-safe. This design of igniter circuit tester incorporates internal protective circuits, which render it incapable of delivering excessive voltage or current to the igniter under test. The meter was pre-tested at the factory where component failure was simulated to duplicate a failed mode. The resulting fail-safe current levels were recorded and supplied as part of the original calibration information. As a further precaution, operating the tester from an internal battery pack eliminates the possibility of an external common-mode voltage delivering unwanted power to the igniter. An external line-powered charger is available for charging the NI CAD battery.

When the front panel power switch is placed in the OFF/CHARGE position, all power is removed from the output terminals, and the battery pack is connected to the charging circuit. When the switch is placed in the ON position, the battery pack is disconnected from the charging circuit. The possibility of a common mode voltage between the igniter and the AC Power Ground is, therefore, eliminated. The operation need not be concerned if the AC Power Charging Adaptor plugged in while measuring igniter resistance. The input range is selected by depressing the desired button on the multi-station interlocking pushbutton array located on the right-hand side of the front panel. The pushbutton for the highest range is nearest to the POWER switch. With the charger disconnected and the input cable connected to the unit connect the Kelvin clips to the igniter. Depress the desired RANGE switch pushbutton. Observe the reading on the digital display. A blinking display indicates the resistance to be measured exceeds full-scale range selected. Select a higher range if this occurs.

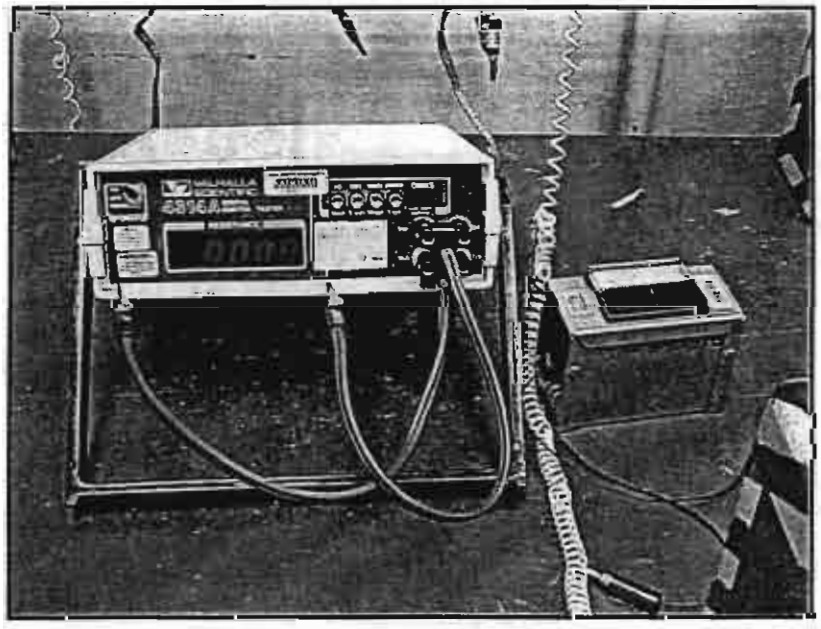


Figure 9.C-3

Block Diagram of VALHALLA Digital Igniter Tester

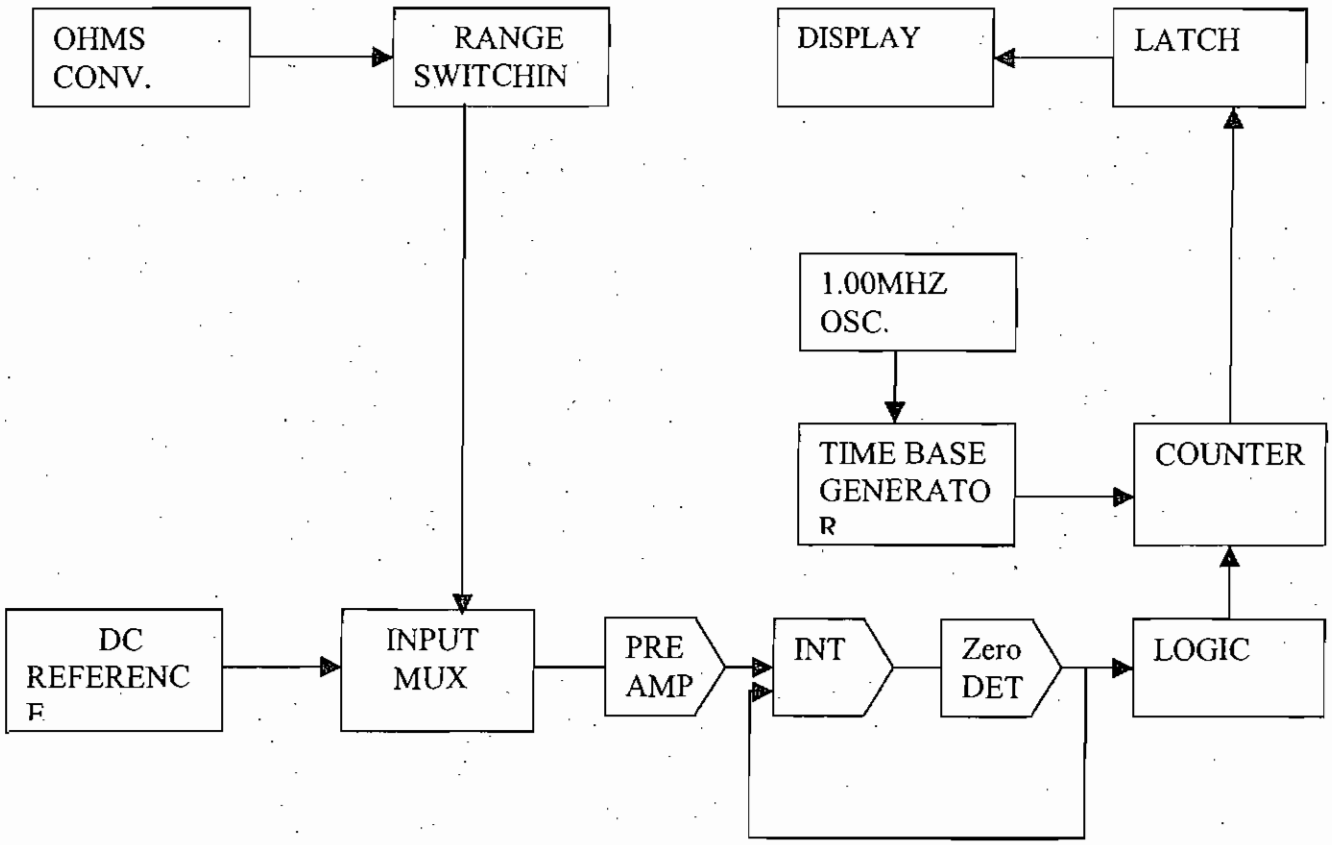


Figure 9.C-4

To Set Up Valhalla Calibration For Use:

1. Allow 5minutes of warm up time before starting to calibrate with resistors. This will ensure the must accurate reading possible with this igniter circuit tester.
2. Select the 100 OHMS range. Connect the Kelvin clips of the input cables to a shorting bar. Reading used be 0000.
3. Select the100ohm resistor. Connect the Kelvin Clips to the 0.1ohm resistor. Once the appropriate resistor is in place the meter display should read 0010.
4. If this reading falls outside the limit repeat the previous steps.
5. Return to the NASA WFF calibration laboratory if the igniter circuit tester calibration reading falls out of manufacture specifications.

Table 9.C-1 on the following page lists the VALHALLA Specifications.

Table 9.C-1: VALHALLA SPECIFICATIONS:

Accuracy:
±0.02% of reading
±0.02% of range for the 20ohms, 200 ohms, 2K ohms and 200k ohms ranges; ±1.0% of reading ±2.0% of range for the 2M ohm range; ±2.0%of reading ±2.0%for range of 20M-ohm range
Display: 4ea - ½ digit display LED
Terminal Configuration:
Four – Wire Kelvin
Overload Indication:
Display Flashes
Maximum Input:
250 VDC or Peak without damage/ AVG. 115VAC **(charging)**
Operating Temperatures:
0° to 50° C
Temperature Coefficient: ± 0.002% / C
0° TO 15° C AND 35° TO 50° C - T.C. applies to ranges up to 200K ohms
Conversion Rate:
Approximate 300msec.
POWER:
Recharge 5V Nickel-Cadmium batteries and charging /16 hrs. every 8hrs of continuous use
SIZE:
235 mm/9" L * 216 mm/8.5" W * 64mm/2.5" H
Weight:
1.6lbs.
Test Equipment for Calibration:
Precision Resistors .1ohms ± 0.01% / 100ohms ± 0.005%

Chapter 10: THE EED FIRING CIRCUIT

The EED firing circuit has evolved from the simplest basic circuit to the safe and reliable circuit designs that are in use today in sounding rocket systems. Before we get into the safety features required by the NASA Safety Handbook, let us just look at how and why some of these required features came about. We will trace the evolution of the firing circuit so that we can understand the need and wisdom of having some of the now required features of a firing circuit.

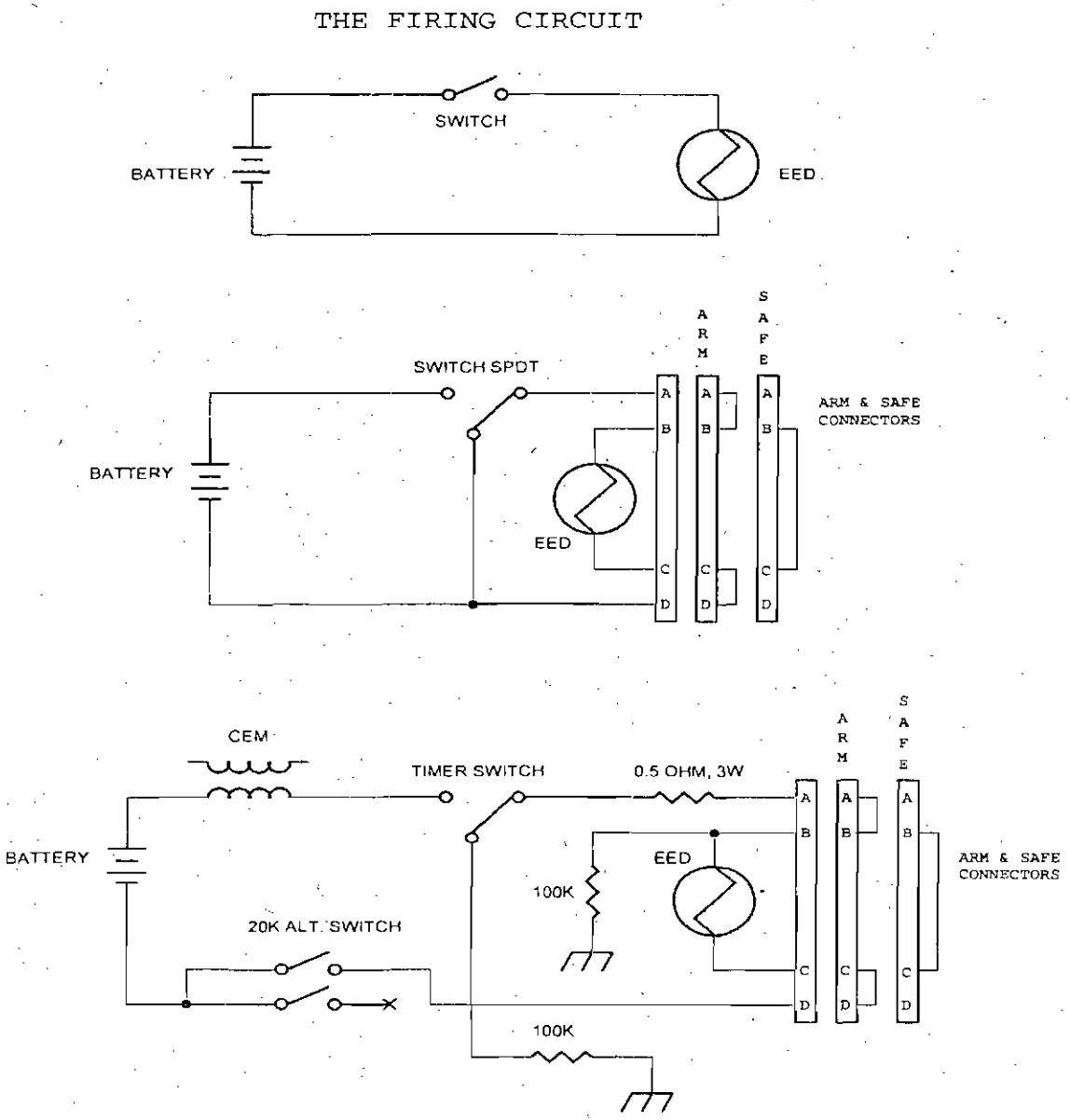
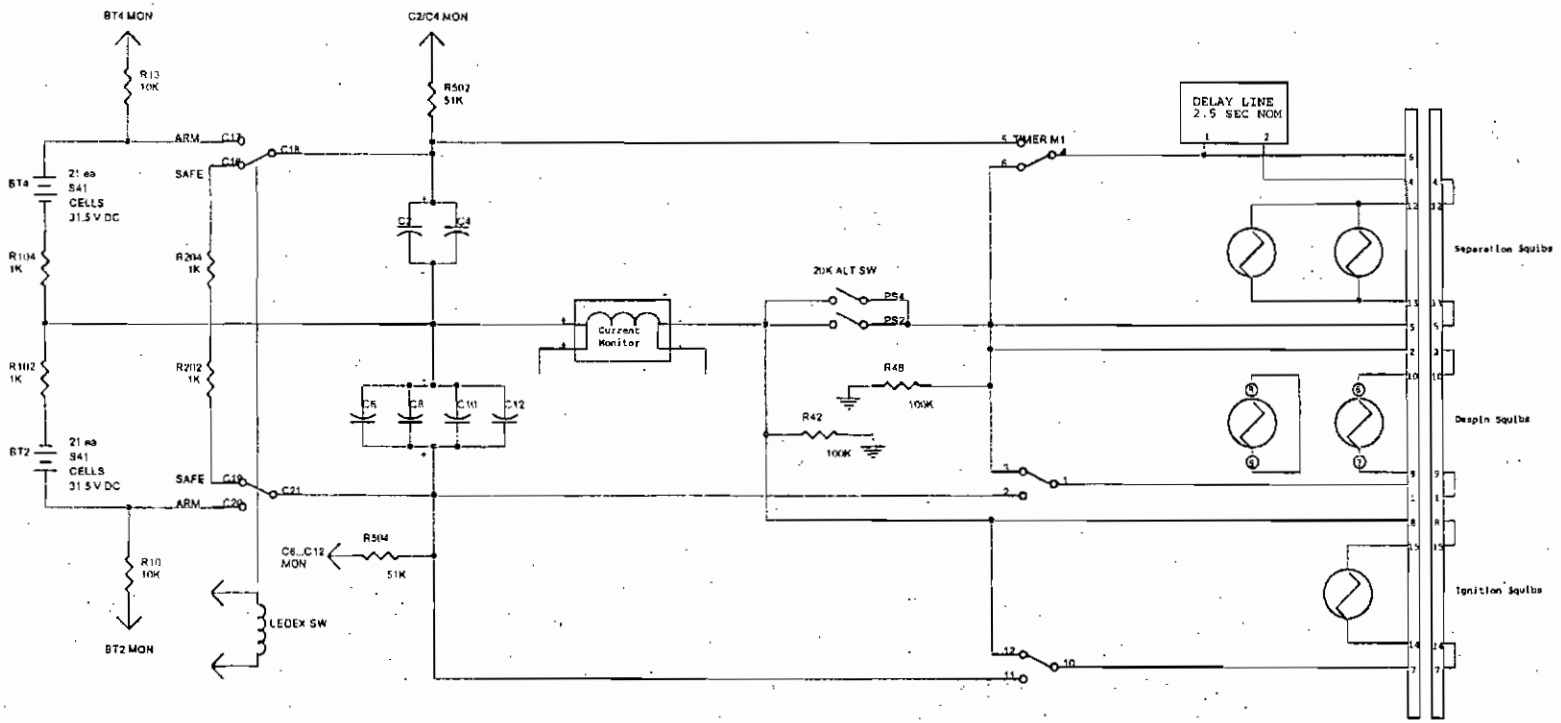


Figure 10-1

Below are several circuits used with the sounding rocket program. The Black Brant circuitry is basically a Capacitive Discharge Ignition (CDI) system.



	DESPIN	P/L SEP	IGNITION
FIRING CHARACTERISTICS	HOLEX 5801	HOLEX 6104	HOLEX 9293-1
NO FIRE CURRENT (A)	1.0 FOR 1 MIN.	0.5	1.0 FOR 1 MIN.
ALL FIRE CURRENT (A)	4.5	1.2	2.77
REC FIRE CURRENT (A)	5.0	4.5	4.5
BRIDGEWIRE RESISTANCE	1+/-0.1	1+/-0.15	0.94 +/-0.04
PIN TO CASE RESISTANCE (MEGAOHM)	2	2	2
NR. OF BRIDGEWIRES	2	2	1

SIMPLIFIED DIAGRAM OF THE BLACK BRANT V IGNITER HOUSING FIRING CIRCUITS

Figure 10-2

The Wallops Flight Facility NSROC Capacitive Discharge Ignition (CDI) system is shown below. It is similar to the Black Brant circuitry in some respects. The NSROC CDI consist of Ca-pow packs, Ledex switch, Altitude switches, 30 channel multifunction timers (MFTs), squib current monitor box, relays, safe / arm continuity plugs, batteries and various interfaces / busses. The safe / arm continuity plugs, relays, altitude switches and Ledex switch provide safety for the ordnance system. The NSROC CDI is used to initiate vehicle events involving category "A" systems. This includes but is not limited to motor ignition, motor separation, despin, parachute deployment, other separations / deployments and chemical releases. The system is totally redundant and conforms to the design criteria set forth in RSM02, 803-WI-8072.1.1A. A version of this system is used to initiate spin motors and clamp release.

Figure 10-3 on the following page shows a representative drawing of a Payload Pyrotechnic Power system. It is different from the two previous CDI systems. It consist of a pyrotechnic battery, altitude switches, squib current monitor box, relays and various interfaces / busses. This payload system initiates ordnance for various separations / deployments as well as payload functions. The relays and altitude switches are the safeties, which allow for the system to be category "B".

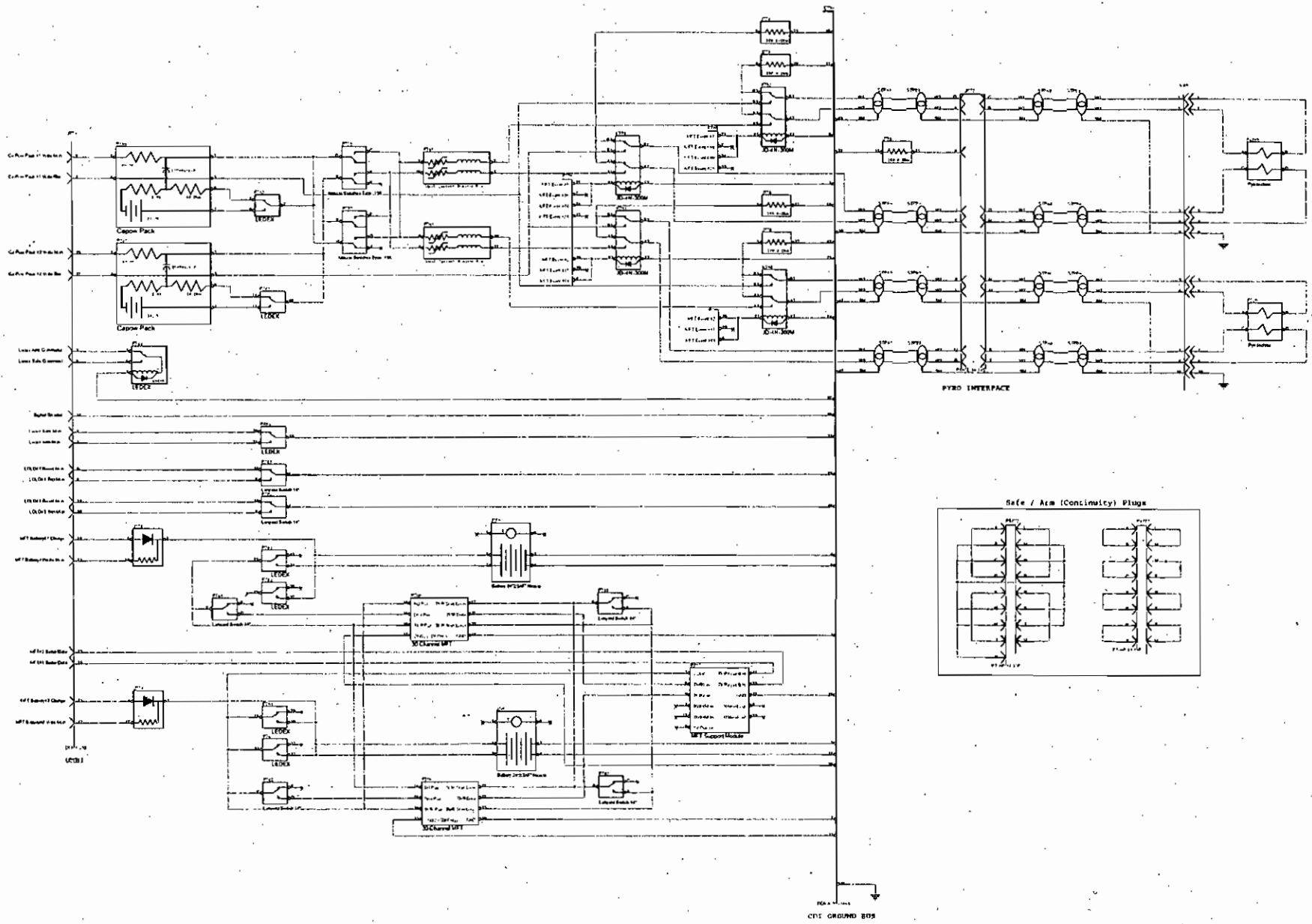


Figure 10-3: Payload Pyrotechnic Firing System

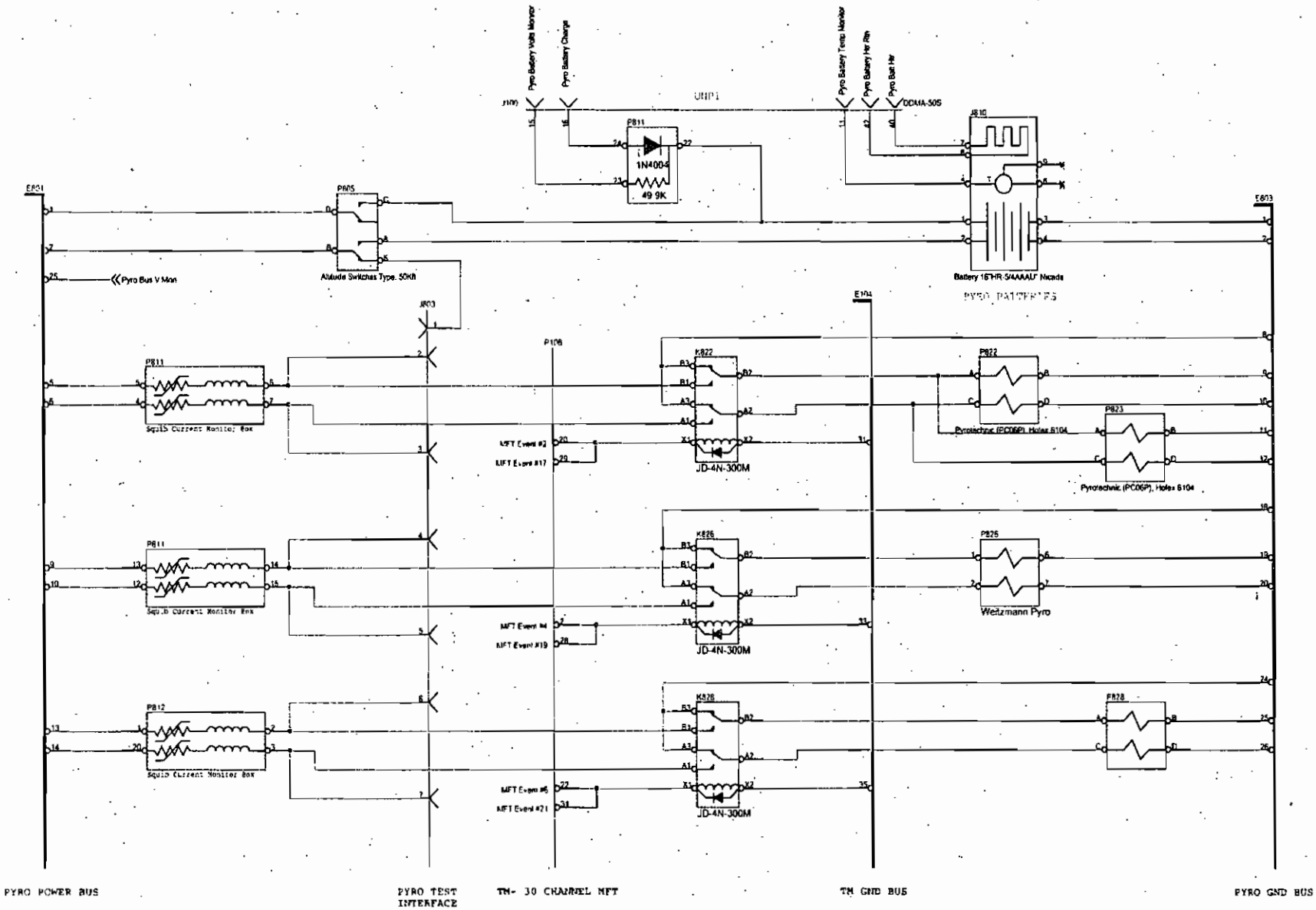


Figure 10-3 (continued)

A. Detailed Design Criteria

Power Source - Separate and dedicated power distribution points shall be used for the electro-explosive subsystem firing sources. A firing source can share the same power source with other loads, but all currents flowing from the firing source point shall be for firing circuits only.

Shields - Cable shielding shall provide a minimum of 85 percent of optical coverage. There shall be no gaps or discontinuities in the shielding, including the termination at the back faces of the connectors, nor apertures in any container, which houses elements of the firing circuit. Shields terminated at a connector shall provide 360-degree continuous shield continuity without gaps. Shields shall not be used as intentional current-carrying conductors, but may be multiple-point grounded to the structure. Multipoint grounding of the shields to structure is recommended.

Cables - Electrical cables may be fabricated such that several electro-explosive subsystem circuits are contained in a common shielded cable bundle. There shall be no splices used to join elements of ordnance cables. A connector shall be provided wherever mating or demating of a circuit is required. All cable runs shall be routed as close to metal structure as possible.

Insulation Resistance - All current-carrying components and conductors shall be electrically insulated from each other and system ground. The insulation resistance between all insulated parts, at a potential of 500v, minimum, DC, shall be greater than 2 megohms.

Short-Circuit Protection - Electro-explosive subsystems shall include positive protection for line-to-line and line-to-ground shorts, which may develop within a fired EED. Relays, fuses, or current limiting resistors may be used to satisfy this requirement.

Wiring - Shielded twisted pairs shall be used unless other configurations can be shown to be more effective. Any grounding of the firing circuits shall be done at one point only. Ungrounded firing circuits shall be connected to structure by static bleed resistors. Structural ground shall not be used as return for ordnance circuitry. The source circuits shall terminate in a connector with socket contacts. The design shall preclude sneak circuits and unintentional electrical paths.

Connectors - All connectors used with the electro-explosive devices shall: a) be approved by the procuring activity, b) have a stainless steel shell or suitable electrically conductive finish, c) complete the shell-to-shell connection before the pins connect, and d) provide for 360 degree shield continuity. There shall be only one wire per pin, and in no case shall a connector pin be used as a terminal or tie-point for multiple connections. Spare pins are prohibited in connectors which are part of firing output circuitry. Connectors shall be selected such that they are not subject to demating when exposed to the maximum anticipated environment. Connectors that twist and lock into position are preferred. Where redundant circuits are required to meet fault tolerance requirements, separate connectors shall be used.

These are only a few of the design criteria that you may be concerned with, and each installation may have their additional requirements to supplement those listed above. Most of all the design of the firing circuits and safety require good common sense. Keep the circuits as simple and reliable as you can make them.

NO VOLTAGE TESTS - The no voltage test is the first test that the qualified ordnance handler would make in the process of final arming before launch. This test is performed to verify that there are no voltages or currents present on the firing line side of the Safe & Arm connector before installing the Arm connector. The no voltage test is performed using an approved volt-ohmmeter and the measurements are made pin to pin and all pins to case or structure ground. We will discuss why each test is made and discuss the circuitry. Remember that the J7 connector and the associated circuitry shown is only one half of two identical, and redundant circuits. These same tests would b performed on J12 that represents the other redundant circuit.

Using a volt-ohmmeter make the following measurements:
(Refer to the Igniter Housing Diagram above and fill in the readings)

Measurement points	**Volts**	**Current**	**Resistance**
J7-1 and J7-2	_____	_____	_____
J7-4 and J7-5	_____	_____	_____
J7-7 and J7-8	_____	_____	_____
All pins to case ground			
J7-1 or J7-2 to case	_____	_____	_____
J7-4 or J7-5 to case	_____	_____	_____
J7-7 or J7-8 to case	_____	_____	_____

Remove the volt-ohmmeter and stow it in its proper place.
Using an Alinco Igniter Tester, make the following measurements:
(Be sure to make the Maximum Output Current Test on the Alinco before using)

Squib Bridge wire Resistance Readings (Subtract Lead Wire Resistance)

Measurement Points	Resistance
J7-9 to J7-10	_____
J7-12 to J7-13	_____
J7-14 to J7-15	_____

(To verify there are no shorts from bridge wire to case, set Alinco to highest range)

J7-9 or J7-10 to case	_____	(should read over 10Kohm)
J7-12 or J7-13 to case	_____	"
J7-14 or J7-15 to case	_____	"

SAFETY RULES FOR ARMING AND DE-ARMING EXPLOSIVE CIRCUITS

1. Always utilize the "Buddy System" when arming or de-arming.
2. Wear proper clothing, i.e., cotton garments, safety shoes, hard hats, etc.
3. When installing squibs or squib connectors always be sure that you, the squib, and the rocket are all at the same potential. Wrist straps or leg stats are recommended, however, if they are not available or there is not a certified ground to connect the wrist strap to, be sure that you touch the rocket launcher or rocket skin and keep one hand in contact with the launcher or rocket skin at all times. Static discharge is the greatest danger in handling explosives but it can be minimized if you follow the rules and treat the explosives with the respect they deserve.
4. Use only the Alinco Igniter Tester, the Blasting Galvanometer, or other approved instruments for making squib bridge wire resistance measurements.
5. Cease all ordnance activities and clear the launch pad if lightning is within a 10-mile radius.
6. When shorting an installed EED, place the shunt as close to the EED as possible, DO NOT leave a long antenna hanging on the squib.
7. Always make the NO VOLTAGE tests on the source circuit prior to connecting any connector to the EED.
8. Always know exactly what readings you should have at each test point when doing the NO VOLTAGE and BRIDGEWIRE RESISTANCE MEASUREMENTS. Report all deviations, or out-of-tolerance readings.
9. Do not feel offended if your partner or supervisor, or other launch personnel want to verify that all connectors are mated properly or want to make a final inspection. After all, checks and double-checks are only insurance for a successful mission.
10. Before ARMING or DE-ARMING activities take place, verify that radar avoidance is in effect, and all power to the rocket is turned off, if possible, and if not possible to have all power off, then verify that there will be no switching (on and off) of power, to avoid switching transients.
11. ALWAYS KNOW WHAT YOU ARE WORKING WITH, OBSERVE ALL SAFETY RULES, AND THINK BEFORE YOU ACT. MAKE ALL ACTIONS DELIBERATE. KNOW WHAT YOU ARE DOING AND WHAT YOU ARE GOING TO DO NEXT.

Figure 10.A-1

B. EED Sensitivity

Reliability and safety are important requirements for any electro-explosive device. When installed in a practical, well-designed system an EED should be sensitive enough to fire

reliably when the proper firing-signal is received. Moreover, for safety's sake, the EED should be insensitive enough that any stray currents or voltages that may appear in the absence of a proper firing signal will not make the EED fire. In short, reliability and safety of the EED systems can only be achieved if the EED sensitivity is well known.

THE BRUCETON TEST METHOD

The Bruceton Test method provides a statistical tool for measuring the 50% firing point and other percentage points by extrapolation for electro-explosive devices. That is, the Bruceton Test method can be used to estimate the amperage at which any given percentage of parts can be expected to function at any specified confidence level. This information can be use to estimate the ALL FIRE and NO FIRE amperages for a particular device. The ALL FIRE and NO FIRE amperages are those currents at which all parts or no parts respectively will fire. The Bruceton method of sensitivity testing was developed specifically for ordnance testing.

The Bruceton test is carried out using equally spaced test levels that are chosen before the test commences. The test is sequential in that the test level for a given shot is determined by the outcome of the previous shot. If a given shot fires, the next shot is made at the next lower test level. If a given shot does not fire, the subsequent shot is made at the next higher level.

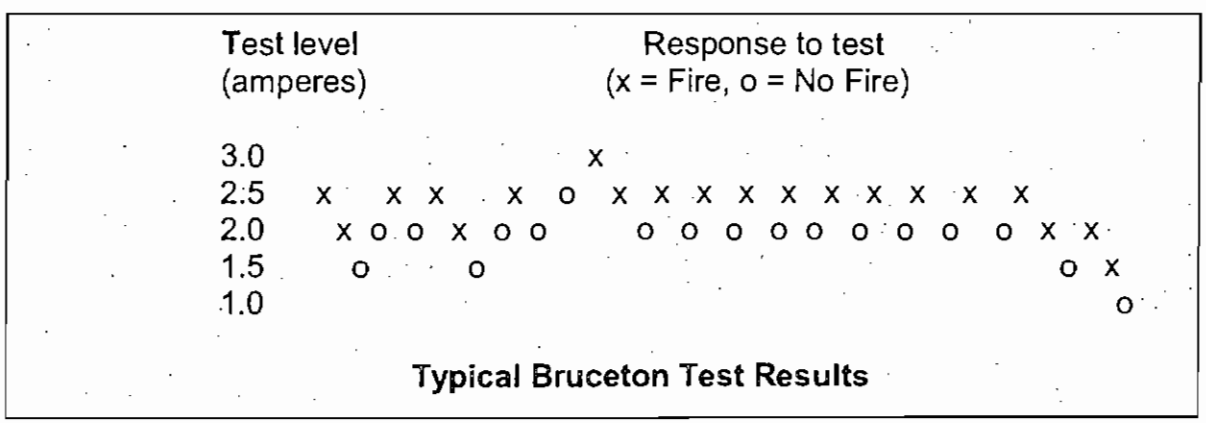


Figure 10.B-1

There are other tests for reliability and sensitivity but the Bruceton method seems to be the most commonly used and referenced.

Chapter 11: DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

Arm/Disarm Device - A device to make (ARM) and break (DISARM) electrical continuity from the firing controller to the Electro-Explosive Devices (EED).

Booster - an explosive charge augmenting the initiating component of an explosive train to cause ignition or detonation of the main explosive charge or to increase the output of the assembly.

Bridge wire - A resistance wire incorporated into an EED to convert electrical energy into heat to cause ignition of the pyrotechnic material.

Bruceton Analysis - A method of sensitivity testing to estimate the mean of the distribution and, less accurately, the standard deviation from a limited number of samples. In this test, the level of variables applied depends upon the results of the previous test. It is used to determine the ALL FIRE and NO FIRE levels.

Burst Pressure - A manufacturers rated Burst pressure, the pressure that the vessel is designed to fail. (For flight Pressure vessels this is minimum of 2 times the MAWP.

Certification - Certification for handling explosives signifies that an individual has acquired the knowledge, experience, and skills necessary to perform safe and effective explosives and pyrotechnic operations.

Charge Holder - An assembly consisting of an explosive train permanently mounted in a bolder (usually metallic) designed for vehicle installation; the train may be one intended for structural separation or a transfer charge.

Class 1, Division 1 Explosives (1.l) – These are generally defined as materials which function by substantial instantaneous release of gas and heat; materials such as black powder that can be easily caused to deflagrate by sparks or small flame; and solid explosives which contain no liquid explosive ingredient and which, when unconfined, can be detonated by a Number 8 blasting cap. Materials having a card gap value of more than 70 cards are considered Class 1, Division 1 explosives by the military. Included in this class are high explosives, trinitrotoluene (TNT), amatol, tetryl, pentolite, and commercial dynamite.

Class 1, Division 2 Explosives (I.2) – These are defined as those explosives that, when initiated, produce fragmenting projectiles as well as shock wave. Included in this class are, grenades, warheads, bomblets, etc.

Class 1, Division 3 Explosives (I.3) – These are defined as those explosives, which in general function by rapid combustion rather than detonation and include some explosive devices such as special fireworks, flash powders, some pyrotechnic signal devices, and liquid, or solid propellant explosives, which include some smokeless powders. Examples are ammunition, jet thrust units, rocket, and JATO igniters.

Class 1, Division 4 Explosives (I.4) – These are defined as certain types of manufactured articles which contain Class 1.1 or Class 1.2 explosives or both, as components, but in restricted quantities, and certain types of fireworks. These

explosives include electric squibs, primers, safety fuse, mild detonating fuse, explosive cable cutters, igniters, etc.

Closed Bomb - A fixed volume chamber used for testing pressure cartridges.

Confined Detonating Cord (CDC) - A detonating cord surrounded by a flexible sheath of plastic, fiber fabric, or combinations thereof that confines the effects of the explosive core. Generally used for energy transfer between multiplexed components in a pyrotechnic system.

Core Charge - A high explosive material contained in a suitable configured sheath, usually of metal. It is a generic term for both Mild Detonating Fuse (MDF) and Linear Shaped Charge (LSC); the basic component of an explosive train as defined herein.

Cyclotrimethylenetrinitramine (RDX) - A secondary explosive. Color: white.

Deflagration - A deflagration is a rapid chemical reaction in which the output heat is sufficient to enable the reaction to proceed and accelerate without the input of heat from another source. Deflagration is a surface phenomenon with the reaction proceeding towards the unreacted material along the surface at subsonic velocity. The effect of a true deflagration under confinement is an explosion. Confinement of the reaction increases pressure, rate of reaction, and temperature, and may cause transition into a detonation.

Delay Column - The component of a delay element, which introduces a controlled time delay in the functioning of a series of explosive events. It consists of a length of tube primarily dependent upon the burning rate of the delay material being used and the time delay required. Sometimes the column consists of a "priming" material at one end to initiate the delay material and a relay charge at the output end to transfer an impulse and augment the output to a succeeding element in the train.

Delay Element - An assembly that consists of an initiating element at one end, a delay column in the middle, and a base charge at the terminal end to transfer an impulse to the next succeeding element in the train.

Detonation - A detonation is a violent chemical reaction within a chemical compound or mechanical mixture evolving heat and pressure. A detonation is a reaction that proceeds from the reacted to the unreacted materials at supersonic velocity. When the detonation is located on or near the surface of the ground, a crater normally characterizes it.

Detonator – A pyrotechnic device capable of initiating detonation in a subsequent high explosive component.

Device - Any device other than an EED, which contains explosives and/or mixtures of explosives and when initiated, produces pyrotechnics, gases, or flames (e.g., chemically/mechanically initiated guillotine cutters (reefing line cutters) in parachutes.

Dual-Redundant System – A system which will sustain two failures of one assembly / component and still retain the capability of performing the intended function. Such a system is frequently attained by adding two like assemblies /

components to the system; for example; if one battery is required to provide a source of firing current, two additional batteries provide dual-redundancy of the current source and the batteries are said to be dual-redundant.

Dud - An explosive device, which fails to initiate.

Electrical Circuit Safe/Arm--A device which electro-mechanically interrupts the firing circuit between the initiator and the final firing control device and which provides additional safety from premature firing. (Example--Ledex Switch in Black Brant Rockets.)

Electro-Explosive Device (EED) - Any cartridge, squib, igniter, etc., containing a pyrotechnic charge and/or explosive, which are initiated electrically.

Explosion - A rapid chemical reaction with the generation of high temperature, flame and gas, or, a shock wave that proceeds at greater than the speed of sound, depending on the type of explosive material that has been initiated.

Explosive - The term "explosive" or "explosives" includes any chemical compound or mechanical mixture which, subjected to heat, impact, friction, detonation or other suitable initiation, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gasses which exert pressure in the surrounding medium. The term applies to detonating, deflagrating, and pyrotechnic materials.

Explosive Bolt – A bolt that is intended to be fractured at a predetermined point by a contained or inserted explosive charge for the purpose of releasing a load.

Exploding Bridge wire (EBW) Device - An exploding bridge wire device is defined as an electro-explosive device in which the bridge wire is designed to be exploded (disintegrated) by a high energy electrical discharge which in turn causes the explosive charge to react.

Explosive Lot – A specific traceable quantity of an explosive material resulting from a one-time blending or mixing of one or more batches, all of which are prepared within a short time period.

Explosive Train - An explosive train consists of elements arranged according to decreasing sensitivity and increasing potency. The explosive train starts with an initiator usually made with a primary explosive or propellant. The initiator fires into a detonator usually made with a primary or secondary explosive. The detonator fires into a booster containing a secondary explosive. The booster then fires into the secondary explosive main charge.

Hang Fire – A failure or delay in the action of a primer, igniter, or propelling charge, after the tiring signal has been applied. It must be ascertained that the firing signal has been applied and current had been drawn, but the device did not initiate. In a Hang fire situation, there is a waiting period before any personnel may approach the launcher, usually a minimum of 30 minutes. Each Range will have their Safety Rules regarding a Hang fire situation. Explosive Classification - The six explosive classifications and explosives storage compatibility's are listed in Appendix A at the end of this chapter.

Hazard - A potential risk situation caused by an unsafe act or condition.

Hexanitrostilbene (HNS) - A secondary explosive. Color--buff to pale yellow.

Igniter - Usually defined as any type of ignition cartridge, which is designed to ignite a secondary charge.

Initiator - An initiator is also a primer, just as is an igniter, however, the term initiator is more commonly used in conjunction with high explosive applications.

Lead Azide - A sensitive primary explosive. Color-White.

Linear Shaped Charge (LSC) - a metal tube containing a core of high explosive, formed into a "V" or chevron shape to produce a cutting jet.

Lot Certificate - A NASA approved document pertaining to a specific lot of a specific pyrotechnic device which lists all specific serialized parts in the lot that are certified for flight vehicle installation; it is prepared on the basis of manufacturing and acceptance data and represents the status of each device at the time of the certification activity.

Magazine/Bunker - A structure that is designed or specifically designated for the storage of explosives.

Malfunction - When a device fails to perform according to design.

Man Safe Pressure - This is the pressure that flight pressure vessels, are allowed to be pressurized to, when personnel are in the area of the system. This is 25% of the designed Burst Pressure.

MAWP - Maximum Allowable Working Pressure

Misfire – The failure of the firing circuit to deliver the initiating energy required for ignition.

PAGE - Pneumatics Aerospace Ground support Equipment.

Pentaerythrite Tetranitrate (PETN) - A secondary explosive more sensitive than RDX or HNS. Color-White.

Percussion - A method of initiating a pyrotechnic charge by an intentional sudden pinching or crushing of the explosive material, as between a blunt firing pin and an anvil.

Piggyback – The practice of backing up one LSC with another by placing one LSC on the back of the LSC performing the cutting such that the liner of the backup charge is in contact with the backside of the cutting charge.

Primary Explosive - A sensitive explosive, one of the first elements in an explosive train. Very sensitive to heat and shock.

Production Lot - A group of components, devices, or assemblies of the same design, construction, and materials fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time.

Proof Pressure - The pressure that the vessel is usually re-tested too. This is 1.5 times the MAWP.

Propellant - An energetic material that is employed in an environment where it burns (sometimes at a high rate) but without the destructive force of an explosive. Under certain conditions involving mass and shape factors, a propellant also functions as an explosive.

Pyrotechnics - This generic term is used throughout the space program in lieu of "ordnance" to avoid the connotation of weaponry, as in "pyrotechnic systems". Pyrotechnic devices include all devices and assemblies contained or operated/actuated by propellant and/or other explosives. This term does not include large solid rocket motors (SRM) such as on the Shuttle.

Random Sample - A sample selected without bias or prejudice.

Redundancy-Single - A single-redundant system is one that will sustain one failure of an assembly/component and still retain the capability of performing the intended function. This level of redundancy is attained by adding one like assembly/component to the system; for example, if one battery is required to provide a source of firing current, one additional battery provides single-redundancy of the current source and the batteries are said to be redundant.

Secondary Explosive - Explosive materials that are relatively insensitive to heat or impact and must be initiated by a suitable primary explosive or another secondary explosive. Secondary explosives are generally more brisant and more powerful than primary explosives; synonymous with "high explosive".

Sensitivity - The characteristics of an explosive or component which expresses its susceptibility to initiation by externally applied energy; may apply to electrical, shock, or other stimuli.

Single Point Ground - A single-point ground is a feature of a power distribution network wherein each conductively isolated segment (i.e., transformer-coupled or supplied from a separate source) of the distribution network has only one physical connection to ground. A 10K Ohm or greater resistor placed between a circuit segment and ground does not violate the single point ground concept.

Squib - A general term usually meaning any one of many EED's.

Static Bleed Resistor - Resistors, which are placed between firing circuits and ground to prevent the build-up of static electricity on circuits.

References - The most important regulations (Other than local Safety Regulations) covering the use, storage, classification, and shipping of explosives are as follows:

A. *NASA Safety Standard (NSB) for Explosives, Propellants, and Pyrotechnics* 1740.12, August 1993.

B. *DOD 6055.9-STD, Dept. of Defense Ammunition and Explosives Safety Standard,* 1992, w/Change 1.

C. *Air Force Occupational Safety and Health (AFOSH)91-201,* U.S. Air Force Regulations, Explosives, Safety Standards, 1995.

D. *49 Code of Federal Regulations (CFR) Parts 101, 106, 107, and 171-180, Department of Transportation*

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Appendix A: COPY OF ALINCO CHECKS MADE PRIOR TO USE

CHECKS THAT WILL BE MADE PRIOR TO USE OF TESTER
ALINCO IGNITER TESTER

WARNING: PRIOR TO USE, THE MAXIMUM CURRENT OUTPUT AND ACCURACY OF THE ALINCO MODEL 101-5BF IGNITER CIRCUIT TESTER MUST BE CHECKED. IF CURRENT OUTPUT READING OF IGNITER CIRCUIT TESTER IS MORE THAN 5 MILLIAMPERES, OR IF MEASURED RESISTANCE VALUE OF STANDARD PRECISION RESISTOR IS NOT WITHIN 1% OF RATED RESISTANCE VALUE, REJECT THE IGNITER CIRCUIT TESTER. IGNITER CIRCUIT TESTER MUST UNDERGO CALIBRATION BY QUALIFIED EVALUATION FACILITY IN ACCORDANCE WITH RANGE SAFETY MANUAL RSM-93.

1. Place igniter circuit tester on level surface. _____

2. Ensure tester needle is on center zero. If it is not, center needle by rotating the zero adjust screw, located below the dial of the meter. _____

3. Connect a low resistance, 10-milliampere, full-scale deflection, and 2.5-ohm ammeter across the igniter tester terminals. _____

4. Place OHMS and OHMS ADD knob to highest setting. (If the current limiting resistor R7 is missing or defective, starting off with a short circuit will severely damage the ammeter.) _____

5. Press KEY on the Igniter Tester. If milliammeter reading is greater than 5.0 milliamperes—STOP. REJECT ANY TESTER THAT HAS A CURRENT OUTPUT GREATER THAN 5.0 MILLIAMPERES. _____. If milliampere reading is less than 5.0 milliamperes, proceed to Step 6. _____

6. If reading is less than 5.0 milliamperes, reduce the settings of both the OHMS and OHMS ADD dials until both dials are at ZERO indication. _____

7. Press Key on the Igniter Circuit Tester, adjust the OHMS and, if necessary, the OHMS ADD dials until a NULL or Zero needle indication on the meter. Record the reading _____mA

8. Disconnect milliammeter and connect a precision standard resistor having a value of less than 10 ohms, across the tester. _____

9. Place the OHMS ADD dial to Zero, Press KEY, adjust the OHMS dial to bring meter needle to center zero. Record reading_____ohms. In tolerance? _____ Yes _____ No.

Appendix B: COPY OF PYROTECHNIC DATA SHEET

COMPANY	DEVICE	PART #	BRIDGE	MAXIMUM NO FIRE CURRENT	MINIMUM ALL FIRE CURRENT	RECOMM. FIRING CURRENT	BRIDGE RESIST. (OHMS)	CONNECTOR / MATE
Conax	Latch Pin Assy.	1808-076 - 02	SINGLE	0.5 Amp	1.5 Amps	1.5 Amps	1.0	FLEXIBLE LEADS
Hercules	Bellows Actuator	BA31K47	SINGLE	100 Milliamp	0.3 Amp	1.0 Amp	4.0-5.0	SOLID PINS
Holex	Thruster	11876-1	DUAL	50 Milliamps	0.3 Amp	1.0 Amp	4.0-5.0	SOLID PINS ?
Holex	Pressure Cartridge	2100-2300	DUAL	0.5 Amp	1.0 Amp	1.0 Amp	0.85-1.15	PC02-8-4P PC06-8-4S
Holex	Guillotine	2800-2803	DUAL	1.0 Amp	3.0 Amps	5.0 Amps	.58-.74	FLEXIBLE LEADS
Holex	Linear Actuator	2900/ 2118	DUAL	0.5 Amp	1.0 Amp	5.0 Amps	.85-1.15	PC02-8-4P PC06-8-4S
Holex	Pressure Cartridge	3000	SINGLE	1.0 Amp	3.0 Amps	4.5 Amps	.90-.98	PT02-8-2P PT06-8-2S
Holex	Pressure Cartridge	3100	SINGLE	1.0 Amp	3.0 Amps	4.5 Amps	.90-.98	PT02-8-2P PT06-8-2S
Holex	Ignition Cartridge	3200	SINGLE	1.0 Amp	4.5 Amps	4.5 Amps	.90-.98	PC02-8-2P PC06-8-2S
Holex	Ignition Cartridge	3300	SINGLE	1.0 Amp	4.5 Amps	4.5 Amps	.90-1.10	PT02-8-2P PT06-8-2S
Holex	Pressure Cartridge	3600	DUAL	1.0 Amp	3.0 Amps	4.5 Amps	.90-1.10	PC02-8-2P PC06-8-2S
Holex	Pressure Cartridge	3700	DUAL	1.0 Amp	3.0 Amps	4.5 Amps	.90-1.10	PT02-8-4P PT06-8-4S
Holex	Detonator	4800	SINGLE	1.0 Amp	4.5 Amps	5.0 Amps	.90-1.10	SOLID PINS
Holex	Detonator	4900	DUAL	1.0 Amp	4.5 Amps	5.0 Amps	.90-1.10	SOLID PINS
Holex	Ignition Cartridge	5600- 5700	DUAL	1.0 Amp	3.0 Amps	4.5 Amps	.90-1.10	PC02-8-4P PC06-8-4S
Holex	Guillotine	5800- 5803	DUAL	1.0 Amp	4.5 Amps	5.0 Amps	.90-1.10	FLEXIBLE LEADS
Holex	Pressure Cartridge	6100- 6300	DUAL	0.5 Amp	1.2 Amps	4.5 Amps	.85-1.15	PC02-8-4P PC06-8-4S
Holex	Detonator	7819	SINGLE	1.0 Amp	4.5 Amps	4.5 Amps	.90-1.10	PT02-8-2P PT06-8-2S
Holex	Ignition Cartridge	7900	DUAL	1.0 Amp	3.5 Amps	5.0 Amps	1.0-1.20	PC02-8-4P PC06-8-4S
Holex	Ignition Cartridge	9293	SINGLE	1.0 Amp	4.5 Amps	4.5 Amps	.90-1.10	PC02-8-2P PC06-8-2S
ICI Atlas	Squib Switch	MS-4.2-1.0-C4R	DUAL	0.1 Amp	1.0 Amp	5.0 Amps	1.60-2.0	SOLID PINS
ICI Atlas	Pin Puller	228-50000	DUAL	0.1 Amp	1.0 Amp	1.0 Amp	1.60-2.0	SOLID PINS
ICI Atlas	Guillotine	ISE-192C	SINGLE	0.1 Amp	1.0 Amp	1.0 Amp	1.60-2.0	SOLID PINS
Northern	Flare Northern	F-ND209	SINGLE	1.0 Amp	2.5 Amps	5.0 Amps	.98-1.20	FLEXIBLE LEADS
Special Devices	Igniter	SDI-101350	SINGLE	1.0 Amp	4.5 Amps	5.0 Amps	1.0-1.20	FLEXIBLE LEADS
Dupont	Match Squib	S-65	SINGLE	0.2 Amps	0.6 Amps	1.0 Amps	1.12-1.50	FLEXIBLE LEADS
Eagle Picher	Bellows Actuator	1MT170	DUAL	0.04 Amps	0.30 Amps	0.5 Amps	5.00 – 9.00	FLEXIBLE LEADS
Conax	Cable Cutter Assembly	1810-030-01	SINGLE	1.0 Amp	3.5 Amps	3.5 Amps	0.85 – 1.15	FLEXIBLE LEADS

Appendix C: ORDNANCE INSPECTION AND CONNECTION CHECK LIST

1) Achieve RF avoidance when necessary.

2) Make sure all safety equipment is available.

   a. Wrist Stats (1Mohm to 20Mohm)

   b. Static Coat

   c. Safety Glasses

   d. Safety Shoes

   e. System Procedures

3) Two-man rule is in effect when inspecting, checking or handling ordnance.

4) Check the wrist stats for continuity with the electrical wrist stats checker.

5) Test the Alinco igniter circuit tester for current output (5ma max), Valhalla (15ma max).

6) Test the explosive certified voltmeter to ensure it is working properly.

7) Manufacture specification data sheet on the device being checked or appropriate procedure should be available.

8) Measure the lead resistance being used with the igniter circuit tester and record it.

   _____

9) Connect wrist strap to the certified ordnance ground.

10) Remove the pyrotechnic from its protective package.

11) Inspect the pyrotechnic for any damage.

12) Remove the short from the pyrotechnic device and connect the igniter circuit tester following the template below and record the readings.

(Note: Remember to subtract the above-recorded lead resistance)

Guillotine	Quantic	Resistance	Limits	Results Should Be
W1 to W2	A to B			Reading
B1 to B2	C to D			Reading
W1 to B1	A to D			Open
W2 to B2	B to C			Open
W1 to B2	C to A			Open
W2 to B1	D to B			Open
B1 to Case	A to Case			Open
B2 to Case	B to Case			Open
W1 to Case	C to Case			Open
W2 to Case	D to Case			Open

13) Re-install the short to the pyrotechnic device if connection is to be made continue to the next step. If no connection is required return the pyrotechnic device to its original protective material.

(Note:) If a larger number of connector check points are used check the procedure for the number or letter assignments.

Connect Volt Meter	0 Volts All Scales AC/DC	Back Contact Short
A to B		
C to D		
A to D		
B to C		
C to A		
D to B		
A to Case		
B to Case		
C to Case		
D to Case		

14) Connect wrist stat to the certified ordnance ground.

15) The system-shorting plug or safety connector should be installed in the firing system.

16) Complete the No Voltage on the firing system being connected to the pyrotechnic device using the template above.

17) Refer to all schematics that apply for back contact short continuity location.

18) If no voltage was present, remove the short from the pyrotechnic.

19) Make the connection, being careful not to bend pins or cross thread the connection.

Appendix D: CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Original Document Baseline	June 23, 1993	
A	August 25, 1999	Updated References: Added Note: "The WFF Range Safety Manual Referenced Documents Library is located in Building E-107, Room 218, and is maintained by the Code 803 Quality Records Coordinator
B	April 29, 2002	Updated to incorporate comments from first dry run.
C	October 23, 2002	Updated to reflect changes from Range Safety Manual – 2002.
D	June 17, 2003	Updated Flight Safety risk criteria and Danger Time/Caution Time definitions. Other minor modification throughout.

Appendix E: ORDNANCE CASE STUDIES

Ordnance Case Study

Assigned Number: NSROC-OCS-001

Date of Incident: April 18, 2000 Severity: Major

Description of Incident:

During despin and separation deployment testing for new motor bid, an electrical engineered supervised by the fabrication supervisor performed the deployment firings. When the electrical engineer arrived at F-10, the AstroTech personnel already had one ordnance hooked up to the spin table slip rings. The banana jacks at the firing console were shorted by the electrical engineer and it was noticed the AstroTech personnel were not using wrist-straps. They informed the engineer the despin ordnance had been hooked up and wanted to run all four pyros out to the firing console. The NSROC personnel convinced AstroTech to parallel the ordnance at the payload and only use two sets of banana plugs at the firing console. NSROC personnel also tried to convince AstroTech to only hooking up one set of ordnance for the first deployment. AstroTech wanted to hook both sets up to save time. The electrical engineer measured the bridge-wire resistance in the spin deploy room which was cleared of all non-essential personnel. The resistance measurement read 1.04 ohms for four bridge-wires in parallel. AstroTech personnel then hooked up the second system. After hooking up the second system ordnance the electrical engineer again read the bridge-wires. This reading was 1.03 ohms. AstroTech personnel then bolted the payload to the table leaving the safes on the v-band joint. Deployment testing proceeded with spinning the table and connecting AstroTech's battery pack to the firing panel banana jacks and fired the despin system. After stopping the table it was evident that the separation ordnance had fired and not the despin ordnance. At this point NSROC and NASA safety were notified.

Proposed Resolutions:

AstroTech personnel will provide documentation of certification and detailed procedures for arming ordnance devices. Two separate procedures provided for despin and separation ordnance. Procedures must have requirements for wrist-straps, circuit drawings and requirements to short out ordnance not to be fired. These procedures need to be reviewed by NSROC. All ordnance needs to be clearly labeled and identified.

Lessons Learned:

All ordnance handled at Wallops will be clearly marked and identified. Certified ordnance handlers will only handle the ordnance. All hazardous operations will be performed in conjunction with an approved procedure.

Ordnance Case Study

Assigned Number: NSROC-OCS-002

Date of Incident: October 1, 2001 Severity: Major

Description of Incident:

During WFF I&T of the three Larsen missions, 33.069 / 33.070 / 33.073, the schedule called for a pre-vibration sequence test. Concluding successful sequence tests each payload was to be filled with Kerosene (K-1) and then build-up for environmental. During the sequence testing of each of the subject payloads the explosive valves (2 per payload) were inadvertently fired. This resulted in six explosive valves being inadvertently fired (three payloads/two valves per payload). The ordnance involved was
Conax # 1830-308-02
Lot Acceptance Test (LAT) 7

Proposed Resolutions:

Team members involved in the incident were removed immediately and replaced by other personnel. Clear labeling for payloads installed with live ordnance and for shorting plugs used to safe ordnance is required. Procedures were deviated from and not recognized either due to inexperience or lack of training.

Lessons Learned:

More thorough training is required for all certified ordnance handlers. This includes classroom instruction, hands-on training, on-the job training and close supervision during hazardous operations. Any ordnance whether Wallops supplied or supplied from an outside source needs to be clearly labeled or marked with RED stickers or labels. Shorting plugs exist for the protection of individuals involved in a hazardous operation and are there for a reason. These shorting plugs need to be clearly labeled, possibly with a RED flag and only removed when required by a procedure. All hazardous operation procedures need to be followed exactly. Any deviation from such procedures should be addressed in contingency procedures and approved before implemented.

Ordnance Case Study

Assigned Number: NSROC-OCS-003

Date of Incident: January 1, 2002 Severity: Minor

Description of Incident:

While supporting one of the Poker missions, 40.016 (Kletzing), a certified ordnance handler failed to follow procedures related to safe handling of ordnance. A connection was made between live ordnance and a capacitive discharge system without performing the required no voltage checks as mandated by ordnance handling procedures.

Proposed Resolutions:

The ordnance handler involved in this incident was put on ordnance probation and is required to have supervision when handling ordnance or involved in a hazardous operation. All further ordnance incidents will be documented in the form of a case study as represented by this one. When deviations from approved ordnance handling and hazardous operations procedures are required, contingency procedures must be developed, approved and adhered to in all circumstances.

Lessons Learned:

All ordnance handlers should adhere to the procedures no matter what the circumstance. If there exist a need to deviate from an approved, written procedure, contingency procedures should exist. When performing any hazardous operation, the two man rule should be applied, the OSS, Operational Safety Supervisor, should take a more active role in hazardous operations and for all operations an ordnance briefing will be held prior to any operation. The ordnance briefing will consist of all essential personnel.

RANGE SAFETY MANUAL (RSM-2002)

FOR

GODDARD SPACE FLIGHT CENTER (GSFC)/ WALLOPS FLIGHT FACILITY (WFF)

WFF Safety Office/Code 803
June 28, 2002

National Aeronautics and
Space Administration

Goddard Space Flight Center
Wallops Flight Facility

FOREWORD

Safety is the responsibility of all National Aeronautic and Space Administration (NASA) personnel, NASA contractors, tenants, experimenters, and range users while conducting operations at NASA Goddard Space Flight Center's Wallops Flight Facility (GSFC's WFF) or other off-range locations. This requires a concerted effort by all personnel to operate in a manner that will minimize the risks inherent in performing rocket, aircraft, balloon, and associated operations. This document identifies the range safety requirements established by GSFC's WFF for implementing NPG 8715.3, NASA Safety Manual, to insure that risk are controlled and minimized.

Safety participation early in the planning stages of a program will reduce the possibility of costly engineering changes and/or scheduling delays. Therefore, coordination with the GSFC's WFF Safety Office should be established through the Range Support Manager as early in the planning stages of a program as possible. The GSFC's WFF Safety Office personnel should be notified of and be represented at technical interchange meetings, preliminary design, system design and critical design reviews, and flight readiness reviews, where ground and flight safety issues are addressed.

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1.0 INTRODUCTION

1.1 Purpose

1.1.1 Identify GSFC's WFF range requirements to implement safety policies and criteria defined in NPG 8715.3, NASA Safety Manual.

1.1.2 Define specific design requirements, restrictions, operational procedures, and support requirements.

1.1.3 Identify data requirements necessary for GSFC's WFF to perform appropriate safety analyses and grant approval to conduct operations.

1.1.4 Acquaint range users with the range safety organization at GSFC's WFF.

1.2 Scope

1.2.1 Applicability

1.2.1.1 This document is applicable to all Programmatic Operations and specific aircraft operations conducted at or managed by GSFC's WFF. It is applicable to all NASA personnel, NASA contractors, tenants, experimenters, and range users. It is the responsibility of all personnel to acquaint themselves with the requirements set forth in this document, NPG 8715.3 and GMI 1300.2.

1.2.1.2 For aircraft operations, this document is applicable for hazardous systems incorporated within or attached to aircraft platforms, operations conducted on the GSFC's WFF test range, and operations which expose the public to risk greater than that incurred by normal aircraft operations. Aircraft operational requirements for the WFF airfield are defined in 830-PG-7900.1.

1.2.2 For GSFC's WFF managed operations conducted at other ranges, the requirements established by this document shall be used as a minimum unless requirements of the host range are more stringent, in which case the more stringent requirements will apply.

1.2.3 More stringent safety requirements will be considered by GSFC's WFF if requested by the range users, experimenters, or tenants.

1.3 Policy

It is GSFC's WFF policy to conduct all operations within the risk levels specified by Section 6, Flight Safety, of this document. This manual defines the specific requirements, which shall be met to implement this policy.

2.0 RANGE SAFETY ORGANIZATION AND RESPONSIBILITIES

Range Safety responsibilities are defined in GPG-8715.X.X and GMI 1300.2, and are summarized in this document for clarity.

2.1 Director of GSFC - Final authority and accountability for all aspects of safety at GSFC/WFF rest with the Director of GSFC. In order to ensure that appropriate attention is focused on WFF range safety, certain responsibilities are delegated to the Code 800 Suborbital and Special Orbital Projects Directorate (SSOPD). The Director of GSFC makes risk management decisions for test range operations when the assessed risk

exceeds the guideline discretionary levels set forth in Section 6.2, Risk Criteria, for the Director of SSOPD.

2.2 Director SSOPD - Responsibilities involving range safety have specifically been delegated to the Director of Suborbital and Special Orbital Projects (Code 800). Code 800 has designated the Range Safety Officer (RSO) and established the Safety Office (Code 803) to promote range safety. The Director of SSOPD makes risk management decisions for test range operations when the assessed risk exceeds negligible guideline levels in accordance with discretionary guidelines set forth in Section 6.2, Risk Criteria. The Director of SSOPD approves variances from range safety requirements specified in this manual in accordance with the procedure set forth in 803-PG-8072.1.12.

2.3 Chief, Safety Office - Management responsibility for the implementation of the Range Safety Program rests with the Chief of the Safety Office. The Safety Office Chief supervises the Range Safety Officer and personnel in the Ground Safety Group (GSG) and the Flight Safety Group (FSG) who perform risk analyses, document risk mitigation strategies in Safety Plans, and supervise or implement operational risk mitigation measures.

2.4 Range Safety Officer (RSO) - The RSO provides range safety policy guidance and direction and operational oversight during test range missions. The RSO is vested with the engineering authority to certify the design, test, maintenance and use of all elements of the Range Safety System. The RSO acts as the approval authority for Ground and Flight Safety Risk Analyses and Safety Plans. The Range Safety Officer is given the authority to grant operational variances from requirements set forth in Ground and Flight Safety Plans where the requirements of this manual are met. The RSO or designee implements the measures specified in Ground and Flight Safety Plans during test range operations.

2.5 Program and Project Managers - Program and Project Manager safety responsibilities are detailed in NPD 8700.1, NASA Policy for Safety and Mission Success. Additionally, for missions that pose risks above negligible threshold levels, the Program or Project Manager is responsible for preparing and presenting an assessment of circumstances and mission benefits that warrant acceptance of the risks to the appropriate level of GSFC management.

2.6 The GSFC's WFF Operations Safety Supervisor (OSS) is responsible for supervising all potentially hazardous operations for which he/she has been assigned. The OSS is also responsible for implementation of Ground Safety Plans and operating procedures. In some instances the OSS may delegate his responsibilities to other qualified personnel for specific operations.

2.7 The responsibility of implementing GSFC's WFF safety policy, criteria, and planning at ranges other than GSFC's WFF shall be delegated according to the following hierarchy:

a. The GSFC's WFF RSO*

b. The GSFC's WFF Campaign Manager

c. The GSFC's WFF Payload Manager

* Poker Flat Research Range (PFRR) Range Safety Officer or designee at PFRR; National Scientific Balloon Facility (NSBF) Head of Balloon Operations or designee for NSBF.

2.8 For the Balloon Program, the Chief, Balloon Program Office shall assure that (1) the requirements and procedures defined in appropriate safety plans and balloon risk analysis are implemented, and (2) the operational responsibilities normally assigned to the RSO, OSS, or Project or Campaign Manager in this document are implemented for balloon operations.

3.0 RANGE USERS PRE-ARRIVAL REQUIREMENTS

3.1 Range users shall design their systems to conform to the requirements established by this document.

3.2 For operations other than balloons, range users shall prepare and provide to GSFC's WFF formal documentation pertaining to the project for safety review. This documentation shall include information describing ground and flight systems, operating procedures, and unique requirements of the project. Specific details of the data required are provided in Section 8.0, GSFC/WFF Safety Data Requirements.

3.3 For balloon operations, range users shall provide data necessary for NSBF to assure the program meets the Safety Analysis Report (SAR) requirements.

3.4 Prior to arrival at GSFC's WFF, range users shall submit written requests for waivers to the GSFC's WFF Range Support Manager or to the Chief, Balloon Program Office (as appropriate) for any requirements of this document which cannot be satisfied.

4.0 DEFINITIONS AND REFERENCES

4.1 Definitions

Active-Essential Personnel -- Those individuals whose activities contribute directly to the performance of a potentially hazardous operation which is actually under way, and whose presence is mandatory for completion of the operation.

Actual Burst Pressure -- The pressure at which pressure system components undergoing pressurize-to-burst testing rupture.

Burst Factor -- This quantity is equal to the Maximum Allowable Working Pressure (MAWP) divided by the design burst pressure.

Casualty Expectation -- The probabilistic number of casualties due to conduct of a mission.

Category "A" Systems -- Those systems which meet all the following; (1) initiation of the system could lead to a chain of events which result in injury or death to personnel or damage to property; (2) sufficient potential energy exists to initiate the device; and (3) the energy output of the system is not controlled by approved mechanical restraints or other safety devices.

Category "A/B" Systems -- Those systems which change from Category "B" to Category "A" during the various stages of processing. The change in hazard category is accomplished by utilizing approved out-of-line SAFE/ARM devices, mechanical restraining devices, employing the man-rated design requirements or by other approved means which reduce the effects of an inadvertent actuation to a nonhazardous condition or reduces the probability of occurrence to acceptable levels.

Category "B" Systems -- Those systems which (1) are highly improbable of being initiated, or (2) shall not cause injury to personnel or damage to property by either the expenditure of their own energy or the chain of events they initiate.

Caution Time -- That time period when any hazardous device or system is present in the hazard area and is in a safe inactive state. When a caution time exists, nonparticipating personnel are allowed to enter the

launch area only when authorized by the OSS. Active-essential and standby-essential personnel continue working during a caution time.

Danger Area -- That area including impact areas, abort areas, storage areas, or Danger Areas resulting from a system malfunction in which the hazards from impacting objects, debris, or toxic materials exceed the established maximum acceptable risk level.

Danger Time -- That time period when any electrical operations, arming, explosive installation, launching, or other hazardous function is taking place.

Design Burst Pressure -- The pressure is a calculated test pressure that pressurized components shall withstand without rupture to demonstrate its design adequacy in a qualification test.

Electroexplosive Device (EED) -- An electric initiator or other component in which electrical energy is used to cause initiation of explosives contained therein.

Emergency System/Component -- An emergency system component is any system/component which prevents a hazardous event from occurring or escalating. These systems normally experience very few cycles, but their performance is extremely safety critical. Typical emergency components are relief valves and shut-off valves. Typical emergency systems are fire suppression systems and emergency purge/vent systems.

Flight Hardware -- includes all propellant tanks, pressure vessels, lines and components that constitute airborne equipment on a launch vehicle or payload.

Flight Hazard Area -- The operational area within which the risk due to impacting object(s) may exceed the established risk criteria.

Flight Safety -- A philosophy and methodology whereby rocket, balloon, drone, and aircraft flight operations can be performed in a reasonable and prudent manner without undue risk to people or property or embarrassment to NASA or the United States Government.

Ground Safety -- Those safety considerations, procedures, and resultant restrictions associated with hazardous systems during storage, handling, prelaunch, launch, and recovery/abort operations, where by operations can be performed in a reasonable and prudent manner without undue risk to people or property or the environment.

Hangfire -- A launch attempt where current to the vehicle initiator was delivered by the firing system and the vehicle failed to ignite as planned.

Impact Area -- The operational area within which one or more objects are predicted to impact in the vicinity of each other.

Inherently Safe -- The predicted trajectory of the vehicle is based solely on the launch and dispersion parameters and on known system errors.

Instantaneous Impact Point (IIP) -- The point at which an object would impact if thrusting were stopped at a given time.

Launch Abort -- Premature and abrupt termination of a launch attempt because of existing or imminent degradation of mission success probability or safety requirements.

Launch Area -- The area comprising rocket launching pads, a blockhouse, and auxiliary support facilities. For airborne launches, it is the defined operational hazard area which has been obtained from controlling authorities.

Launch Vehicle -- Any rocket, rocket system, or balloon that is used to launch a suborbital or orbital payload, probe, satellite, or other experiment.

Leak-Before-Burst (LBB) -- A fracture mechanics design concept in which it is shown that any initial flaw shall grow through the wall of the pressure vessel rather than bursting and causing catastrophic failure.

Maximum Allowable Working Pressure (MAWP) --The maximum operating pressure, to which operational personnel may be exposed, for a pressure system (vessel, tubing, piping, flex hose or component). This pressure is synonymous with Maximum Expected Operating Pressure (MEOP), as it is used and defined in AIAA/ANSI S-080 or AIAA/ANSI S-081.

Maximum Design Operating Pressure (MDOP) -- The system pressure rating based on structural and functional reliability. This is the pressure at which relief devices are set and is equal to 110% Maximum Operating Pressure (MOP).

Maximum Expected Operating Pressure (MEOP) -- This term, as defined in AIAA/ANSI S-080 or AIAA/ANSI S-081, is synonymous with MAWP. (See the definition for MAWP, as given above.)

Maximum Operating Pressure (MOP) -- The maximum pressure a system shall be subjected to during static and dynamic conditions. Usually this pressure is less than or equal to MAWP. This pressure may exceed MAWP as long as pressurization(s) are performed remotely. However, under no conditions shall MOP exceed proof pressure.

Megger Test -- A measurement performed on EED's using a megohmmeter to determine the pin-to-case insulation resistance. The test is performed at a known voltage (normally 500 volts) to verify that the insulation shall not break down and permit EED ignition in this mode.

Misfire -- A launch attempt in which current was not delivered to the vehicle initiator.

NOTAMS -- An advisory issued to airmen listing restricted or hazardous airspace during certain times.

NOTMARS -- An advisory issued to mariners listing restricted or hazardous areas during certain times.

Participating Personnel -- Those individuals who are participating in the operation.

Power Switching -- Power transfers where the net energy change exceeds 1.5 volts or 10 milliamperes.

Proof Pressure -- The test pressure applied to pressure systems or individual components without failure, leakage, or permanent deformation.

Public -- All people that are not participants in the operation.

Range Safety -- The ground and flight safety control associated with all phases of rocket, balloon, and aircraft operations.

System Initiator - Any device that initiates the action of a system. This includes but is not limited to electroexplosive devices, non-explosive initiators, and exploding bridgewire initiators.

TNT Equivalency - The explosive energy per unit mass of the energetic material in question (propellants in our case) divided by the energy per unit mass of Trinitro-toluene (TNT); this number can be expressed as a percentage or a fraction.

4.2 References:

(a) GMI 1300.2, Policies and Procedures for the Use of GSFC/WFF Test Range, dtd. April 12, 1989

(b) 830-PG-7900.0.1, Aircraft Operations Manual (AOM)

(c) NSS 1740.12, Safety Standard for Explosives, Propellants, and Pyrotechnics

(d) AFMAN 91-201, Explosives Safety Standard

(e) NSS/GO-1740.9, Safety Standard for Lifting Devices and Equipment (NASA-STD-8719.9)

(f) GMI 1710.6, Certification and Recertification of Lifting Devices and Equipment and Critical Lift Requirements

(g) IEEE C95.1-1991, American National Standard Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 30 KHz to 100 GHz

(h) GHB 1860.2, Radiation Safety Handbook

(i) GHB 1860.1, Radiation Protection – Ionizing Radiation

(j) ANSI Z136.1-1993, American National Standard for the Safe Use of Lasers

(k) GHB 1860.3, Radiation Safety -- Laser

(l) 1999 National Electric Code, Article 500 - Hazardous Locations

(m) NPD 8710.5, NASA Safety Policy for Pressure Vessels and Pressurized Systems

(n) NPG 1700.6, Guide for Inservice Inspection of Ground Based Pressure Vessels and Systems

(o) MIL-STD-1522, Standard General Requirements for Safe Design and Operation of Pressurized Missile & Space Systems

(p) Range Commanders Council Document (RCCD) "Flight Termination Systems Commonality Standard " Standard 319-99

(q) CFR 14, Federal Aviation Administration, Part 101, Moored Balloons, Kites, Unmanned Rockets, and Unmanned Free Balloons

(r) FACSFAC VACAPES Operating Instruction, 31201H

(s) MIL-HDBK-217F, Reliability Prediction of Electronic Equipment, dtd February 1995 (Change 2)

(t) Eastern and Western Range 127-1, Range Safety Requirements, dtd. October 1997

(u) WFF-822-95-001, Geodetic Coordinates manual, NASA GSFC WFF dtd, January 1995

(v) DoD 6055.9-STD, DoD Ammunition and Explosives Safety Standards

(w) ANSI/AIAA S-080-1998, Space Systems – Metallic Pressure Vessels, Pressurized Structures, and Pressure Components

(x) ANSI/AIAA S-081-2000, Space Systems – Composite Overwrapped Pressure Vessels (COPVs)

(y) NPD 8700.1, NASA Policy for Safety and Mission Success

(z) CFR Title 10, Parts 19 and 20

5.0 GROUND SAFETY

5.1 General

5.1.1 The ground safety goal of GSFC's WFF is to minimize the risks to personnel and property involved in conducting operations at GSFC's WFF and to prevent mishaps that would result in embarrassment to NASA or the United States Government.

5.1.2 It is required that all systems be designed such that a minimum of two independent, unlikely failures shall occur in order to expose personnel to a hazard.

5.2 Hazard Control

5.2.1 Hazard Control Methods

The methods employed by GSFC's WFF to protect personnel and property and to minimize the risk in conducting potentially hazardous operations are:

* Identify all the known hazards associated with the program.
* Implement safety design criteria.
* Minimize exposure of personnel to hazardous systems.
* Establish safe operating procedures
* Plan for contingencies.

5.2.2 Exposure Limits

The cardinal principle to be observed in any location or operation involving explosives, severe fire hazards, high pressure systems, or other hazardous materials, shall be to limit the exposure to a minimum number of personnel, to a minimum time, and to a minimum number of potential hazards, consistent with safe and efficient operations. Operations shall be arranged such that, should an incident occur, it will cause the least possible injury to personnel and damage to facilities or surrounding property. Operations shall be conducted in a manner such that the distance a person is from a hazardous system increases as the possibility of actuating the system increases.

5.2.3 Personnel Limits

5.2.3.1 Only active essential personnel (no less than 2 and no more than 12) shall be permitted on launch pads, in explosives handling areas, or other hazardous areas. This limit includes supervisors, range users, and others determined necessary by the OSS. The Chief, Safety Office may grant exceptions following review of formal requests.

5.2.3.2 The OSS (or other NASA official in charge of the operation) shall assure that the number of personnel performing potentially hazardous tasks are kept to a minimum.

5.2.3.3 For off-range operations, WFF employees (NASA and/or contractor) shall abide by the requirements of the launch range conducting the operation(s) if that range has requirements or limits more stringent than WFF.

5.2.3.4 The GSFC's WFF OSS shall determine the number of personnel necessary to perform each task.

5.2.3.5 Requirements regarding official visitors or guests, tours, etc. are as follows:

5.2.3.5.1 Early notification of an impending visit or tour shall be given to the OSS responsible for the operations prior to the individual or group arrival. Potentially hazardous operations or tasks shall be brought to a safe stopping place (Category "B" state) and all work on hazardous systems will cease while the tour is in progress.

5.2.3.5.2 If the hazardous system cannot be placed in a Category "B" status (e.g., pad arming has already occurred), and it has been determined by the Chief, Range and Mission Management Office (or his designee) that the visit is necessary, the OSS and the RSO shall determine the most convenient time and duration for the visit.

5.2.3.5.3 For operations at other ranges (mobile or permanent), the GSFC's WFF lead manager (Campaign Manager, Program Manager, or Project Manager), in conjunction with the local safety official(s) shall determine the necessity of the visit or tour and will determine the most convenient time, consistent with safety policies/requirements for the visit to occur

5.2.3.5.4 Tour groups will be accompanied by a person of authority such as the OSS and will consist of no more than twelve (12) people. The twelve (12) people will include the Tour Guide (Supervisor, Campaign Manager, Payload Manager, Project Manager, or their designee). If the group is larger than twelve (12), it will be split into as many smaller groups as are necessary to maintain the limit.

5.2.3.5.5 Members of the tour group shall not be permitted to touch or handle any ordnance or other hazardous hardware.

5.2.3.5.6 All area-specific safety requirements shall be enforced (i.e., safety glasses, hard hats, grounding, clothing, etc.). The person of authority shall determine the necessity of wearing static dissipative garments when in the vicinity of explosives or other static sensitive materials.

5.2.4 Ground Safety Plan

5.2.4.1 A Ground Safety Plan will be prepared by the Ground Safety Group (GSG) prior to any potentially hazardous operation or launch conducted at GSFC's WFF. This plan will identify the potential hazards and describe the system designs and methods employed to control the hazards. This plan shall also establish controls to protect high value property, as required.

5.2.4.2 For launch or other potentially hazardous ground operations conducted at other ranges, this information shall be provided in a Ground Safety Plan or Ground Safety Data Package.

5.2.4.3 Where applicable, a general Ground Safety Plan may be prepared for repetitive operations/ programs which shall identify safety planning for all potential hazards. This plan may be augmented for mission operations by a mission specific Ground Safety Plan.

5.2.5 Hazard Categories

Hazard categories are established to differentiate between hazardous and non-hazardous systems. Each system is analyzed and categorized as either Category "A," Category "B," or Category "A/B." All hazardous systems shall be considered Category "A" until Category "B" conditions have been determined and approved.

5.2.5.1 Category "A" systems are those systems which meet all the following: (1) initiation of the system could lead to a chain of events which result in injury or death to personnel or damage to property; (2) sufficient potential energy exists to initiate the device; and (3) the energy output of the system is not controlled by approved mechanical restraints or other safety devices.

5.2.5.2 Category "B" systems are those systems which (1) are highly improbable of being initiated, or (2) shall not cause injury to personnel or damage to property by either the expenditure of their own energy or the chain of events they initiate.

5.2.5.3 Category "A/B" systems are those systems which change from Category "B" to Category "A" during the various stages of processing. The change in hazard category is accomplished by utilizing approved out-of-line SAFE/ARM devices, mechanical restraining devices, employing the man-rated design requirements defined in 5.3.4.4.5, Man-Rated Circuit Design Requirements, or 5.3.11, Man-Rated Liquid Propulsion Systems, or by other approved means which reduce the effects of an inadvertent actuation to a nonhazardous condition or reduces the probability of occurrence to acceptable levels. The Category "A" or Category "B" requirements shall apply as appropriate.

5.2.5.4 The classification of each system, the devices or means of reducing the classification level, the danger area, restrictions, and list of responsible persons shall be identified in the Ground Safety Plan or Ground Safety Data Package for each program.

5.2.6 Multiple Operations

Multiple unrelated operations shall not be conducted simultaneously within a single operational danger area unless the operations are reviewed and specifically approved by the WFF RSO or his designee. When such approval is granted, the operations shall not exceed personnel limits established in 5.2.3, Personal Limits.

5.3 Specific Policies and Criteria

5.3.1 Hazard Categorization

5.3.1.1 All hazardous systems, including electrical, chemical, pressure etc., shall be categorized into either hazard category "A", "B", or "A/B. "

5.3.1.2 Hazardous systems shall be assumed Category "A" until conditions have been met which shall permit a change to Category "B." Category "A" systems can be categorized Category "A/B" when any of the following conditions exist:

5.3.1.2.1 Approved restraining devices are employed to reduce the effects of an inadvertent actuation to a nonhazardous condition.

5.3.1.2.2 The hazardous system is installed but not connected to its controlling electrical circuit. Hazardous ordnance systems shall also have their Electroexplosive Devices (EED's) shorted, grounded, and shielded.

5.3.1.2.3 Ordnance systems employ an approved mechanical or electromechanical SAFE/ARM device, which provides an out-of-line feature in the SAFE position.

5.3.1.2.4 Systems employ the man-rated circuit design requirements established in 5.3.4.4.5, Man-Rated Circuit Design Requirements.

5.3.1.2.5 For hazardous chemical systems, the system is closed, contains two independent verifiable safeties in the flow path, and leak integrity is verified.

5.3.1.2.6 For pressure systems, the pressure is steady-state and less than or equal to the Maximum Allowable Working Pressure (MAWP). The MAWP is defined as the maximum pressure to which personnel may be exposed, and is synonymous with Maximum Expected Operating Pressure (MEOP) as defined in Reference o.

5.3.1.3 For Category "A/B" systems, the change from Category "B" to a Category "A" shall be performed as late as possible in the processing sequence.

5.3.2 Danger Areas

For all hazardous systems, a danger area shall be defined which will adequately contain the hazard and protect personnel should an inadvertent actuation occur. Restrictions shall

be established to prohibit access into the danger area when the possibility of initiating the hazardous system exists.

5.3.2.1 Prelaunch and Launch Danger Areas shall be defined in the Ground Safety Plan/Data Package for each mission.

5.3.2.2 Mission-specific danger areas for chemical, pressure, radiation, or other hazardous subsystems shall be defined on a case-by-case basis and shall be identified in the Ground Safety Plan/Data Package for that mission.

5.3.2.3.1 Flight control danger areas and their implementation shall be defined in the Ground Safety Plan/Ground Safety Data Package when applicable.

5.3.3 Operations/Design Considerations

5.3.3.1 This document allows range users to utilize various acceptable design techniques defined in 5.3.4, Hazardous Circuit Design Requirements. Prelaunch operational requirements should be a factor in selecting a specific design because operations that require personnel to be located inside danger areas during power switching, power on, and RF transmissions can only be performed if:

(1) The system is in a Category "B" condition, or
(2) The man-rated design defined by 5.3.4.4.5, Man-Rated Circuit Design, is employed.

5.3.3.2 Category "A" systems may be converted to a Category "B" state by implementing any of the requirements cited in paragraph 5.2.5.3.

5.3.3.3 All Category "A" danger areas shall be cleared of personnel for operations that require power switching, power ON, or RF transmissions, except as identified in 5.3.3.8.

5.3.3.4 Personnel may be allowed in the danger area of a Category "A" system whenever there are no power switching, power ON, or RF transmissions occurring and two independent inhibits are verified in place.

5.3.3.5 No personnel shall be allowed within the danger area of a Category "A" system if the system has been reduced to only one inhibit.

5.3.3.6 Prior to switching Ground Support Equipment (i.e., vacuum systems, heaters, etc.) ON for the first time, the applicable danger area will be cleared of all personnel regardless of the system status.

5.3.3.7 Prior to making an electrical change on a non-hazardous (Category "B") system, all personnel in the vicinity shall be notified of the impending event.

5.3.3.8 Personnel may be allowed in danger areas to perform work external to the vehicle when power is supplied to a Category "A" system and no power switching is occurring. This operation shall be specifically approved by the WFF RSO or his designee and can only occur after power has been cycled several times and has remained ON in a steady state condition for a reasonable amount of time.

5.3.4 Hazardous Circuit Design Requirements

5.3.4.1 All circuits that initiate ordnance devices or initiate other hazardous systems shall be approved by the GSG prior to granting approval for use at GSFC's WFF.

5.3.4.2 Category "B" System Requirements

Category "B" systems shall contain a minimum of two independent safety devices which prevent an inadvertent actuation.

5.3.4.3 Category "A/B" system requirements

5.3.4.3.1 The electrical circuit shall contain a minimum of two independent open contacts between the power source and the system initiator.

5.3.4.3.2 The system shall be designed such that the conversion from Category "B" to Category "A" shall minimize personnel exposure to the hazard. The final conversion to Category "A" shall occur during arming operations.

5.3.4.3.3 Mechanical restraint designs shall be approved by the Chief, Safety Office or his designee.

5.3.4.4 Category "A" System Requirements

5.3.4.4.1 All circuits initiating Category "A" devices or systems shall satisfy the circuit design criteria identified below.

5.3.4.4.1.1 All EED's shall meet a 1 amp/1 watt NO FIRE requirement and be 100% qualified with a 500 VDC megohmmeter test for 5 seconds from bridgewire to case (and bridgewire to bridgewire if dual bridgewires are used) unless the Chief, Safety Office or his designee, grants an exemption.

5.3.4.4.1.2 Electrical wiring and power source shall be completely independent and isolated from all other systems; they shall not share common cables, terminals, power sources, tie points, or connectors with any other system.

5.3.4.4.1.3 All circuit wiring shall be twisted and shielded and independent of all other systems. When not physically possible to maintain the shield throughout the entire electrical circuit, as a minimum the wiring shall be twisted and shielded from the system initiator to the point of the first short circuit condition. This requirement is applicable both before and after installation of SAFE/ARM type connectors. The use of single wire firing lines, with the shield as the return, is prohibited.

5.3.4.4.1.4 Shielding shall provide a minimum of 20 dB safety margin below the minimum rated function current of the system initiator (max NO-FIRE current for EED's) and provide a minimum of 85% optical coverage. (A solid shield rather than a mesh would provide 100% optical coverage.)

5.3.4.4.1.5 Shielding shall be continuous and terminated to the shell of connectors and/or components. The shield shall be electrically joined to the shell of the connector/component around the full 360 degrees of the shield. The shell of connectors/components shall provide attenuation at least equal to that of the shield.

5.3.4.4.1.6 The electrical circuit to which the system EED is connected shall be isolated from vehicle ground by no less than 10K ohms.

5.3.4.4.1.7 All circuits shall be designed with a minimum of two independent safety devices. Any time personnel are exposed to a hazardous system; a minimum of two independent safety devices is required to be in place.

5.3.4.4.1.8 The system EED shall be provided with an electrical short until its programmed actuation unless the Chief, Safety Office, grants an exemption. This requirement does not negate the use of solid state switches.

5.3.4.4.1.9 Any electrical relay or switch, which is electrically adjacent to the system initiator (either in the power or return leg of the electrical circuit), shall not have voltage applied to the

switching coil (or the enable/disable circuit for solid state relays/switches) until the programmed initiation event.

5.3.4.4.2 Charged ("Hot") batteries may be installed into Category "A" circuits only if at least one of the following design approaches is utilized. Otherwise, the battery shall be charged at the latest feasible point in the countdown process with no personnel in the defined danger area.

5.3.4.4.2.1 The system is designed with a mechanical or electromechanical SAFE/ARM device, which shall adequately contain the output of the system or its initiator when in the SAFE position.

5.3.4.4.2.2 The system is designed to meet Capacitive Discharge Ignition (CDI) circuit criteria as defined in 5.3.4.4.4, CDI Circuit Design Requirements.

5.3.4.4.2.3 The system is designed to meet man-rated circuit requirements as defined in 5.3.4.4.5, Man-Rated Circuit Design Requirements.

5.3.4.4.2.4 The system is designed to meet Exploding Bridgewire (EBW) circuit requirements as defined in 5.3.4.4.6, Exploding Bridgewire Circuit Design Requirements.

5.3.4.4.3 Category "A" circuits shall be designed such that the following operations can be accomplished:

5.3.4.4.3.1 Mechanical installation and electrical connection of the system initiators can be performed at the latest possible time in the assembly process, consistent with other assembly operations.

5.3.4.4.3.2 Prior to connecting an EED to its electrical circuit, it shall be shorted, shielded, and grounded. Connect EED's to chassis ground and the chassis to a single-point earth ground.

5.3.4.4.3.3 Prior to connecting system initiators to their electrical circuit, voltage checks shall be made between each leg of the circuit and from each leg to ground to ensure no voltage is present.

5.3.4.4.4 <u>CDI Circuit Design Requirements</u>

CDI circuit shall meet the requirements in paragraph in 5.3.4.4 through 5.3.4.4.3.3 and the following additional requirements.

5.3.4.4.4.1 The charging battery shall be current limited such that it shall not exceed 10% of the minimum rated function current of the system initiator (max NO-FIRE current for EED's).

5.3.4.4.4.2 The firing capacitor shall be provided with an electrical short (when the circuit is in the SAFE condition) and a means of remotely monitoring capacitor voltage. Whenever personnel are exposed to the system, the firing capacitor shall be shorted.

5.3.4.4.4.3 There shall be a minimum of two independent open switches between the power source and the system initiator.

5.3.4.4.5 <u>Man-Rated Circuit Design Requirements</u>

Man-rated circuit shall meet the requirements in paragraph in 5.3.4.4 through 5.3.4.4.3.3 and the following additional requirements.

5.3.4.4.5.1 The system initiator shall be both physically and electrically isolated from the power source by a minimum of three independent safety devices. This requirement is applicable

both before and after installation of SAFE/ARM type connectors. Electromechanical out-of-line SAFE/ARM devices that can be both Armed and Disarmed remotely shall be counted as two safety devices.

5.3.4.4.5.2 The system initiator shall be electrically isolated by switches in both the power and return legs. The wiring between the initiator and the switch in both the power and return legs shall have the following additional features:

5.3.4.4.5.2.1 The wiring shall be in a separate cable, which is twisted, shielded, double insulated, and independent of all other systems. Shielded wiring shall meet the requirements of 5.3.4.4.1.4 and 5.3.4.4.1.5.

5.3.4.4.5.2.2 Protection by use of physical barriers or by physical location of components shall be employed such that short circuits to other power systems are impossible, even assuming loose or broken wires.

5.3.4.4.5.3 A Failure Mode and Effects Analysis (FMEA) shall be performed to ensure a minimum of three independent failures are required for a premature actuation to occur. The detail level of the FMEA shall be established by the WFF RSO and shall be based on factors such as type of system, system design, and level of hazard.

5.3.4.4.5.4 A Quality Assurance Program shall verify compliance with all requirements and certify the "as built" configuration.

5.3.4.4.6 Exploding Bridgewire (EBW) Circuit Design Requirements

5.3.4.4.6.1 A means of continuously monitoring the firing capacitor voltage shall be provided.

5.3.4.4.6.2 Two separate electrical paths to discharge the firing capacitor shall be provided. This can be provided either through the EBW circuit or through the Ground Support Equipment.

5.3.4.4.6.3 A positive means of interrupting the capacitor charging circuit shall be provided.

5.3.4.4.6.4 A positive means of interrupting the EBW triggering circuit shall be provided.

5.3.4.4.6.5 A time delay of several seconds between application of the arming signal and application of the trigger signal for the EBW to fire shall be provided.

5.3.5 Ground Support Equipment (GSE)

5.3.5.1 The design of GSE used to make measurements on or provide control of hazardous devices, systems, or circuits shall be approved by the Chief, Safety Office or his designee.

5.3.5.2 All electrical meters or test equipment used to make measurements of hazardous systems shall be current limited to the manufacturer's recommendation for that device. This value shall not exceed 50 mA.

5.3.5.3 All GSE used in, or to obtain measurements of, hazardous systems (electrical meters, pressure gages, slings, scales, etc.) shall be calibrated/certified and may not be used beyond the certification period. Certifications shall be performed at GSFC's WFF unless approval for certifications performed at other sites/facilities is obtained from the Chief, Safety Office.

5.3.5.4 All meters that are used to measure resistance of ordnance devices are required to be tested for proper operation immediately prior to starting the procedure.

5.3.5.5 All lifting devices, fixtures, and equipment shall conform to the standards and regulations of NSS/GO-1740.9 and GMI 1710.6.

5.3.5.6 Electrically operated GSE (vacuum systems, heaters, pumps, etc.) used on Category "A" systems shall meet the following design criteria and restrictions.

5.3.5.6.1 All GSE shall be designed such that the system can be remotely switched ON/OFF.

5.3.5.6.2 No personnel shall be permitted to be within Danger Areas defined in safety plans while power is being supplied to its GSE.

5.3.5.6.3 GSE shall be switched OFF prior to system arming operations. After arming operations are complete, the GSE may be switched ON provided items 5.3.5.6.1 and 5.3.5.6.2 above are satisfied.

5.3.5.6.4 The design of GSE should consider the impact of the above restrictions on operations. Flyaway connectors should be used to permit system operation late in the countdown process. For vacuum systems, a remotely operated valve is recommended to maintain vacuum integrity when power is switched OFF.

5.3.6 Electrostatic Discharge (ESD) Hazards

5.3.6.1 Precautions shall be taken to eliminate or reduce the risk of electrostatic discharge during potentially hazardous operations. The method used to eliminate or reduce static electricity is to provide an electrically continuous path to ground. All conductive objects (including personnel) shall be electrically connected to a common ground.

5.3.6.2 Grounding straps shall be used to bridge locations where electrical continuity may be broken by grease, paint, or rust. Equipment in contact with conductive floors or tabletops is not considered adequately grounded.

5.3.6.3 Wire used as a static ground conductor shall be large enough to withstand mechanical damage and shall not be less than American Wire Gauge (AWG) No. 8 or a braided cable of equal conductivity.

5.3.6.4 Connection of static ground conductor shall be made to certified grounding points. Grounding point certification shall be performed semiannually.

5.3.6.5 When performing potentially hazardous operations on electrostatic sensitive systems, personnel shall comply with the following:

5.3.6.5.1 Wrist straps shall be worn and connected to a certified ground when handling EED's or when working on exposed rocket motor grain.

5.3.6.5.2 Outer garments (e.g. lab coats or overalls) that dissipate static charges shall be worn. Under special circumstances, the WFF RSO, or his designee may waive the use of static dissipative outer garments.

5.3.6.5.3 Personnel are required to touch the ground system upon entering an ordnance work area. This grounding requirement applies even when wearing protective clothing.

5.3.6.5.4 Ionization - Ionizers may be used for static neutralization in ordnance work areas, only with specific approval from the Chief, Safety Office. Use of these instruments shall be allowed only when other means of static neutralization are not effective and may never be used directly on ordnance items.

5.3.7 Electrical Storm Criteria

5.3.7.1 When an electrical storm is detected within 15 nautical miles or the potential for an electrical storm is forecast within 10 nautical miles of potentially hazardous work areas, a warning shall be issued to bring operations to an appropriate stopping point.

5.3.7.2 When the storm is detected within 10 nautical miles or the potential for an electrical storm is forecast within 5 nautical miles of potentially hazardous work areas, the area shall be evacuated regardless of the status of the operations.

5.3.7.3 If a warning system is not available to determine the approach of an electrical storm, the potentially hazardous work area shall be cleared upon hearing thunder or observing weather conditions, which have the potential of producing electrical storms.

5.3.8 Radiation Systems

Radiation shall be adequately controlled during all operational phases to assure the protection of personnel, facilities and equipment and compliance with applicable federal, state, and NASA regulations. Such sources include radio-frequency/microwave emitters, radioactive materials, X-ray devices, lasers, and optical emitters. Radiation hazards shall be jointly defined with the GSFC Radiation Safety Committee.

5.3.8.1 Non-ionizing Radio Frequency (RF) Radiation Controls

5.3.8.1.1 The RF-radiation sources used at WFF shall be approved by the Wallops Frequency Utilization Management Working Group.

5.3.8.1.2 All operations involving the use of RF transmitters shall be coordinated through the Range Control Center (5.4.2.2) and conform to the standards and regulations specified in IEEE C9S.1-1991 and GHB 1860.2.

5.3.8.1.3 Mission-specific descriptions of RF transmitters and restrictions shall be provided in the Ground Safety Plans/Data Packages.

5.3.8.1.4 RF radiation into areas where ordnance operations are conducted shall be controlled to assure insufficient energy exists to cause premature initiation of ordnance.

5.3.8.1.5 The RF avoidance times shall be established in operational plans for all transmitters capable of producing a potential hazard to any ordnance operation. The RF avoidance is defined as no radiation within ±20° (azimuth and elevation) of the ordnance site. Any deviation of this requirement shall be approved by the WFF RSO or his designee.

5.3.8.1.6 Personnel and ordnance hazard distances for all transmitters shall be jointly defined with the GSFC Radiation Safety Committee.

5.3.8.2 Ionizing Radiation Controls

5.3.8.2.1 All operations involving the use of radioactive sources shall conform to the standards and regulations of the Nuclear Regulatory Commission (GHB 1860.1) and regulations of the host range.

5.3.8.2.2 The range user is responsible for obtaining all licenses for radioactive materials.

5.3.8.2.3 Procedures for the use, handling, and storage of radioactive sources shall be designed to minimize the exposure of personnel.

5.3.8.2.4 Range users shall identify all radioactive sources and provide Material Safety Data Sheets (MSDS) for each radioactive source to be used. This includes calibration sources as well as test sources.

5.3.8.2.5 Range users shall provide GSFC's WFF with detailed operating procedures for use, handling, and storage of non-exempt radioactive sources as defined in Title 10 - Code of Federal

Regulations - Parts 19 and 20 while on the range. Specific data requirements are listed in Section 8.0, GSFC/WFF Safety Data Requirements, and GHB 1860.3.

5.3.8.2.6 Ionizing radiation sources shall be removed from the range by the range user at the end of the program.

5.3.8.3 Laser Hazards Control

5.3.8.3.1 All operations involving the use of lasers shall comply with the standards and regulations of ANSI Z136.1 and GHB 1860.3.

5.3.8.3.2 Access and laser illumination levels shall be controlled to insure that no personnel are present within the ocular hazard area of the laser unless suitable protection is provided.

5.3.8.3.3 Range users shall provide WFF with characteristics and detailed operating procedures for controlling and use of lasers.

5.3.8.3.4 Lasers with potential to strike orbiting satellites will obtain a 'site window' from the laser safety clearing house referenced in NPG 8715.3.

5.3.9 Chemical Hazards.

A chemical hazard is posed by any material (solid, liquid, or gas) that presents a health risk or physical hazard to personnel, property, or the environment.

5.3.9.1 Procedures addressing use, clean up, and spill response of hazardous materials shall be developed. These procedures shall be reviewed and approved by the GSG and WFF Environmental Office.

5.3.9.2.1 The WFF Safety and Environmental Offices shall be notified of hazardous materials requiring disposal.

5.3.9.3 The MSDS shall be available during all operations involving hazardous materials. Hazardous material handlers, cognizant GSG personnel, and WFF Environmental Office personnel shall have knowledge of material compatibilities, physical and health hazards, and first aid techniques relevant to the hazardous materials in question.

5.3.9.4 The following measures shall be employed if a possibility of a hazardous chemical spill exists.

5.3.9.4.1 Spill potentials shall be evaluated on a case-by-case basis, and potential hazard areas shall be defined in a Ground Safety Plan.

5.3.9.4.2 A means to minimize the surface area of potential spills by diking, design, or other methods shall be employed.

5.3.9.5 The following measures shall be used to address potential leaks of hazardous fluids or gases:

5.3.9.5.1 All GSE electrical hardware used in areas where flammable/combustible chemicals may be present in local vapor concentrations greater than 25% of the Lower Explosive Limit (LEL) shall be rated "explosion proof" in accordance with 1999 Electrical Code, Article 500 – Hazardous Locations, or, if this is not possible, (1) the flammable/combustible chemical concentrations shall be continuously monitored and (2) a master switch capable of deactivating "non-explosion proof" electrical hardware shall be conveniently located in the work area.

5.3.9.5.2 Areas of hazardous fluid or gas transfer and storage shall be monitored by approved equipment to detect toxic and flammable concentrations.

5.3.9.5.3 Chemical transfer operations which are hazardous shall not occur without prior approval of and supervision by the OSS.

5.3.10 Hazardous Chemical System Hardware

Hazardous chemical hardware shall be designed to prevent hazardous chemicals from spilling or leaking and, thereby, injuring personnel, property, or contaminating the environment.

5.3.10.1 Hazardous chemical systems that release caustic, toxic, or reactive chemicals shall be designed such that the flow path contains two independent safeties to prevent an inadvertent release.

5.3.10.2.1 Components of hazardous chemical systems shall feature redundant mechanical or welded seals at all fittings to prevent the inadvertent flow or release of caustic, toxic, and/or reactive chemicals.

5.3.10.3 Materials selected for use in hazardous chemical systems shall be compatible with the hazardous chemical used. This should include compatibility under operating pressure, shock, vibration, reactivity and temperature conditions. Analyses on items such as stress corrosion or adiabatic compressibility shall be performed when applicable. Specific properties of propellants may be determined by reference to standard industry manuals such as the CPIA Publication 394.

5.3.10.4 Bi-propellant systems that incorporate both a fuel and an oxidizer shall be designed such that a malfunction of either the oxidizer or fuel subsystems cannot result in mixing. In general, all hazardous chemical systems shall be designed to preclude the inadvertent mixing of hazardous chemicals, especially in cases where chemical reactions could have catastrophic consequences.

5.3.10.5 Monopropellant systems that feature a fuel and a catalytic bed shall incorporate at least two independent safeties in the flow path to prevent inadvertent fuel contact with the catalytic bed.

5.3.10.6 The need for remote status monitoring of the system and/or its components shall be evaluated by the GSG on a case-by-case basis.

5.3.10.7 Hardware (tanks, transfer lines, etc.) shall conform to applicable ASME and DoT specifications.

5.3.11 Man-Rated Liquid Propulsion Systems

5.3.11.1 General Requirements

5.3.11.1.1 A man-rated propulsion system shall be employed when the following two conditions exist: (1) a leak or spill of the propellant poses a catastrophic hazard and (2) the propulsion system may be placed in a condition whereby spill response is not possible.

5.3.11.1.2 The propulsion system's primary leak path (i.e., from the propellant tank through the thrusters) shall contain a minimum of three mechanically independent safeties in series. If the mechanical safeties are electrically controlled, the electrical controls shall be independent of each other. A pyrotechnically actuated isolation valve with two fault tolerant electrical safeties immediately downstream from the liquid propellant tank shall be considered equivalent to two flow control safeties.

5.3.11.1.3 Secondary leak paths (i.e., through or around wetted fittings to the ambient environment) shall contain a minimum of two safeties in series to prevent a catastrophic leak/spill past a wetted fitting. A fitting that has been sealed by welding shall be considered equivalent to two mechanical seals. Metal-to-metal fittings (e.g., Swagelok and AN fittings) shall be considered equivalent to two safeties.

5.3.11.1.4 Prior to a launch, flow control devices within the liquid propulsion system shall not be operated under condition(s) that preclude spill/leak response.

5.3.11.2 Electrical Hardware

5.3.11.2.1 The electrical circuit(s) that operate the liquid propellant flow control devices shall be man-rated (i.e., two fault tolerant). At least two of the three electrical inhibits shall be remotely monitored when conditions preclude spill/leak response.

5.3.11.2.2 Electrical circuit(s) that operate components whose failure may cause the liquid propellant to catastrophically overheat (thus causing either propellant decomposition or propellant tank over pressurization) shall be man-rated.

5.3.11.3 Pressure Relief

5.3.11.3.1 The pressurant side of hazardous liquid propulsion systems shall be either electrically and mechanically single fault tolerant to exceed system Maximum Operating Pressure (MOP), or shall be equipped with a pressure relief device. The relief device shall be set and certified by tagging at 10% above system MOP.

5.3.11.3.2 The system shall be mechanically and electrically two fault tolerant to exceeding system burst pressure.

5.3.11.4 Seals

5.3.11.4.1 A quality control program shall verify that all system fittings and seals are properly installed and have leak integrity.

5.3.11.4.1.1 Welds shall be made only by certified welders.

5.3.11.4.1.2 Lot and batch short-term compatibility testing shall be performed for elastomeric seals to assure material compatibility.

5.3.11.4.1.3 Positive means such as periodic leak checking, manufacturer's gaging techniques, and/or other measures shall assure that metal-to-metal seals (e.g., Swagelok and AN fittings) do not lose leak integrity by improper installation or loosening ("backing-off") during transport or handling.

5.3.11.4.2 The optimum design for redundant mechanical seals is to seat one at the fitting face and the other radially to seal the fitting.

5.3.11.5 Monitoring

5.3.11.5.1 An instrument that continuously monitors for airborne concentrations of the toxic liquid propellant shall be used during ground operations.

5.3.11.5.2 During those operations that cannot be considered ground operations but still place personnel under the jurisdiction of WFF at risk (e.g., captive flight), and when spill/leak response is not possible, system pressure monitoring shall be required as a minimum effort.

5.3.11.5.3 All personnel who work in the proximity of the fueled liquid propulsion system shall wear passive dosimeters to monitor possible personnel exposures.

5.3.12 Pressure Systems

5.3.12.1 All ground support pressure systems shall meet NPG 1700.6.

5.3.12.2 Unrestricted access shall be granted for all airborne pressure systems (gaseous and liquid) that are designed in accordance with recognized DoT and ASME standards or have stored energy levels less than 19,130 Joules (14,240 ft-lbs) and operating pressure less than 100 psi. Systems that contain fluids that are toxic and/or flammable shall also meet requirements of sections 5.3.9, 5.3.10, or 5.3.11 as applicable.

5.3.12.3 If the airborne pressure system does not meet 5.3.12.2, then it shall be remotely pressurized for any of the following:

5.3.12.3.1 During the initial pressurization of the system, following system assembly or refurbishment. Initial pressurization shall certify system integrity up to 25% of Design Burst Pressure.

5.3.12.3.2 After the pressure system has been exposed to excessive vibration or shock or it has been transported in an unknown environment.

5.3.12.3.3 During pressurization above 25% of the Design Burst Pressure.

5.3.12.4 All airborne systems shall comply with the design requirements of References w or x.

5.3.12.5 Restricted access is permitted for airborne pressure systems designed to the requirements of ANSI/AIAA S-080 or ANSI/AIAA S-081.

5.3.12.5.1 Restricted access shall be permitted when the system steady state pressure is less than the MEOP.

5.3.12.6 Whenever the system pressure exceeds the MEOP, personnel shall be separated from the pressure vessel(s) by a barrier designed to protect against blast and fragmentation, or personnel shall be outside the pressure vessel danger area

5.3.12.6.1 The pressure vessel danger area shall be defined in the Ground Safety Plan/Data Package for that mission.

5.3.12.7 Flight pressure systems shall be re-certified by inspection, testing, or analysis prior to being reflown. The method of recertification shall be documented in an approved plan for each pressure vessel.

5.3.12.8 If a pressure relief device is employed, it shall be set and certified by tagging at no greater than 10% above MOP. This pressure level is defined as the Maximum Design Operating Pressure (MDOP), and may not exceed the proof pressure.

5.3.13 Personal Protective Equipment

Safety glasses, safety shoes, hard hats, arctic clothing, shop coats, etc., are required to be used by GSFC's WFF employees, contractors, experimenters, and range users when exposed to certain hazardous conditions.

5.3.13.1 All personnel shall wear static-dissipating clothing in processing areas for ordnance or other hazardous systems, which are susceptible to electrostatic discharge. Ordnance handlers shall not wear static producing clothing (i.e., wool, rayon, nylon, polyester, etc.).

5.3.13.2 During operations involving EED or exposed grain, all personnel are required to wear approved, grounded wrist-straps. Approved leg-stats may be used in place of wrist-straps for specific operations approved by the Chief, Safety Office.

5.3.13.3 Safety glasses or face shields are required for operations where an ocular hazard may exists.

5.3.13.4 Hardhats are required for operations where personnel work on multiple levels.

5.3.13.5 Operations involving chemicals that pose a health risk require that personnel wear protective equipment (identified on a case-by-case basis in the specific operational procedure) that shall provide respiratory and/or full body protection during:

5.3.13.5.1 Connecting or disconnecting wet lines or contaminated (neither purged nor flushed) dry lines.

5.3.13.5.2 Sampling operations.

5.3.13.5.3 Flow/transfer operations.

5.3.13.5.4 Operations where there is only one safety device preventing a chemical spill.

5.3.13.5.5 Chemical spill cleanup.

5.3.13.6 Personnel working with cryogenic liquids shall wear proper protective equipment including: hand and foot protection, face protection, and appropriate outer garments

5.4 Operational Security, Controls, and Procedures

The GSFC's WFF has established operational safety controls with which all persons at GSFC's WFF shall comply. These controls include:

5.4.1 Security

5.4.1.1 There are four classes of badges signifying the wearer's authorization to be in potentially hazardous areas. These badges are applicable to the entire facility (Wallops Island, Wallops Mainland, and WFF Main Base) and all off range sites under the auspices of Code 800. These classes and their definitions are as follows:

5.4.1.1.1 ALL-HAZ
All hazards – wearer is authorized unescorted access to all potentially hazardous areas. However, OSS approval is required prior to the wearer entering an area where a hazardous operation is occurring. ALL-HAZ badges are reserved for personnel associated with facility infrastructure.

5.4.1.1.2 SPEC-HAZ
Mission specific hazards – wearer is permitted same level of access as ALL-HAZ except that the wearer must be specifically associated with the hazardous system/area.

NOTE: The Chief of the Safety Office must approve all ALL-HAZ and SPEC-HAZ badges.

5.4.1.1.3 NON-HAZ
No hazards – Default badge class - wearer is only allowed in areas where no hazardous programmatic systems exist.

NOTE: Personnel possessing a NON-HAZ badge can gain access to hazardous areas provided their presence is required in the area and they are escorted by someone wearing an ALL-HAZ or a SPEC-HAZ badge.

5.4.1.1.4 NONE

No NASA areas - Issued to Navy personnel granting them access to the Navy facilities on Wallops Island.

5.4.1.2 Danger Area Access - Access into operational danger areas at GSFC's WFF is controlled by the Danger Area Warning System and roadblocks. Admittance into the danger area is always controlled by the OSS.

5.4.1.2.1 Danger Area Warning System - GSFC's WFF Danger Area warning systems involve the use of lights, sirens, signs, and/or roadblocks to alert personnel of the potential hazards present in certain areas and/or to prevent personnel from entering these areas. Under no circumstances shall personnel pass through an active danger area warning system without first obtaining permission from the OSS or his designee.

5.4.1.2.2 Launch Pad Warning System – GSFC's WFF Launch Pad Warning Systems involve the use of lights and exterior public address systems to advise personnel during Danger Time I, Danger Time II, Caution Time, and All Clear status changes, or other hazardous periods. Hazard warning lights are visible from all angles of approach. These systems are operated to indicate the following conditions:

5.4.1.2.2.1 Danger Time II - Flashing red light at launch pad and danger area roadblocks are in place. No personnel are permitted access to the pad.

5.4.1.2.2.2 Danger Time I - Flashing amber light at pad and danger area roadblocks are in place. Only active/essential personnel performing specific tasks are permitted access to the pad, with the permission of the OSS. This condition will exist if system(s) are in a potentially hazardous condition (i.e. Category A)

5.4.1.2.2.3 Caution Time - Flashing amber light at pad and danger area roadblocks are in place. Only essential personnel with OSS's permission are permitted access to the pad. This condition will exist if system(s) are not in a potentially hazardous condition (i.e. Category B).

5.4.1.2.2.4 All Clear - No warning lights at pad or prelaunch roadblock. All personnel are permitted access to the pad.

5.4.1.2.3 Launch Pad Roadblocks - In addition to the warning systems, manned and/or unmanned roadblocks are established at various places and times. The unmanned roadblocks are equipped with flashing red lights indicating Prelaunch Danger Area status. Unmanned roadblocks shall be equipped with communications equipment and a sign directing action. Under no circumstances shall personnel pass through a roadblock without permission from the OSS or his designee.

5.4.1.3 Explosives Signs and/or Symbols - Based on procedures of the U. N. document "Transportation of Dangerous Goods" (documented in NSS/GO-1740.9, NASA STD-8719.9 and DOD 6055.9), the GSFC's WFF utilizes four symbols to denote different classes of ordnance. These symbols are prominently displayed on International Orange signs at each magazine and refer to the most hazardous material stored within.

5.4.1.3.1 Class 1, Division 1: an octagonal-shaped sign displaying the numeral "1" in the center denotes the presence of DoD Hazard Class/Division 1.1 explosives, which present a blast and fragmentation hazard and can be expected to mass detonate when exposed to fire.

5.4.1.3.2 Class 1, Division 2: an X-shaped sign displaying the numeral "2" in the center denotes the presence of DoD Hazard Class/Division 1.2 explosives, which present a fragmentation hazard.

5.4.1.3.3 Class 1, Division 3: an inverted triangular sign displaying the numeral "3" in the center, denotes the presence of DoD Hazard Class/Division 1.3 explosives, which present a mass fire hazard.

5.4.1.3.4 Class 1, Division 4, on a diamond-shaped sign displaying the numeral "4" in the center, denotes the presence of DoD Hazard Class/Division 1.4 explosives, which present a moderate fire hazard.

5.4.1.4 RF Radiation Controls

5.4.1.4.1 Operational Restrictions - All RF emitters used at GSFC's WFF shall be periodically analyzed to determine whether or not they pose a potential hazard to personnel or ordnance. When a potential hazard exists, operational restrictions and/or controls shall be established to protect personnel and/or ordnance systems.

5.4.1.4.2 Barricades/Signs - In areas where RF hazards to personnel exist, signs and/or barricades shall be erected to prevent personnel from entering the potential hazard area.

5.4.1.4.3 Warning Lights - On high power RF emitters such as Radar Systems, red and blue warning lights shall be utilized to warn personnel of the potential RF hazard. A red flashing light shall be illuminated whenever power is supplied to the system. A blue flashing light shall be illuminated whenever the emitter is radiating.

5.4.2 Operational Controls

For all potentially hazardous operations at GSFC's WFF, the Test Director, Assistant Test Director, RSO, and OSS exercise control over all personnel associated with the operation. For off-range operations, Section 2.5 establishes the hierarchy for operational control.

5.4.2.1 All NASA personnel, NASA contractors, experimenters, range users, and tenants are responsible for:

5.4.2.1.1 Adhering to the requirements established in this document.

5.4.2.1.2 Adhering to the directions issued by the Test Director, RSO, and/or OSS.

5.4.2.1.3 Reviewing vehicle and payload operations with the OSS.

5.4.2.1.4 Obtaining permission from the OSS before conducting any operation in assembly, test, or launch areas.

5.4.2.1.5 Identifying active essential personnel for each operation to assure maximum personnel limits are not exceeded.

5.4.2.2 All RF radiation on GSFC's WFF is controlled through the Range Control Center, to assure that RF limits (5.3.8.1) are not exceeded and to preclude possible interference with other transmitters. Range users shall obtain permission through the OSS before any RF transmitters can be switched ON.

5.4.2.3 The Ground Safety Plan/Data Package defines Danger Area clearance requirements and personnel restrictions for all potentially hazardous operations. All personnel at GSFC's WFF are responsible for complying with these restrictions.

5.4.2.4 All personnel performing potentially hazardous operations (explosives handling, chemical transfer, etc.) shall be trained and experienced. These personnel are required to be certified or directly supervised by certified personnel when performing these operations. The GSFC's WFF will approve all personnel certifications or may approve certifications established by user programs. Range users shall provide documentation that supports training, experience, or certification of their personnel.

5.4.3 Operational Procedures

5.4.3.1 Range users are responsible for submitting to GSFC's WFF comprehensive handling, assembly, and/or checkout procedures for all hazardous systems for review and approval. Operations shall not be conducted until the Safety Office has approved these assembly and test procedures.

5.4.3.2 Under no circumstances shall a potentially hazardous operation begin without prior approval from the OSS.

5.4.3.3 The GSFC's WFF requires that no unrelated tasks be conducted simultaneously, within overlapping Danger Areas, on hazardous systems. It is the responsibility of all supervisory personnel to prepare work schedules to comply with this requirement.

5.4.3.4 Instruments used to measure the resistance of EED's shall (a) contain a certification sticker and (b) be checked, immediately prior to use, to assure the short circuit current is less than 50mA.

5.4.3.5 Range users shall obtain permission from the OSS prior to making a power switch on any vehicle/payload or ground support system.

5.4.3.6 Emergency Procedures - Prior to conducting an operation, GSFC's WFF shall establish emergency procedures and an emergency response team in the event of launch abort or recovery. Range Users shall identify personnel as required by the GSFC's WFF to participate on any emergency or recovery team.

5.4.3.7 For off-range operations, permission to perform the above operations shall be granted by the hierarchy defined in Section 2.5.

6.0 FLIGHT SAFETY

6.1 Policies

6.1.1 The flight safety goal is to protect the public, range participants, and property from the risk created by conducting potentially hazardous operations at GSFC's WFF and to prevent mishaps that would result in embarrassment to NASA or the United States Government. Although these risks can never be completely eliminated, the flight should be carefully planned to minimize the risks involved while enhancing the probability for attaining the mission objectives.

6.1.2 The GSFC's WFF is responsible for flight safety until all flight components have reached impact or have achieved orbital insertion. A Flight Safety Program shall be implemented to protect the public and participating personnel for all GSFC's WFF launch operations and operations conducted by GSFC's WFF at mobile ranges established at remote sites. For operations conducted at other established ranges, GSFC's WFF is responsible for

assuring that NASA personnel, contractors, and experimenters are not exposed to risk greater than the acceptable risks established by this document.

6.1.3 Flight safety is generally associated with the containment of vehicle flight within approved operational areas and impacts (spent stages, payloads, balloons, payload/parachutes, etc.) within planned impact areas. Since the entire set of variables (vehicle aerodynamic/ballistic capabilities; azimuth and elevation angles; wind, air and sea traffic, and proposed impact areas) are unique, flight safety analysis shall be performed for each mission. Vehicle design, reliability, performance, and error predictions for each flight case shall be reviewed by the Safety Office personnel to certify the flight-worthiness of the launch vehicle.

6.1.4 Flight safety data shall be prepared by the Flight Safety Group (FSG) of GSFC's WFF prior to any launch operations where GSFC's WFF has flight safety responsibilities. This data shall be published in a Flight Safety Plan and shall describe the proposed vehicle flight and the means to contain it safely. For operations at other established ranges, any special flight safety restrictions or requirements shall be documented in a Flight Safety Data Package for that operation. For NSBF balloon operations, any special flight safety restrictions or requirements shall be documented in a program Safety Analysis Report (SAR) or an individual mission Risk Analysis document.

6.1.5 The Range Safety Officer shall certify the flight worthiness of all rockets, missiles, drones, and other similar vehicles.

6.1.6 Flight Safety for aircraft operations shall assure that public exposure to risk does not exceed the limits defined in Section 6.2, Risk Criteria.

6.2 Risk Criteria

All mission activities shall be conducted such that the risk shall not exceed negligible risk levels. For those missions where the safety risk cannot be mitigated below negligible levels, the risk shall be analyzed and presented by the Safety Office (Code 803), recommending approval or disapproval, to the Director of Suborbital and Special Orbital Projects (Code 800) in a Safety Analysis Report (SAR). The Range Support Manager (RSM) shall prepare and present an assessment of the specific circumstances and benefits of the mission that warrant acceptance of the risks. The decision whether or not to proceed with the mission shall be made by the Director of Suborbital and Special Orbital Projects or the Director of GSFC in accordance with the guidelines for acceptable risk set forth below and a judgment of whether or not the benefits outweigh the risks.

Risk controls for protecting landmasses shall be implemented by establishing casualty expectation limits and risk controls for protecting ships and aircraft shall be implemented by establishing maximum hit probabilities.

6.2.1 Negligible Risk

6.2.1.1 The casualty expectation, for all mission activities, shall be less than 1×10^{-6}.

6.2.1.2 The probability of hitting a ship shall be less than 1×10^{-5} for each impacting area.

6.2.1.3 The probability of hitting an aircraft shall be 1×10^{-7} for each impacting area. The minimum aircraft hazard area shall be 2 sigma.

6.2.1.4 The probability of spent stages of other vehicle hardware impacting in unapproved areas shall be 1×10^{-3}.

6.2.2 Director of Code 800 Acceptable Public Risk

6.2.2.1 The casualty expectation, for all mission activities, shall be less than 30×10^{-6}.

6.2.2.2 The probability of hitting a ship shall be less than 3×10^{-5} for all impact areas.

6.2.2.3 The probability of hitting an aircraft shall be less than 1×10^{-7} for each impact area. The minimum aircraft hazard area shall be 2 sigma.

6.2.2.4 The probability of spent stages or other vehicle hardware impacting in unapproved areas shall be a factor in determining mission approval.

6.2.2.5 Director of Code 800 Participating Personnel Risk

6.2.2.6 The casualty expectation, for all mission activities, shall be less than 30×10^{-5}.

6.2.2.7 The probability of hitting a ship shall be less than 3×10^{-5} for all impact areas.

6.2.2.8 The probability of hitting an aircraft shall be less than 1×10^{-7} for each impact area. The minimum aircraft hazard area shall be 2 sigma.

6.2.3 Director of GSFC Acceptable Public Risk

6.2.3.1 The casualty expectation, for all mission activities, shall be less than 300×10^{-6}.

6.2.3.2 The probability of hitting a ship shall be less than 30×10^{-5} for all impact areas.

6.2.3.3 The probability of hitting an aircraft shall be less than 10×10^{-7} for each impact area. The minimum aircraft hazard area shall be 2 sigma.

6.2.3.4 The probability of spent stages or other vehicle hardware impacting in unapproved areas shall be a factor in determining mission approval.

6.2.3.5 Director of GSFC Participating Personnel Risk

6.2.3.6 The casualty expectation, for all mission activities, shall be less than 300×10^{-5}.

6.2.3.7 The probability of hitting a ship shall be less than 30×10^{-5} for all impact areas.

6.2.3.8 The probability of hitting an aircraft shall be less than 10×10^{-7} for each impact area. The minimum aircraft hazard area shall be 2 sigma.

6.3 Flight Termination

6.3.1 Flight termination systems are required to meet design features as specified in the RCCD Standard 319-99.

6.3.2 Flight termination may consist of command destruct, thrust termination, auto destruct, recovery initiation, command fire system, or command no-fire systems.

6.3.3 Requirements for rockets, missiles, drones, UAV's and other similar vehicles

6.3.3.1 A flight termination system is required in every stage (each motor) of a launch vehicle, unless it is shown that the maximum range of the vehicle is less than the range to all protected areas, or a risk analysis shows that all of the mission risk criteria specified in Section 6.2, Risk Criteria, are satisfied, or the vehicle is inherently safe.

6.3.3.2 An operation is considered inherently safe if the predicted flight is based solely on launch and dispersion parameters and known system errors. The Chief, Safety Office or his

designee, is responsible for determining if an operation is inherently safe and for approving the type and design of the flight termination system.

6.3.3.3 Operations are considered inherently safe if all of the following conditions are true:

6.3.3.3.1 The vehicle does not contain a guidance or control system.

6.3.3.3.2 The vehicle can be accurately wind weighted to provide an acceptable impact location.

6.3.3.3.3 Launch limits, as stated in section 6.4.1.4.1 and 6.4.1.4.2, are met.

6.3.4 Requirements for Balloons

6.3.4.1 A flight termination system is required, unless the maximum weight and weight per surface area criteria of CFR 14, FAA, Part 101, are satisfied.

6.4 Operational Procedures

6.4.1 Rocket, Missile, Drone, UAV's and Other Similar Vehicles

6.4.1.1 Hazard Areas

6.4.1.1.1 Hazard areas are developed by probabilistic calculations or by maximum range capability.

6.4.1.1.2 Aircraft hazard areas shall be developed for all operations. For vehicles whose computed aircraft hazard area radius is less than 2 sigma dispersion, an aircraft hazard area radius equal to 2 sigma dispersion shall be implemented.

6.4.1.1.3 DoD ship clearance hazard areas shall be developed for all impacts in the Virginia Capes (VACAPES) that meets the maximum ship impact probability of 1×10^{-6}.

6.4.1.1.4 Ship impact probability calculations shall be performed for all operations where applicable.

6.4.1.2 Range Clearance

6.4.1.2.1 GSFC's WFF shall coordinate its operations with the Federal Aviation Administration (FAA), the U. S. Navy, and other organizations, as required, to clear potential hazard areas.

6.4.1.2.2 All impacts within the VACAPES operating areas require clearance from the Fleet Area Control and Surveillance Facility (FACSFAC) prior to launch. Any part of the ship hazard area that is within VACAPES shall be surveyed for ships.

6.4.1.2.3 Clearance with the FAA is required for any aircraft hazard area that extends beyond the VACAPES operating areas.

6.4.1.2.4 NOTAMS and NOTMARS shall be issued at least twenty-four hours prior to launch.

6.4.1.3 Satellite Collision Avoidance (COLA)

6.4.1.3.1 The GSFC's WFF shall insure that all manned spacecraft and GSFC mandated spacecraft (as required) are protected from collision with sounding rocket and ELV motors, payloads, or other expended items.

6.4.1.3.2 Manned spacecraft shall be protected with a minimum separation distance of 200KM.

6.4.1.3.3 All others shall be protected with a minimum separation distance of 25KM.

6.4.1.4 Wind Weighting

6.4.1.4.1 All unguided vehicles shall be wind weighted, except as noted in 6.4.1.4.2. An unguided portion of flight for guided vehicles shall also be wind weighted.

6.4.1.4.2 Low performance vehicles (i.e., test rockets) may be launched without being wind weighted, provided the effective elevation is 80° or less and all other safety criteria are met.

6.4.1.4.3 The operational wind weighting system shall produce solutions with errors no greater than those used to determine vehicle dispersion and potential hazard areas.

6.4.1.5 Ground Launched Vehicles Without Flight Termination Systems

6.4.1.5.1 The maximum effective launcher elevation setting is 85°.

6.4.1.5.2 The maximum wind corrected launcher elevation setting is 86°.

6.4.1.5.3 For unproven launch vehicles, the maximum effective launcher elevation setting is 80°. The effective azimuth shall be chosen such that the geographical advantages of the impact area are realized.

6.4.1.5.4 For unproven launch vehicles, the maximum wind corrected launcher elevation setting is 82°.

6.4.1.5.5 Surface, ballistic, and other wind limits shall be established based on vehicle wind sensitivity.

6.4.1.5.6 Effective launch azimuth and elevation settings shall be established such that the planned impact shall occur within approved operating areas.

6.4.1.5.7 Launch limitations shall be published in the Flight Safety Plan.

6.4.1.6 Vehicles with Flight Termination Systems

6.4.1.6.1 Launch Limitations

6.4.1.6.1.1 Flight limits shall be established to implement flight safety criteria. Examples include: impact limits, vehicle attitude, heading, time of flight, and position. These limits may be implemented as launch criteria and/or flight requirements.

6.4.1.6.1.2 Surface, ballistic, and other wind limits shall be established based on vehicle wind sensitivity.

6.4.1.6.1.3 Effective launch azimuth and elevation settings shall be established such that the planned impact shall occur within approved operating areas.

6.4.1.6.1.4 Launch limitations shall be published in the Flight Safety Plan.

6.4.1.6.2 Flight Termination Criteria

6.4.1.6.2.1 Flight termination by the RSO is required when valid data shows the launch vehicle violating a flight termination boundary.

6.4.1.6.2.2 Flight termination is required when launch vehicle performance is unknown and the vehicle is capable of violating a flight termination boundary.

6.4.1.6.2.3 The vehicle Instantaneous Impact Point (IIP) shall not be permitted to overfly populated land areas unless the vehicle is flying within 5 sigma of nominal performance.

6.4.1.6.2.4 A flight may be terminated by the RSO as a result of gross trajectory deviation or obvious erratic flight. This action may be taken if, in the judgment of the RSO, further flight is likely to increase the hazard potential.

6.4.1.6.2.5 Other flight termination criteria may be enforced due to the uniqueness of a particular mission. These criteria shall be documented in the Flight Safety Plan.

6.4.1.6.3 Design Requirements

6.4.1.6.3.1 The Flight Termination System for rockets, missiles, UAV's and drones shall meet all requirements specified in the Reference p, Reference t or tailored to meet specific hazard analysis requirements.

6.4.1.6.3.2 The Flight Termination System for balloons shall meet the design requirements established by the NSBF.

6.4.1.6.4 Prelaunch Checks

6.4.1.6.4.1 Flight Termination Systems for rockets, missiles, UAV's and drones shall be tested to certify the requirements in 6.4.1.6.3.1 are implemented.

6.4.1.6.4.2 Flight Termination Systems for balloons shall be tested such that all requirements of the NSBF and the Federal Aviation Administration (FAA) are implemented.

6.4.1.6.4.2 Prelaunch checks shall be performed to operationally certify the Flight Termination System.

6.4.1.6.4.3 Ground support components of the flight termination command system shall be operationally certified.

6.4.1.6.4.4 Operational tests shall be performed to certify that the vehicle system operates within the RF limits specified by link analysis.

6.4.1.6.4.5 A functional test shall be performed during the countdown process to certify the flight termination system.

6.4.1.6.5 Data requirements

6.4.1.6.5.1 At least two independent data systems are required to provide real time positional/IIP data during launch. If one of the data systems is a skin tracking radar, a ceiling limitation shall be imposed to ensure visibility until the skin tracking radar has adequate time to provide quality data. The data systems shall be designed such that no single order vehicle failure mode or ground system failure mode could cause the loss of both data systems.

6.4.1.6.5.2 A loss of data, such that the RSO cannot certify vehicle performance within flight safety limits, shall result in a flight termination action.

6.4.1.6.5.3 All data systems, which provide information used to evaluate flight safety requirements, shall be certified prior to launch.

6.4.1.7 Weather Constraints for Expendable Launch Vehicle (ELV) are defined in Attachment 1.

6.4.2 Balloon Operations

6.4.2.1 All operations shall be conducted within flight limits, which satisfy the risk criteria stated in Section 6.2, Risk Criteria.

6.4.2.2 A predicted trajectory shall be calculated based on the prelaunch wind profile. The predicted trajectory and its descent vector shall be updated based on the current wind profile.

6.4.2.3 A flight termination point and time shall be selected that satisfies the risk criteria. The time and location of the flight termination point shall be coordinated with, and clearance to terminate shall be obtained from the FAA or equivalent foreign agency.

6.4.2.4 A functional test of the flight termination system shall be performed prior to launch to certify the flight termination system.

6.4.3 Aircraft Operations

6.4.3.1 All aircraft operations managed by WFF or conducted on the GSFC's WFF test range shall be performed within the requirements established by an approved Operations and Safety Directives.

6.4.3.2 All operations shall be conducted such that the risk criteria stated in Section 6.2, Risk Criteria, are satisfied.

6.4.3.3 Aircraft shall be operated in accordance with the flight rules specified in 830-PG-7900.1 and FACSFAC VACAPES Operating Instruction 31201H or Oceanic Airspace, as applicable. Visual Meteorological Conditions (VMC) are required for all aircraft that are not Instrument Flight Rated (IFR).

6.4.3.4 For separation purposes, preassigned airspace and altitude boundaries shall be established prior to the mission for each participating aircraft. Minimum separation criteria is 1000 feet in altitude or 1 NM laterally unless formation flight is approved by the Aviation Safety Officer and a briefing with appropriate mission personnel is conducted prior to the start of the operation. Pilots shall retain the responsibility for aircraft separation; ground based coordinators shall only be used for position vectoring and advisories.

6.4.3.5 FACSFAC VACAPES shall be notified by aircraft prior to initial entry into the VACAPES area. If the aircraft is unable to notify FACSFAC, they should inform Wallops Range Control who shall notify FACSFAC.

7.0 RANGE USER AND TENANT RESPONSIBILITIES

7.1 Obtain approval prior to conducting any potentially hazardous operation.

7.2 Provide data to WFF for safety analysis (see Section 8.0, GSFC WFF Safety Data Requirements).

7.3 Identify the minimum safety requirements for test operations. If a range user or tenant determines that his safety requirements are more stringent than those imposed by the GSFC's WFF, he shall coordinate these requirements (through the Range Support Manager) with the Safety Office.

7.4 Participate in discussions to familiarize FSG and GSG personnel with all aspects of the mission.

7.5 Participate in real time data evaluation for mission control and/or flight termination, as required by the Safety Office.

7.6 Notify the Range Support Manager of all meetings pertaining to the mission that involves safety related issues, i.e., Design Reviews, Operational Planning meetings.

7.7 Participate in failure/anomaly investigations and provide post flight data as required.

7.8 Provide a written waiver request, to the Range Support Manager, for any requirements specified in this document that cannot be satisfied.

8.0 GSFC's WFF SAFETY DATA REQUIREMENTS

8.1 Launch Vehicle and Payload Description Data

8.1.1 Hazardous Electrical Circuits - Range users shall provide the GSFC's WFF Range Support Manager with two readily distinguishable copies of schematic and wiring diagrams of all pyrotechnic and other circuits that initiate hazardous systems. The Safety Office shall be promptly notified of any changes to hazardous electrical circuits.

8.1.2 Mechanical Systems - Range users shall provide a description, including technical details and precautions, for all hazardous mechanical systems. Scale drawings shall be supplied showing the location of these and all other hazardous systems (ordnance, pressure, etc.).

8.1.3 Ordnance Devices - For each EED, data sheets shall be provided listing the minimum all fire current, maximum no-fire current, recommended firing current, normal resistance, pin-to-case resistance, and, if available, the RF sensitivity characteristics. A technical description of all SAFE/ARM type devices (out-of-line S/A, S/A connectors, mechanical restraints, etc.) employed shall be provided. For ordnance devices such as: rocket motors, shape charges, detonating cord, etc. data sheets shall be provided which identify the DoD explosive classification, normal output characteristics, composition, or any other relevant information needed to perform safety analyses.

8.1.4 Chemicals - The range user shall provide a description and schematic diagram of the system. All hardware "plumbing," components (tanks, fittings, valves), and system safety features shall be defined. An MSDS for each chemical used on the project shall also be provided.

8.1.5 Pressure Systems - The range user shall provide a description of all pressure systems used on the program. Technical characteristics, including design burst, proof, and MAWP pressures, internal volume, and materials of construction shall be provided.

8.1.6 Radiation Sources

8.1.6.1 Non-Ionizing (RF) Sources - The range user shall provide data on all non-ionizing emitters including frequency, type of emission, type of radiating antenna, and radiated power (both peak and average).

8.1.6.2.1 Ionizing Sources - The range user shall provide data on all ionizing sources as required by GHB 1860.1.

8.1.6.3 Optical Sources - The range user shall provide data on all hazardous optical emitter (e.g., lasers) including wavelength, pulse width, pulse repetition frequency, divergence angle, and power output.

8.1.7 Ground Support Equipment (GSE) - Range users shall provide schematics, drawings, operational description, technical details, and documentation of certification for all GSE used to support hazardous systems or operations. This includes but is not limited to pyrotechnic checkout meters, breakout boxes, calibration sources, pressure systems, chemical service modules, and lifting and handling devices. This requirement is in addition to the requirements of 5.3.5, Ground Support Equipment (GSE).

8.2 Operating Procedures

8.2.1 Hazardous Systems

Detailed procedures for handling, assembly, and checkout for all hazardous systems (ordnance, mechanical, pressure, chemical, etc.) shall be provided to GSFC's WFF prior to beginning operations.

8.2.2 Recovery

For recovery operations, procedures shall be provided which provide a description of the items to be recovered, reasons for recovery, hazards involved, and any recovery aids and their characteristics. These procedures shall describe the methods employed to verify that all hazardous systems are in a SAFE condition during recovery operations. A list of recovery aids such as chaff (frequency, quantity), locator beacons (frequency, power output, period of operation), dye marker (color persistence, time of deployment), flashing light (color, frequency, duration, candle power, directional characteristics), smoke (color, duration, time of deployment), radar reflective parachute (when deployed, size), or any other aids used should be included. Also, provide the desired period of recovery operations and the disposition of the recovered items.

8.2.3 Contingencies

Contingency procedures shall be provided prior to beginning operations. These contingency procedures include steps to be taken in the event of launch postponement, launch cancellation (including destaging), hold or abort, booster ignition failure, unintentional land impact, emergency response, chemical spill cleanup, or any other contingency that may endanger personnel or property.

8.2.4 Approval

All procedures for handling, assembly, and checkout of hazardous systems shall be approved by the Safety Office prior to use at GSFC's WFF. Approvals shall be obtained prior to performing any potentially hazardous operation.

8.3 Performance and Flight Worthiness Data Requirements

8.3.1 The specifications defined in this section are intended as a synopsis for information required to perform a flight safety analysis. The actual requirements shall be mission specific. The range user is responsible for coordinating data requirements with the Safety Office.

8.3.2 Rockets, Missiles, Drones, UAV's and Other Similar Vehicles

8.3.2.1 Provide a vehicle description including a scaled drawing and operating procedures.

8.3.2.2 Nominal Trajectory Inputs

8.3.2.2.1 For these operations, the minimum data requirements shall be sufficient to perform a five degree-of-freedom analysis.

8.3.2.2.2 Mass Properties - weights, inertias, and center of gravity.

8.3.2.2.3 Propulsion - thrust or chamber pressure.

8.3.2.2.4 Aerodynamics - drag, C_{Na}, C_{ma}, C_{mq}, C_{lp}, and C_{ld}.

8.3.2.2.5 Guidance and Control - guidance program, attitude gains, and attitude rate gains.

8.3.2.2.6 Launch Parameters - launcher settings, launch coordinates (WGS - 84 geodetic datum or other Safety Office approved earth model), and a sequence of events (ignitions, burnouts, separations, etc.).

8.3.2.3 Trajectory Outputs

Output data may be required in printed, plotted, or computer medium format for each impacting or orbital body. The output should include:

8.3.2.3.1 Time, velocity, altitude, horizontal range, weight, thrust, drag, dynamic pressure, angle of attack, velocity vector elevation and azimuth angles, body elevation and azimuth angles, present position and instantaneous impact prediction latitude and longitude, "round earth" x, y, and z, slant range, azimuth, and elevation relative to the launcher, and control system forces, moments and deflections.

8.3.2.3.2 Maximum horizontal range, maximum velocity and turn rate analysis may be required.

8.3.2.4 Provide stability and dynamics analyses including flexible body, static margins, and a roll rate vs. pitching frequency.

8.3.2.5 Provide the results of an aero elastic and structural analysis.

8.3.2.6 Provide the results of a thermal analysis.

8.3.2.7 Provide total dispersion data, either theoretical and/or empirical, in terms of one, two, and three sigma ellipses for all impacting bodies. The Safety Office shall approve all techniques and values of error sources used in the dispersion analysis. A theoretical analysis shall include the following effects: thrust offset, thrust misalignment, aerodynamic errors, uncompensated wind, launcher misalignments, weight and impulse errors, guidance and control system errors, ignition delay, and any other errors unique to this vehicle. Provide flight history trajectory data on previous vehicle flights.

8.3.2.8 Provide a physical and mathematical description of all vehicle guidance and control systems.

8.3.2.9 Provide a debris analysis including technique and input parameters. The Safety Office may elect to perform a debris analysis. Therefore, chamber pressure and the number and type of debris fragments caused by vehicle breakup shall be required. The data for each debris fragment shall include ballistic coefficient, weight, dimensions, drag coefficient, and the incremental velocity imparted by the vehicle breakup.

8.3.2.10 Provide a wind effect analysis and the method used for calculation. Provide data consistent with currently used GSFC's WFF wind compensation methods

8.3.2.11 A Gross Hazard Analysis could be required on critical systems, depending on the project. Identification of each potential hazard, the preventive measures to reduce each potential hazard, and a risk assessment for those potential hazards that cannot be eliminated by preventive measures should be included in the Gross Hazards Analysis.

8.3.3 Balloons

8.3.3.1 Identify launch site and launch window.

8.3.3.2 Provide payload and balloon characteristics.

8.3.3.2.1 Payload dimensions and total suspended weight.

8.3.3.2.2 Balloon material, volume, and weight.

8.3.3.2.3 Gross inflation weight.

8.3.3.2.4 Theoretical stress index (if applicable).

8.3.3.3 Provide payload/parachute weight, drag coefficient, and reference area.

8.3.3.4 Provide the time of day (day or night) that each of the following mission phases will be performed: launch and ascent, float, descent and impact.

8.3.3.5 Provide anticipated float direction and duration of flight.

8.3.3.5.1 Float altitude.

8.3.3.5.2 Predicted float altitude variation during day/night cycle.

8.3.3.5.3 Float time or distance.

8.3.3.5.4 Float direction and estimated wind velocity at float altitude.

8.3.3.6 Provide description of any balloon control system (such as a valving system).

8.3.3.7 Provide balloon flight history data.

8.3.3.7.1 Balloon system reliability data including number of flights, number and types of failures, and where the failures occurred (ascent, float, or descent).

8.3.3.7.2 Actual and predicted payload/parachute descent vectors. Actual balloon descent vectors if available.

8.3.3.8 Provide balloon wind limitations.

8.3.4 Aircraft

8.3.4.1 The range user shall provide flight profiles including aircraft velocities, altitudes, and separations (for multiple aircraft).

8.3.4.2 Data on platform instrumentation shall be provided if it is of a hazardous nature (i.e., pressure systems, ordnance, gases, lasers, high-voltage, etc.).

8.4 Telemetry (TM) Data Requirements for Vehicles with Flight Termination

The specifications defined in this section are intended as a synopsis for pre-flight and real time data requirements. Actual requirements shall be mission specific and the range user is responsible for coordinating TM data requirements with the Safety Office.

8.4.1 Command Receiver(s) signal strength (AGC) and check channel (command receiver channel 4).

8.4.2 Inertial Navigation System (INS) Parameters

8.4.2.1 Inertial position, velocity and acceleration. Inertial EFG coordinates are preferred. All reference systems shall be defined.

8.4.2.2 INS initialization parameters.

8.4.3 Guidance commands including nozzle deflections in the pitch and yaw axes.

8.4.4 Vehicle attitude data including pitch, yaw and roll angles and rates.

8.4.5 Motor Chamber Pressures.

8.4.6 Flight Termination System.

8.4.6.1 Control Circuit Status.

8.4.6.2 External/Internal Battery Voltage.

8.4.6.3 Safe/Arm Status.

8.4.7 Global Positioning Satellite (GPS) Positional and Velocity Data.

8.5 Schedules for Providing Required Data

8.5.1 NASA DoD and commercial ELV's shall meet the schedule defined in Attachment 2.

8.5.2 For sounding rocket vehicle or payload systems not previously launched from GSFC's WFF, all final data shall be supplied no later than T-90 days. Preliminary data for these systems shall be submitted no later than T-120 days.

8.5.3 For sounding rocket vehicle or payload systems previously launched from GSFC's WFF, final data shall be submitted no later than T-60 days. Preliminary data for these systems shall be submitted no later than T-120 days.

8.5.4 For balloon systems, all final data shall be supplied no later than T-30 days. If the payload contains hazardous systems, which are not covered by the general Balloon Ground Safety Plan or if the launch site/operations area is not contained in the Balloon Risk Model Population Data Base, the required data shall be submitted no later than T-90 days.

8.5.5 If deadlines are not met, Safety Office personnel may not be able to prepare all necessary safety plans in time to support a proposed flight. In every case, the mission shall not be conducted until adequate safety preparations are made.

8.6 Waivers

The range user shall provide a copy of any waiver for the launch vehicle or payload granted by another range.

8.7 Reviews

8.7.1 It is highly recommended GSFC's WFF Safety Office personnel participate in Design and Mission Readiness Reviews for each mission. The Range User should Safety Office personnel through the GSFC's WFF Range Support Manager at least ten days prior to conducting such reviews. Safety participation in such reviews may prevent costly engineering changes and scheduling delays.

8.7.2 Should GSFC's WFF not be represented at Design and Mission Readiness Reviews, a copy of the review material shall be submitted to GSFC's WFF as early as possible following the review.

ATTACHMENT 1

WEATHER CONSTRAINTS FOR
EXPENDABLE LAUNCH VEHICLE (ELV)

The RSO must have clear and convincing evidence the following constraints are not violated.

1. Do not launch if any type of lightning is detected within 10 NM of the launch site or planned flight path within 30 minutes prior to launch, unless the meteorological condition that produced the lightning has moved more than 10 NM away from the launch site or planned flight path.

2. Do not launch if the planned flight path will carry the vehicle:

a. through cumulus clouds with tops higher than the +5°C level; or

b through or within 5 NM of cumulus clouds with tops higher than the -10°C level; or

c through or within 10 NM of cumulus clouds with tops higher than the -20°C level; or

d through or within 10 NM of the nearest edge of any cumulonimbus or thunderstorm cloud including its associated anvil.

3. Do not launch if at any time during the 15 minutes prior to launch time the one minute average of absolute electric field intensity at the ground exceeds 1 kilovolt per meter (1 kV/m) within 5 NM of the launch site unless:

a there are no clouds within 10 NM of the launch site; and

b smoke or ground fog is clearly causing abnormal readings.

4. Do not launch if the planned flight path is through a vertically continuous layer of clouds with an overall depth of 4,500 feet or greater where any part of the clouds are located between the 0°C and the -20°C temperature levels.

5. Do not launch if the planned flight path is through any cloud types that extend to altitudes at or above the 0°C level and that are associated with disturbed weather within 5 NM of the flight path.

DEFINITION: Disturbed weather is any meteorological phenomenon that is producing moderate or greater precipitation.

6. Do not launch through thunderstorm debris clouds, or within 5 NM of thunderstorm debris clouds not monitored by a field mill network or producing radar returns greater than or equal to 10DBz.

DEFINITION: Debris Cloud is any cloud layer other than a thin fibrous layer, that has become detached from the parent cumulonimbus within 3 hours before launch.

GOOD SENSE RULE: Even when constraints are not violated, if any other hazardous weather conditions exist, the RSO may hold at any time based on the instability of the weather.

ATTACHMENT 2

DATA REQUIREMENTS AND
REVIEW SCHEDULE

TIME	EVENT	PURPOSE	POC	INPUT	OUTPUT
Issuance of MAD and AMIS	Project Initiation Conference (PIC)	Define Mission Objectives	WFF RSM Program MIM P/L Mgr L/V MIM	(1) Description of Payload & Proposed Orbit (2) Project Team presentations	PIC minutes and action items
Prior to P/L PDR	Safety TIMS	Address Specific Safety Issues	WFF RSM P/L Mgr. L/V MIM	Formal presentation of issues by project team & WFF Range Safety	-TIM minutes -Project status memo -Action items resolution
NLT L-18 months	P/L PDR	Define System preliminary Hazard Analysis (PHA)		Project Team provides: -Preliminary Safety Analysis -Gross Hazard Analysis -P/L Design Docs & Dwgs -Special Ops -Preliminary Trajectory	
PDR +60 days	Preliminary Safety Data Package	User provides Preliminary Safety Document for Vehicle, P/L and Special Ops	WFF RSM P/L Mgr. L/V MIM	Project provides: -Preliminary Safety Data for Safety Plan Development	SDP for review
PDR + 60 days	Safety TIMS	Discuss SDP	WFF RSM P/L Mg. L/V MIM	Project Team presents: -Trajectory Data -Safety Analyses -Facility Mods -Prelim Operations Plan	TIM Minutes Status Resolution Action Items

TIME	EVENT	PURPOSE	POC	INPUT	OUTPUT
NLT L-12 months	P/L CRD	Finalize Design	WFF RSM P/L Mgr. L/V MIM System Experts	Project Team presents Final P/L design	Preliminary Safety Approval (subsystem) Final GHA
	Safety TIMS	Resolve Action Items and Safety Issues	WFF RSM P/L Mgr. L/V MIM	Project Team Identifies: - Design changes -Operational methods -Testing	TIM Minutes documenting resolution of issues
CDR +60 days	Operational Support System TIMS	Define Operational Support	WFF RSM P/L Mgr. L/V MIM Mission Ops Mgr.	Project Team presents Mission Operation (data) requirements WFF Safety presents: Real Time Data requirements	RF Link Analysis Mission Support Allocation
L-75 Days	Final SDP	User provides Final Safety document for Vehicle, P/L, and Operations	WFF RSM P/L Mgr. L/V MIM	Project provides Final Safety Data for safety plan development	Approved SDP
L-75 Days	Final Hazard Procedures Submittal	User submits to Range final procedures for all hazardous operations	WFF RSM P/L Mgr. L/V MIM	Project provides procedures for hazardous operations	Proposed Hazardous Operations Procedures Document
L-75 days	System Safety A/I Resolution Meeting	Attempt to close out safety action items	WFF RSM P/L Mgr. L/V MIM	Project team and WFF safety resolve all action items	Action Item close-out document
L-75 days	Environmental Test Results	Collect results for vehicle, P/L and A/C	WFF RSM P/L Mgr. L/V MIM	Project environmental team provides data	Test Result Reports

TIME	EVENT	PURPOSE	POC	INPUT	OUTPUT
NLT L-60 days	Final Trajectory Tape to WFF	Project delivers final trajectory tape to WFF	WFF RSM P/L Mgr. L/V MIM	Project provides Trajectory data tape and inputs to WFF	Final Trajectory Tape (Required for Flight Plan Approval
L-60 days	Final Flight Plan Submittal	Project delivers final Flight Plan for Aircraft Operations	WFF RSM P/L Manager	Project provides Final A/C Ops Plan	Final Flight Plan
L-45 days	Operational Procedures Approval	Internal WFF approval of Operation Procedures	WFF RSM	WFF provides letter approving hazardous operation procedures	Formal statement from WFF identifying approved procedures
L-30 days	Mission Safety Review	Closure of all Safety Action Items Definition of Safety Status	WFF RSM WFF Safety P/L Manager L/V MIM	Final Closure of Action Items by Project Teat and WFF	Memo documenting Mission Safety Readiness
L-21 days	OSD	Define Operational Safety Plan Flight Safety Plan Ground Plan GO/NO-GO Items	WFF participating organizations	WFF provides: -Flight Safety Plan -Ground Safety Plan -GO/NO-GO Items OSD defines: -Requirements Test Directives -Air Ops Plan	OSD
L-21 days	FTS Certification	Test Plan & documentation for FTS	WFF Safety L/V MIM	WFF defines FTS certification documents	FTS test plan and document
L-14 days	Mission Readiness Review	Determine readiness of range, P/L, vehicle and supporting sites	WFF RSM	Readiness Status	Readiness Status
L-5 days	Flight Readiness Review	Determine readiness of support A/C	WFF RSM	Readiness Status	Readiness Status
L-2 days	Launch Readiness Review	Review all prelaunch testing and certification	WFF RSM	Results of prelaunch testing and certification	Launch Readiness Certification
	LAUNCH				

Change History Log

ATTACHMENT II.FF

CONTINGENCY PLAN

ATTACHMENT II.FF
HAZARDOUS WASTE CONTINGENCY PLAN

II.FF.1. Contingency Plan

The Contingency Plan is a stand alone document which is provided to each agency, organization or local community which may be called to action as part of the plan. To facilitate distribution of the plan, it is presented as a separate document (Exhibit II.FF-1) attached to this Permit.

EXHIBIT II.FF-1

Contingency Plan
Open Burning Area

CONTINGENCY PLAN

Open Burning Area

National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337

June 2005

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Appendix 1: Regulatory Compliance And Cross Reference Matrices

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1.0 EMERGENCY COORDINATOR AND OTHER RESPONSIBLE PERSONNEL

1.1 Emergency Coordinator

The Wallops Flight Facility (WFF) Fire Department responds to emergencies at WFF including Wallops Island. The Captain on Duty serves as Incident Commander, taking responsibility for all emergency response activities and, therefore, most responsibilities of the Emergency Coordinator found in Title 40, Parts 264.55 and 264.56 of the Code of Federal Regulations (CFR). He also fulfills the responsibilities of the unnamed position in 40 CFR 112.20(h)(1)(i). The remainder of this document will use the terms Incident Commander or Captain on Duty rather than Emergency Coordinator. The Incident Commander shall be thoroughly familiar with all aspects of the facility's contingency plan, all operations and activities at the facility, the location and characteristics of wastes handled, the location of all records for the facility, and the facility layout. In addition, this person shall have the authority to commit the resources necessary to execute the contingency plan. The Incident Commander will have a support group available for consultation and assistance in determining the course of mitigation of the problem. This group includes the WFF Safety, Environmental, Security, and Public Affairs staffs.

The Fire Department may be reached for emergencies at extension 911 on the facility and at (757) 824-1313 from off the facility. The radio frequency labeled as Channel 1 on all WFF handheld radios is reserved for use by the Fire Department and may be used in lieu of the telephone. Requests to external agencies for additional emergency services and personnel can be handled by the Fire Department. The Fire Department mans the emergency console and fills the position of Captain on Duty on a 24-hour per day basis. Therefore, home telephone numbers are not included in this plan.

1.2 Environmental Coordinator

The Environmental Office will assist the Fire Department by supplying technical information and notifying external agencies. If a chemical release occurs that is above a reportable quantity (i.e., CERCLA, EPCRA), the Environmental Office will immediately report the release to external agencies. The Environmental Office will also conduct reporting to agencies on a non-emergency basis. This non-emergency reporting includes written reports to meet regulatory requirements. Either the Environmental Group Lead or the Program Support Specialist can fulfill the function of Environmental Coordinator. Contact will be made by the Fire Department in any emergency. Activities are conducted at the Open Burning (OB) Area during normal work hours, making after-hours contact unlikely. The Fire Department will contact the following personnel in the order in which they appear:

Member	Facility Phone	Home Phone	Home Address
William B. Bott (Environmental Team Leader)	x1103	(757) 442-2754	6176 Johnson Pt Lane Jamesville, VA 23398
Bonnie H. Crawford (Environmental Protection Specialist)	x2234	(410) 957-2265	1915 Dividing Creek Road Pocomoke City, MD 21851

2.0 RESPONSIBILITIES

The Fire Department will be at the OB Area prior to, during, and immediately after all Open Burning activities. Therefore, all incident responses will be initiated by the Fire Department. In the event of No-Fire, all personnel will remain behind the barricade. Further instructions are found in the Open Burning Procedure Work Instruction found in Attachment 10. Small amounts of unburned, ejected propellant will be removed from the site, when cool enough to handle. These incidents are not considered an emergency and are therefore not covered in this contingency plan. Incidents covered in the remainder of this contingency plan will involve fire, or uncontrolled petroleum or hazardous materials releases.

2.1 Witness

Fire Department personnel, who will already be on the scene, will assume the responsibility of the "witness" during an incident.

In case of an emergency, all personnel must <u>first</u> evaluate and ensure their own safety and notify co-workers in the area.

After the initial safety of personnel is ensured, the witness will observe the material and character of the incident and determine as quickly and safely as possible the following: whether the material is petroleum or hazardous materials; whether it is controlled* or not; whether it is immediately dangerous or not:

If the material is petroleum and controlled:

CALL the Environmental Office at extension 1103 or 2234.

*The material is **controlled** if it is very unlikely to migrate and has not entered waters of the State (i.e., sewers, drains, pond, or stream.)

If additional Fire Department resources are required, the witness will report as much of the following information as possible to the Fire Department Dispatcher:

1. Name of reporting party;
2. Type/name of material released;
3. Location of release;
4. Status of release:
   a. controlled/contained or migrating,
   b. pose an imminent threat to people, facilities, or the environment,
   c. entered any waters such as the intracoastal waterway or the Atlantic Ocean, or
   d. entered soil;
5. Cause of release;
6. Estimated quantity and flow rate of release; and
7. Time of release.

2.2 Fire Department Dispatcher

Any incident covered in this contingency plan will involve fire, uncontrolled petroleum, or hazardous materials. Therefore, the Fire Department, who will already be on the scene, will initiate a response.

1. Dispatcher alerts remaining Fire Department personnel according to internal fire department protocol. These may include Captain on Duty; Fire Inspector; Fire Lieutenant; engine, ambulance, and crash vehicles and crews; Fire Department personnel and equipment at Wallops Island; or Haz-Mat Unit.
2. Dispatcher notifies WFF Security.
3. If it is determined that the incident involves a release of hazardous material or petroleum, the dispatcher completes an incident report form and notifies the Environmental Office.

After an Incident Commander has been established (the Incident Commander will be discussed later in section 2.3), the dispatcher may need to notify others as directed by the Incident Commander. The following is a list of contacts that may be necessary depending upon the size of the incident. The Fire Department maintains a list of these telephone numbers.

1. Mutual Aid Requests (see section 4.1)
2. Facility Operation Manager for the Open Burning Area
3. Public Affairs
4. Environmental
5. Facilities Engineering
6. Facilities Maintenance
7. Supply
8. Transportation
9. Radio Communications
10. Telecommunications
11. Documentation
12. Optical
13. Chemical Laboratory
14. Range Operations

2.3 Incident Commander

Unless already present at the OB Area, the Incident Commander will obtain all data available from the Fire Department Emergency Console or the witness. The Incident Commander may actually be the witness and then perform the next steps.

The Incident Commander must move to the site of the emergency if he/she is not already there. At the site, the Incident Commander must determine the apparent character, intensity, and size of the incident. Based upon the initial assessments made by the Incident Commander, additional staff and equipment may be summoned. Responsibilities may be delegated according to the Incident Command System or Incident Management System as defined in the Fire Department's Incident Management Guideline DOG-2017.

The Incident Commander shall be responsible for the overall management of the incident, from the time an incident is reported through termination of the command. With the WFF Safety, Environmental, Security, and Public Affairs staffs available for consultation, the Incident Commander shall ensure that the following responsibilities are met:

- Assess the situation.
- Initiate the incident command system.
- Isolate the site and establish access control points.
- Establish a command post.
- Establish hazard zone boundaries, taking into account the magnitude of the problem, wind direction, and adjacent structures. Initiate protective actions and evacuate surrounding area, if necessary.
- Identify the character, source, amount, and extent of any released materials by observation or examining facility records or manifests and, if necessary, by chemical analysis.
- Initiate basic hazard and risk assessment activities based on types and quantities of materials involved.
- Notify appropriate state and local agencies with designated response roles (see Section 2.6).
- Notify additional resources, if necessary, including a Response Contractor for cleanup assistance. The following Response companies are available on a 24-hour basis, unless otherwise noted. This list is maintained to provide contacts in the event that an oil or hazardous waste emergency exceeds WFF's resources. Copies of agreements can be found in Appendix 2.

Company	Telephone	Capabilities
A&A Environmental 1132 Marine Road Salisbury, MD 21801	(410) 543-1559 (800) 411-3353 (800) 404-8037	Oil, hazardous materials, medical wastes
Clean Venture, Inc. 2031 Inverness Avenue Baltimore, MD 21230	(410) 368-9170 (800) 347-7672	Oil, medical wastes, hazardous materials, TSD facility, underground storage tanks, explosives
Industrial Marine Service, Inc. P.O. Box 1779 Norfolk, VA 23501	(757) 543-5718 (800) 229-4671	Oil, hazardous materials, underground storage tanks, soil remediation
Petro Chem P.O. Box 1458 Norfolk, VA 23501	(757) 627-8791 (800) 723-6951	Large oil, medical wastes, underground storage tanks
Reactive Management Corporation P.O. Box 2598 Chesapeake, VA 23320	(757) 436-1033 (757) 498-2539 (800) 372-6742	Explosives, reactives, medical wastes, hazardous wastes, small oil

- Select and use the appropriate personal protection equipment.
- Initiate spill containment and control procedures.
- Notify WFF senior management.
- In accordance with Fire Department Emergency Operations Plan, make official announcements concerning the emergency and need for public action. Notify the WFF Public Affairs Office for press releases.
- Take samples of residues, if necessary, for proper characterization.
- Mitigate the hazard to the point where the scene is determined non-hazardous and no longer a threat to human health and the environment. In the case of a fire or explosion, initiate emergency response immediately. In the case of a spill/release, initiate emergency response if:
    - There is a possibility of toxic fumes, fire, or explosion that present imminent hazards to personnel, property, or the environment;
    - The material can not be contained within the immediate work area;
    - Facility personnel are not trained to contain the release; or
    - Any material is released directly into surface waters.
- Implement decontamination activities for PPE and contaminated areas.
- Ensure that contaminated materials and/or residues are containerized or packaged.

The Incident Commander shall ensure the following criteria are met:

- Cleanup procedures do not pose a compatibility threat between released substances and cleaning agents.
- Leaks and cracks are not present in the clean-up containers.
- Unusual heat is not generated in the containers.
- Residual waste materials are isolated.
- All emergency equipment listed in the contingency plan are cleaned and fit for their intended use or are replaced before operations are resumed.
- The time, date, and details of any incident that required implementing the contingency plan are noted in the operating record.

2.3.1 Evacuation Procedures

If an incident presents a threat to personnel, personnel may evacuate in several directions from the OB Area. In most cases, personnel should travel north on the roadway until they are a safe distance from the event. If that direction is blocked, personnel may go east to the ocean or south along the beach. Appendix 3 includes maps of OB Area, evacuation routes, and the surrounding area.

2.3.2 Procedures Assessment

During an open burn event, Material Safety Data Sheets (MSDS) will be available for the burning material. These will provide helpful details and must be consulted for data regarding the characteristics of the material and the nature of the hazards.

The Haz-Mat Response Guideline DOG-2006 includes sections on identifying materials and on hazard/risk assessment. The Department's investigator may obtain any identifying numbers such as a hazardous material identifying placard on a truck or other vehicle, look at shipping papers or manifests, or obtain information from site personnel. Motor shapes, sizes, or types may also be valuable information. The Department of Transportation (DOT) guidebook, *North American Emergency Response Guidebook* (ERG) or other authoritative publication may be used to research the material's identifying numbers or names.

A full list of materials for disposal will be maintained at all times and should be available during OB Area operations. This information on manifests, on MSDS, or on other appropriate documents should be used to obtain data useful to control the danger. A list of typical rocket motors, their propellant compositions, hazards and MSDS can also be found in Appendix 4.

Various tools may be used to obtain data to make assessments. The Incident Commander will make visual on-site assessment from a safe distance. Requests for information may be made to the facility operation manager or nearby workers. Additional tools may be used as noted below:

Tool:	Likely information available:
Report of initial witness	1. Location 2. Incident type 3. Magnitude 4. Materials involved 5. Threats to personnel, facilities, or environment
Facility maps	1. Location of incident 2. Facility surroundings under potential threat 3. Environmental surroundings under potential threat
Facility operation manager	1. Materials involved 2. Personnel involved
Distant visual assessment	1. Incident type 2. Magnitude 3. Materials involved, possibly
Nearby personnel	1. Incident history 2. Personnel involved 3. Materials involved
MSDS	1. Material hazards 2. Safe handling techniques

Tool:	Likely information available:
Hazardous material inventory database	1. Materials involved 2. Other nearby materials which may be threatened
Field analytical instruments such as: 1. LEL Meter 2. Oxygen Meter 3. Photoionization Detector 4. Other instruments	1. Materials involved 2. Level of hazard 3. Level of contamination
Field samples and chemical analysis 1. Soil 2. Sediment 3. Ground water 4. Surface water	1. Level of contamination 2. Remediation end point

In order to effectively manage the use of these tools and the data obtained from them, the Incident Commander may establish an Investigation and Planning Sector, as part of the Incident Command System, with appropriate personnel to assess the hazard.

2.3.3 Prevention of Reoccurrence

During and after an emergency, the Incident Commander shall take all reasonable measures necessary to ensure that fires, explosions, and releases do not occur, reoccur, or spread to other hazardous waste at the facility. These measures shall include, where applicable, stopping processes and operations, collecting and containing released substances, and removing or isolating containers.

2.4 Environmental Office

The Environmental Office is contacted by the Fire Department if the spill involves either uncontrolled petroleum or hazardous materials or is a threat to personnel, the facility, or the environment. The Environmental Office assumes the following responsibilities:

If the spill is greater than 25 gallons of petroleum or has entered the waters of the Commonwealth, the Tidewater Regional Office of the Virginia Department of Environmental Quality (DEQ), must be notified within 2 hours at (757) 518-2000. Also, the Virginia Department of Emergency Management at (800) 468-8892 and the National Response Center at (800) 424-8802 (or on the internet at http://www.nrc.uscg.mil/report.htm) must be notified, within 2 hours. The Environmental Office will give the following information to all parties:

1. Time of discharge;
2. Location of discharge;
3. Type and quantity of release;
4. The extent of injuries, if any;
5. The possible hazard to human health or the environment, outside the facility; and

6. Name, address, and telephone number of person making the report, and all other pertinent and necessary information.

If a release, fire, or explosion occurs, which threatens human health or the environment outside the facility or if a release exceeds the reportable quantity of a hazardous material (i.e., CERCLA, EPCRA), it must be reported immediately to the National Response Center at (800) 424-8802 or on the internet at http://www.nrc.uscg.mil/report.htm, the DEQ at (757) 518-2000, and the Virginia Department of Emergency Management at (800) 468-8892. The full list of minimum reportable quantities is found in Contingency Plan Annex 1 Regulatory Compliance and Cross-Reference Matrices. This list is referenced from 40 CFR 117.3.

The Environmental Staff shall be available to the Incident Commander to assist in the following areas:

- Substantiating regulatory compliance;
- Managing environmental aspects of site restoration including decontamination of personnel, equipment, and the scene;
- Transporting, if practicable, the containerized contaminated debris and materials;
- Assisting with arrangements for either onsite remediation or offsite transportation, treatment, storage, and disposal of hazardous wastes, including sampling for waste identification, by an EPA permitted transportation, storage, and disposal facility;

3.0 FOLLOW-UP ACTIONS

3.1 Remediation of Area

The incident area must be thoroughly remediated and decontaminated before OB Area operations may be resumed. Contaminated soil or water must be containerized, characterized and disposed of in accordance with state and federal regulations. All remediation and decontamination must be documented in the follow-up reports listed below in Section 3.3 before operations may resume.

3.2 Decontamination of Emergency Equipment

The decontamination wash waters (wastewaters), rinseates, soils, and residues collected in the decontamination areas will be managed as potentially contaminated with hazardous waste and tested for the HCOCs and TCLP constituents, as identified in the OB Area Permit. All hazardous wastes will be disposed of in accordance with state and federal regulations.

Any disposable items, such as protective clothing, sampling equipment, filters, clean-up materials, decontamination liner materials, etc., will be containerized, characterized and disposed of in accordance with state and federal regulations.

3.2.1 Small Equipment

A decontamination area will be set up for all non-disposable response equipment decontamination. The area will be set up on plastic and down gradient of the OB units. All nondisposable response equipment will be decontaminated after use. An area for cleaning equipment will be established as close as possible to the work area. A layer of plastic will be placed on a level surface. Buckets or other appropriate containers will be used for capturing the rinseate and holding the wash-water during the cleaning process.

The equipment shall be decontaminated, as follows:

The decontamination procedures for equipment (*EPA Region IV, Standard Operating Procedures and Quality Assurance Manual*, 1986), will be as follows:

1. Remove loose material by brushing or scraping. The material removed will be properly containerized and disposed of in accordance with all applicable state and federal hazardous and solid waste regulations.
2. The equipment will then be washed with a non-phosphate detergent. All decontamination wash waters will be collected and containerized for proper disposal in accordance with state and federal regulations.
3. Rinse with tap water, rinse with methanol or propanol, then rinse with distilled or de-ionized water. These decontamination rinse waters will be collected and containerized for proper disposal in accordance with state and federal regulations.
4. If metal contamination is present, a rinse with 10 percent nitric acid will also be needed. This acid rinse will be followed by another distilled or de-ionized water rinse. This rinseate shall be collected and containerized for proper disposal in accordance with state and federal regulations.
5. Equipment will be allowed to air dry then stored in aluminum foil or plastic bags to prevent contamination.

In addition, the following procedures shall be established for the proper decontamination of personal protective equipment (PPE).

1. PPE will be decontaminated between uses/areas, and upon completion of work.
2. All decontamination will take place in the temporary decontamination area.

3.2.2 Large Equipment

If, the decontamination of heavy equipment is necessary, a temporary decontamination area for this heavy equipment will be constructed. The area will be graded to at least a 2 percent slope toward one corner. A berm constructed of sand bags, or equivalent material, will be placed around the edges. The area will be lined with a plastic liner to prevent infiltration of decontamination wafers into the underlying soils. The liner must be able to sustain the stress caused by moving of heavy equipment in and out of the area. The decontamination waters must

drain to an appropriate container; no accumulation of liquids on the liner is allowed. This collected liquid will be tested for appropriate disposal and disposed of in accordance with state and federal regulations. All decontamination shall occur in the decontamination area constructed and waste generated will be properly handled in accordance with all applicable state and federal hazardous and solid waste regulations. The decontamination procedures for heavy equipment are:

1. Heavy equipment used to remove contaminated soil will be decontaminated by appropriate abrasive methods (i.e., scraping and/or brushing). The material removed will be properly containerized and disposed of in accordance with all applicable state and federal hazardous and solid waste regulations.
2. Equipment will then be cleaned with a high-pressure wash. A non-phosphate detergent shall be used. All decontamination wash waters will be collected and containerized for proper disposal in accordance state and federal regulations.
3. The heavy equipment will then be rinsed with water, rinsed with methanol or propanol, and then rinsed with distilled or de-ionized water. This decontamination rinseate will be collected and containerized for proper disposal in accordance with state and federal regulations.
4. If heavy metal contamination is present, a rinse with 10 percent nitric acid may also be needed. This acid rinse will be followed by another water rinse. These rinse waters shall be collected and containerized for proper disposal in accordance with state and federal regulations.
5. Equipment will be allowed to air dry then covered in plastic sheeting to prevent contamination.

Before operations are resumed, the decontamination of emergency equipment and the disposal of generated wastes will be documented in the follow-up reports listed below in Section 3.3.

3.3 Follow-up Reports

A written report must be submitted to the Secretary of the DEQ and to the EPA Regional Administrator, within 15 days of the incident. This report must include the following:

1. the name, address and telephone number of the operator and the facility;
2. the date, time and type of incident;
3. the name and quantity of material(s) involved;
4. the extent of injuries;
5. an assessment of actual or potential hazards to human health or the environment;
6. the estimated quantity and disposition of recovered material that resulted from the incident;
7. the remediation procedures used and results obtained; and
8. the decontamination procedures employed.

The addresses of these agencies are listed below. These reports must be filed before operations may be resumed. Send one copy of the report to each of the following addresses:

Director, Tidewater Regional Office
Commonwealth of Virginia
Department of Environmental Quality
5636 Southern Boulevard
Virginia Beach, VA 23462

Director, Department of Environmental Quality
Commonwealth of Virginia
Attn: OWP Staff
PO Box 10009
Richmond, VA 23240-0009

United States Environmental Protection Agency
Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

3.4 Security Staff Responsibilities

The WFF Security Staff will assist the Emergency Coordinator in any evacuation procedures, site access, and security measures.

4.0 ADMINISTRATIVE ISSUES

4.1 Mutual Aid Agreements

The Fire Department has established a mutual aid agreement for such emergency services as fire fighting, rescue, Haz-mat response and emergency medical services (including basic life support and advanced life support) with the Accomack County Fire and Rescue Commission. This agreement also covers the Virginia Department of Emergency Services response. It is noteworthy that the office of the Director of Emergency Medical Services for Accomack County (life support services) also holds the position of Director of Emergency Medicine at Shore Memorial Hospital.

The Security Office has entered into verbal agreements of mutual aid with the Town of Chincoteague Police Department, the Accomack County Sheriff's Department, and the Virginia State Police. The Health Unit retains an agreement with the Maryland State Police Aviation Division for Med-Evac helicopter services from WFF. Although, the Med-Evac helicopters will

not transport patients who have been exposed to hazardous materials, the nature of activities at the OB Area is such that an injury incident is much more probable than an exposure incident.

We have a letter from Peninsula Regional Medical Center, Salisbury, Maryland stating that they are "well prepared to handle any and all hazardous material exposure of ... Wallops employees."

Copies of any written agreements are included in Appendix 2 and are also available for review at the Wallops Fire Department.

4.2 Hazmat Emergency Equipment

No equipment is stored at the OB Area. Therefore, this section discusses the equipment that the Fire Department either brings to OB operations or would have available. The following emergency equipment inventory is for Fire Department No. 2 on Wallops Island. The fire department on Wallops Island consists of two fire trucks with a total capacity of 56,788 liters (1,500 gallons) of water and 227 liters (60 gallons) of foam. On the Island, three water storage towers 56,781,189,270, and 189,279 liters (150,000, 50,000 and 50,000 gallons) provide water to a water hydrant system maintained at 3,785 liters per minute at 1.4 kilograms per square centimeter (1,000 gallons per minute at 20 pounds per square inch). In addition, a 378,541 liter (100,000 gallon) storage tank located on the mainland provides water to the Island. The closest water hydrant to the OB Area is located approximately 609 meters (2,000 feet) away at the Virginia Commercial Spaceport. Hydrant flow tests are performed annually by the fire department to ensure the water supply system is functioning properly. Pumper trucks are used at the open burning area. In the event additional capacity is needed, a 26, 498 liter (7,000 gallon) fire truck is available from the Main Base.

Fire Department No. 2 currently stocks the following spill response equipment:

Quantity	Item	Description and Usage	Capacity	Total Capacity
8	Absorbent clay (50 pound bag)	Absorb and prevent the spread of spills	10 gallons oil per 50 pound bag	80 gallons oil
1	Pig putty (12oz tube)	Putty used to seal leaks on drums		
240	Absorbent Pads	Absorb and prevent the spread of spills	20 ounces of oil per pad	37.5 gallons oil
3	Pig Pillows	Absorb and prevent the spread of spills	0.5 gallons oil per pillow	1.5 gallons oil
6	Pig Pans	Absorb and prevent the spread of spills	0.5 gallons oil per pillow	3 gallons oil
30 (167 ft)	4, 6 and 10 foot Booms	Absorb and prevent the spread of spills	2 gallons oil per 10 feet	33.4 gallons oil

4.3 Locations of Copies of this Contingency Plan

Copies of this contingency plan will be maintained in X-55 Launch Support Services Building in the OB records area, at the Fire Department, at the Environmental Office, and in various

administrative files at the WFF. Copies have been sent to all mutual aid facilities described above in Section 4.1 of the Contingency Plan.

4.4 Review and Revision of this Contingency Plan

The plan must be reviewed and revised as necessary when the following occurs:

1. after an emergency incident,
2. when personnel listed in this document change,
3. when the contingency plan for the WFF base is reviewed and modified as necessary,
4. at Open Burn permit renewal, or
5. other times as deemed necessary by management personnel.

This review and any conclusions must be documented and the latest date of review placed at the head of this plan.

Contingency Plan
Appendix 1
Regulatory Compliance and Cross Reference Matrices

Reportable quantities

NOTE: The first number under the column headed "RQ" is the reportable quantity in pounds. The number in parentheses is the metric equivalent in kilograms. For convenience, the table contains a column headed "Category" which lists the code letters "X", "A", "B", "C", and "D" associated with reportable quantities of 1, 10, 100, 1000, and 5000 pounds, respectively.

40 CFR 117.3, TABLE 117.3—REPORTABLE QUANTITIES OF HAZARDOUS SUBSTANCES DESIGNATED PURSUANT TO SECTION 311 OF THE CLEAN WATER ACT

Material	Category	RQ in pounds (kilograms)
Acetaldehyde	C	1,000 (454)
Acetic acid	D	5,000 (2,270)
Acetic anhydride	D	5,000 (2,270)
Acetone cyanohydrin	A	10 (4.54)
Acetyl bromide	D	5,000 (2,270)
Acetyl chloride	D	5,000 (2,270)
Acrolein	X	1 (0.454)
Acrylonitrile	B	100 (45.4)
Adipic acid	D	5,000 (2,270)
Aldrin	X	1 (0.454)
Allyl alcohol	B	100 (45.4)
Allyl chloride	C	,000 (454)
Aluminum sulfate	D	5,000 (2,270)
Ammonia	B	100 (45.4)
Ammonium acetate	D	5,000 (2,270)
Ammonium benzoate	D	5,000 (2,270)
Ammonium bicarbonate	D	5,000 (2,270)
Ammonium bichromate	A	10 (4.54)
Ammonium bifluoride	B	100 (45.4)
Ammonium bisulfite	D	5,000 (2,270)
Ammonium carbamate	D	5,000 (2,270)
Ammonium carbonate	D	5,000 (2,270)
Ammonium chloride	D	5,000 (2,270)
Ammonium chromate	A	10 (4.54)
Ammonium citrate dibasic	D	5,000 (2,270)
Ammonium fluoborate	D	5,000 (2,270)
Ammonium fluoride	B	100 (45.4)
Ammonium hydroxide	C	1,000 (454)
Ammonium oxalate	D	5,000 (2,270)
Ammonium silicofluoride	C	1,000 (454)
Ammonium sulfamate	D	5,000 (2,270)
Ammonium sulfide	B	100 (45.4)
Ammonium sulfite	D	5,000 (2,270)
Ammonium tartrate	D	5,000 (2,270)
Ammonium thiocyanate	D	5,000 (2,270)
Amyl acetate	D	5,000 (2,270)
Aniline	D	5,000 (2,270)
Antimony pentachloride	C	1,000 (454)
Antimony potassium tartrate	B	100 (45.4)
Antimony tribromide	C	1,000 (454)
Antimony trichloride	C	1,000 (454)
Antimony trifluoride	C	1,000 (454)
Antimony trioxide	C	1,000 (454)
Arsenic disulfide	X	1 (0.454)
Arsenic pentoxide	X	1 (0.454)
Arsenic trichloride	X	1 (0.454)
Arsenic trioxide	X	1 (0.454)
Arsenic trisulfide	X	1 (0.454)
Barium cyanide	A	10 (4.54)
Benzene	A	10 (4.54)
Benzoic acid	D	5,000 (2,270)
Benzonitrile	D	5,000 (2,270)
Benzoyl chloride	C	1,000 (454)
Benzyl chloride	B	100 (45.4)
Beryllium chloride	X	1 (0.454)
Beryllium fluoride	X	1 (0.454)
Beryllium nitrate	X	1 (0.454)
Butyl acetate	D	5,000 (2,270)
Butylamine	C	1,000 (454)
n-Butyl phthalate	A	10 (4.54)
Butyric acid	D	5,000 (2,270)
Cadmium acetate	A	10 (4.54)
Cadmium bromide	A	10 (4.54)
Cadmium chloride	A	10 (4.54)
Calcium arsenate	X	1 (0.454)
Calcium arsenite	X	1 (0.454)
Calcium carbide	A	10 (4.54)
Calcium chromate	A	10 (4.54)
Calcium cyanide	A	10 (4.54)
Calcium dodecylbenzenesulfonate	C	1,000 (454)
Calcium hypochlorite	A	10 (4.54)
Captan	A	10 (4.54)
Carbaryl	B	100 (45.4)
Carbofuran	A	10 (4.54)
Carbon disulfide	B	100 (45.4)

40 CFR 117.3, TABLE 117.3—REPORTABLE QUANTITIES OF HAZARDOUS SUBSTANCES DESIGNATED PURSUANT TO SECTION 311 OF THE CLEAN WATER ACT		
Material	*Category*	*RQ in pounds (kilograms)*
Carbon tetrachloride	A	10 (4.54)
Chlordane	X	1 (0.454)
Chlorine	A	10 (4.54)
Chlorobenzene	B	100 (45.4)
Chloroform	A	10 (4.54)
Chlorosulfonic acid	C	1,000 (454)
Chlorpyrifos	X	1 (0.454)
Chromic acetate	C	1,000 (454)
Chromic acid	A	10 (4.54)
Chromic sulfate	C	1,000 (454)
Chromous chloride	C	1,000 (454)
Cobaltous bromide	C	1,000 (454)
Cobaltous formate	C	1,000 (454)
Cobaltous sulfamate	C	1,000 (454)
Coumaphos	A	10 (4.54)
Cresol	B	100 (45.4)
Crotonaldehyde	B	100 (45.4)
Cupric acetate	B	100 (45.4)
Cupric acetoarsenite	X	1 (0.454)
Cupric chloride	A	10 (4.54)
Cupric nitrate	B	100 (45.4)
Cupric oxalate	B	100 (45.4)
Cupric sulfate	A	10 (4.54)
Cupric sulfate, ammoniated	B	100 (45.4)
Cupric tartrate	B	100 (45.4)
Cyanogen chloride	A	10 (4.54)
Cyclohexane	C	1,000 (454)
2,4-D Acid	B	100 (45.4)
2,4-D Esters	B	100 (45.4)
DDT	X	1 (0.454)
Diazinon	X	1 (0.454)
Dicamba	C	1,000 (454)
Dichlobenil	B	100 (45.4)
Dichlone	X	1 (0.454)
Dichlorobenzene	B	100 (45.4)
Dichloropropane	C	1,000 (454)
Dichloropropene	B	100 (45.4)
Dichloropropene-Dichloropropane (mixture)	B	100 (45.4)
2,2-Dichloropropionic acid	D	5,000 (2,270)
Dichlorvos	A	10 (4.54)
Dicofol	A	10 (4.54)
Dieldrin	X	1 (0.454)
Diethylamine	B	100 (45.4)
Dimethylamine	C	1,000 (454)
Dinitrobenzene (mixed)	B	100 (45.4)
Dinitrophenol	A	10 (45.4)
Dinitrotoluene	A	10 (4.54)
Diquat	C	1,000 (454)
Disulfoton	X	1 (0.454)
Diuron	B	100 (45.4)
Dodecylbenzenesulfonic acid	C	1,000 (454)
Endosulfan	X	1 (0.454)
Endrin	X	1 (0.454)
Epichlorohydrin	B	100 (45.4)
Ethion	A	10 (4.54)
Ethylbenzene	C	1,000 (454)
Ethylenediamine	D	5,000 (2,270)
Ethylenediamine-tetraacetic acid (EDTA)	D	5,000 (2,270)
Ethylene dibromide	X	1 (0.454)
Ethylene dichloride	B	100 (45.4)
Ferric ammonium citrate	C	1,000 (454)
Ferric ammonium oxalate	C	1,000 (454)
Ferric chloride	C	1,000 (454)
Ferric fluoride	B	100 (45.4)
Ferric nitrate	C	1,000 (454)
Ferric sulfate	C	1,000 (454)
Ferrous ammonium sulfate	C	1,000 (454)
Ferrous chloride	B	100 (45.4)
Ferrous sulfate	C	1,000 (454)
Formaldehyde	B	100 (45.4)
Formic acid	D	5,000 (2,270)
Fumaric acid	D	5,000 (2,270)
Furfural	D	5,000 (2,270)
Guthion	X	1 (0.454)
Heptachlor	X	1 (0.454)
Hexachlorocyclopentadiene	A	10 (4.54)
Hydrochloric acid	D	5,000 (2,270)
Hydrofluoric acid	B	100 (45.4)
Hydrogen cyanide	A	10 (4.54)
Hydrogen sulfide	B	100 (45.4)
Isoprene	B	100 (45.4)

40 CFR 117.3, TABLE 117.3—REPORTABLE QUANTITIES OF HAZARDOUS SUBSTANCES DESIGNATED PURSUANT TO SECTION 311 OF THE CLEAN WATER ACT		
Material	Category	RQ in pounds (kilograms)
Isopropanolamine dodecylbenzenesulfonate	C	1,000 (454)
Kepone	X	1 (0.454)
Lead acetate	A	10 (4.54)
Lead arsenate	X	1 (0.454)
Lead chloride	A	10 (4.54)
Lead fluoborate	A	10 (4.54)
Lead fluoride	A	10 (4.54)
Lead iodide	A	10 (4.54)
Lead nitrate	A	10 (4.54)
Lead stearate	A	10 (4.54)
Lead sulfate	A	10 (4.54)
Lead sulfide	A	10 (4.54)
Lead thiocyanate	A	10 (4.54)
Lindane	X	1 (0.454)
Lithium chromate	A	10 (4.54)
Malathion	B	100 (45.4)
Maleic acid	D	5,000 (2,270)
Maleic anhydride	D	5,000 (2,270)
Mercaptodimethur	A	10 (4 54)
Mercuric cyanide	X	1 (0.454)
Mercuric nitrate	A	10 (4.54)
Mercuric sulfate	A	10 (4.54)
Mercuric thiocyanate	A	10 (4.54)
Mercurous nitrate	A	10 (4.54)
Methoxychlor	X	1 (0.454)
Methyl mercaptan	B	100 (45.4)
Methyl methacrylate	C	1,000 (454)
Methyl parathion	B	100 (45.4)
Mevinphos	A	10 (4.54)
Mexacarbate	C	1,000 (454)
Monoethylamine	B	100 (45 4)
Monomethylamine	B	100 (45.4)
Naled	A	10 (4.54)
Naphthalene	B	100 (45.4)
Naphthenic acid	B	100 (45.4)
Nickel ammonium sulfate	B	100 (45.4)
Nickel chloride	B	100 (45.4)
Nickel hydroxide	A	10 (4.54)
Nickel nitrate	B	100 (45.4)
Nickel sulfate	B	100 (45.4)
Nitric acid	C	1,000 (454)
Nitrobenzene	C	1,000 (454)
Nitrogen dioxide	A	10 (4.54)
Nitrophenol (mixed)	B	100 (45 4)
Nitrotoluene	C	1,000 (454)
Paraformaldehyde	C	1,000 (454)
Parathion	A	10 (4.54)
Pentachlorophenol	A	10 (4.54)
Phenol	C	1,000 (454)
Phosgene	A	10 (4.54)
Phosphoric acid	D	5,000 (2,270)
Phosphorus	X	1 (0.454)
Phosphorus oxychloride	C	1,000 (454)
Phosphorus pentasulfide	B	100 (45.4)
Phosphorus trichloride	C	1,000 (454)
Polychlorinated biphenyls	X	1 (0.454)
Potassium arsenate	X	1 (0.454)
Potassium arsenite	X	1 (0.454)
Potassium bichromate	A	10 (4.54)
Potassium chromate	A	10 (4.54)
Potassium cyanide	A	10 (4.54)
Potassium hydroxide	C	1,000 (454)
Potassium permanganate	B	100 (45.4)
Propargite	A	10 (4.54)
Propionic acid	D	5,000 (2,270)
Propionic anhydride	D	5,000 (2,270)
Propylene oxide	B	100 (45.4)
Pyrethrins	X	1 (0.454)
Quinoline	D	5,000 (2,270)
Resorcinol	D	5,000 (2,270)
Selenium oxide	A	10 (4.54)
Silver nitrate	X	1 (0.454)
Sodium	A	10 (4 54)
Sodium arsenate	X	1 (0.454)
Sodium arsenite	X	1 (0.454)
Sodium bichromate	A	10 (4.54)
Sodium bifluoride	B	100 (45.4)
Sodium bisulfite	D	5,000 (2,270)
Sodium chromate	A	10 (4.54)
Sodium cyanide	A	10 (4.54)
Sodium dodecylbenzenesulfonate	C	1,000 (454)

40 CFR 117.3, TABLE 117.3—REPORTABLE QUANTITIES OF HAZARDOUS SUBSTANCES DESIGNATED PURSUANT TO SECTION 311 OF THE CLEAN WATER ACT		
Material	Category	RQ in pounds (kilograms)
Sodium fluoride	C	1,000 (454)
Sodium hydrosulfide	D	5,000 (2,270)
Sodium hydroxide	C	1,000 (454)
Sodium hypochlorite	B	100 (45.4)
Sodium methylate	C	1,000 (454)
Sodium nitrite	B	100 (45.4)
Sodium phosphate, dibasic	D	5,000 (2,270)
Sodium phosphate, tribasic	D	5,000 (2,270)
Sodium selenite	B	100 (45 4)
Strontium chromate	A	10 (4 54)
Strychnine	A	10 (4.54)
Styrene	C	1,000 (454)
Sulfuric acid	C	1,000 (454)
Sulfur monochloride	C	1,000 (454)
2,4,5-T acid	C	1,000 (454)
2,4,5-T amines	D	5,000 (2,270)
2,4,5-T esters	C	1,000 (454)
2,4,5-T salts	C	1,000 (454)
TDE	X	1 (0.454)
2,4,5-TP acid	B	100 (45.4)
2,4,5-TP acid esters	B	100 (45.4)
Tetraethyl lead	A	10 (4.54)
Tetraethyl pyrophosphate	A	10 (4.54)
Thallium sulfate	B	100 (45.4)
Toluene	C	1,000 (454)
Toxaphene	X	1 (0.454)
Trichlorfon	B	100 (45.4)
Trichloroethylene	B	100 (45.4)
Trichlorophenol	A	10 (4.54)
Triethanolamine dodecylbenzenesulfonate	C	1,000 (454)
Triethylamine	D	5,000 (2,270)
Trimethylamine	B	100 (45.4)
Uranyl acetate	B	100 (45.4)
Uranyl nitrate	B	100 (45.4)
Vanadium pentoxide	C	1,000 (454)
Vanadyl sulfate	C	1,000 (454)
Vinyl acetate	D	5,000 (2,270)
Vinylidene chloride	B	100 (45.4)
Xylene (mixed)	B	100 (45.4)
Xylenol	C	1,000 (454)
Zinc acetate	C	1,000 (454)
Zinc ammonium chloride	C	1,000 (454)
Zinc borate	C	1,000 (454)
Zinc bromide	C	1,000 (454)
Zinc carbonate	C	1,000 (454)
Zinc chloride	C	1,000 (454)
Zinc cyanide	A	10 (4.54)
Zinc fluoride	C	1,000 (454)
Zinc formate	C	1,000 (454)
Zinc hydrosulfite	C	1,000 (454)
Zinc nitrate	C	1,000 (454)
Zinc phenolsulfonate	D	5,000 (2,270)
Zinc phosphide	B	100 (45.4)
Zinc silicofluoride	D	5,000 (2,270)
Zinc sulfate	C	1,000 (454)
Zirconium nitrate	D	5,000 (2,270)
Zirconium potassium fluoride	C	1,000 (454)
Zirconium sulfate	D	5,000 (2,270)
Zirconium tetrachloride	D	5,000 (2,270)

[50 FR 13513, Apr 4, 1985, as amended at 51 FR 34547, Sept 29, 1986; 54 FR 33482, Aug 14, 1989; 58 FR 35327, June 30, 1993; 60 FR 30937, June 12, 1995]

The applicable regulations are found in 40 CFR 264.50 through 40 CFR 264.55. §264.50 and §264.51 describe applicability and purpose and do not require contents in the plan.

Regulatory section	Plan section	Comments
§264.52(a)	2.0, plus others	Actions of facility personnel
52(b)	Does not require contents	Revised version of SPCC allowed
52(c)	1.1, 2.3, 4.1	Arrangements with local police, fire departments and others
52(d)	2.3	Who is emergency coordinator
52(e)	4.2	List of emergency equipment on site
52(f)	2.3.1	Evacuation plan
§264.53	4.3	Placement of copies of contingency plan
§264.54	4.4	Occasions for amendment of the contingency plan
§264.55	1.0, 2.3	Emergency coordinator
§264.56(a)	1.0, 2.0, 3.3	Internal and external notifications
56(b)	2.1, 2.2, 2.3, 2.3.2	Characteristics of release
56(c)	2.3	Assessment of hazards
56(d)	2.4, 3.3	External notifications
56(e)	2.3, 2.3.3	Segregation of hazardous materials from incident
56(f)	2.3, 3.2	Safety of operational equipment
56(g)	3.1	Clean up of hazardous waste
56(h)	3.1, 3.2	Clean up of emergency equipment and others
56(i)	2.4, 3.3	Initial follow-up reports
56(j)	3.3	Full follow-up reports

Contingency Plan
Appendix 2
Copies of Aid Agreements

Mutual Aid Agreement Between

EG&G Technical Services, Inc
(Wallops Fire Department)

And the

Accomack County Fire and Rescue Commission

The agreement entered into between the EG&G Technical Services, Inc, (EG&G)/ Wallops Fire Department, (WFD) and Accomack Fire and Rescue Commission, (Accomack County) is for the purpose of providing mutual aid for emergency services. Emergency services include Fire Fighting, Rescue, Haz-mat and Emergency Medical Services-(ALS/BLS). This mutual aid agreement is primarily one of services rendered for services provided.

1. Any request for aid hereunder shall be from, the Accomack County (9-1-1) Center, Chincoteague (9-1-1) Center, or an "Officer in Charge" at an emergency. Requests for aid will include the amount and type of equipment, personnel requested, and shall specify the location. The representative of the responding organization shall determine amount and type of equipment and the number of personnel to be furnished. The (EG&G)/(WFD) will not conduct "at-will responses" to Accomack.

2. The responding organization shall report to the "Officer in Charge" of the requesting organization at the location to which the equipment is dispatched, and shall be subject to the orders of that Official.

3. A responding organization shall be released by the requesting organization when the services of the responding organization are no longer required or when the responding organization is needed within the area for which it normally provides services.

4. In the event of a crash of aircraft or aero-space vehicles owned or operated by NASA or the United States within Accomack, The (EG&G)/(WFD) Fire Chief or designated representative, of the Wallops Fire Department, may assume full "Command Duties" on arrival at the scene of the crash.

5. Each party waives all claims against every other party for compensation for any loss, damage, personal injury, or death occurring as a consequence of the performance of this agreement.

6. No official shall profit from this agreement.

7. (EG&G)/(WFD) intends this to be a long-term agreement and recognizes that Accomack County will re-consider this agreement annually. Either party shall give the other Sixty (60) days notice of any intention to cancel.

1 APR 2002

Mr. Joseph B. Conaty, Fire Chief — Date
Wallops Fire Department

1 APR 02

Mr. Clayton S. Wetzell, III, Contract Manager — Date
EG&G Technical Services, Inc.

Richard W. Surran 03/APR/02

Mr. Richard W. Surran, President — Date
Accomack County Fire & Rescue Commission

17/Apr/02

Mr. Donald L. Hart, Chairperson — Date:
Accomack County Board of Supervisors

ROBERT L. EHRLICH JR.
GOVERNOR

MICHAEL S. STEELE
LT. GOVERNOR

STATE OF MARYLAND
MARYLAND STATE POLICE
TOLL FREE: 1-800-525-5555

Aviation Division - H.Q.
3023 Strawberry Point Road
Baltimore, Maryland 21220-5577
(410) 238-5800

COLONEL EDWARD T. NORRIS
SUPERINTENDENT

September 24, 2003

Diane Weller, RN
Health Unit
NASA Wallops Flight Facility
Building F–160
Wallops Island, Virginia 23337

Dear Nurse Weller:

This letter is in response to your request to update the Maryland State Police Med-Evac helicopters response capability to Wallops Island in the event of a medical emergency. Our policy has not changed since the previous correspondence. Guidelines continue to allow for out of state transports within a 30 mile radius of the State of Maryland.

The patient must meet State of Maryland medical protocols as an approved candidate for aerial transport. Currently, we do not transport patients that have been exposed to hazardous materials.

Should you need further information, please feel free to contact me at the above phone number. Should you care to contact our Aeromedical Director, Dr. Douglas Floccare, he can be reached at 410-706-0880.

Sincerely,

Donald G Lewis

Donald G. Lewis, Major
Commander, Aviation Division
Maryland State Police

DGL/pmc

April 8, 2005

We called the Maryland State Police on April 6, 2005 as we had not received a response to our letter of March 7, 2005. Crystal spoke with First Sergeant Bruns, On Flight Operations.
He stated "there have been no changes since September 2003", in the Maryland State Police Med-Evac helicopters response capability to Wallops Island in the event of a medical emergency.

Diane Weller, RN

Diane Weller, RN

NASA Wallops Health Unit
Building F-160
Wallops Island, VA 23337

March 7, 2005

Donald G. Lewis, Major
Commander, Aviation Division
Maryland State Police

Dear Major Lewis,

The biannual NASA Occupational Health Program audit of the Wallops Flight Facility Health Unit is scheduled for April 19, 2005. We are required to have updated documentation of the availability of emergency response capability.

Therefore, I am requesting a letter updating the Maryland State Police Med-Evac helicopters response capability to Wallops Island in the event of a medical emergency.

I have enclosed a copy of the letter we received from you in September 2003 for your reference.

Should you have any questions or concerns, please feel free to contact me at 757-824-1336.

Thank you for your help and support.

Sincerely,

Diane Weller, RN

Diane Weller, RN
Nurse Manager
NASA Wallops Health Unit

PENINSULA REGIONAL
MEDICAL CENTER

May 26, 2005

Marianne Simko
Wallops Flight Facility
Building F 160
Wallops Island, VA 23337

Dear Captain on Duty:

Please be advised that Peninsula Regional Medical Center's Emergency Department is most willing and well prepared to handle any and all hazardous material exposures of your wallops employees. We are a 24/7 fully functional emergency department and appreciate the opportunity to meet your potential needs.

If you have any questions, please let me know.

Sincerely,

William Todd, M.D.
Medical Director

National Aeronautics and
Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337-5099

Reply to Attn of:

250.W

June 10, 2004

MEMORANDUM FOR THE RECORD

FROM: 250/Environmental Group Leader

SUBJECT: Confirmation of Spill Response Contractor Commitments

In February 2004, Ms. Susan Dunn of the Environmental Office contacted the following Spill Response Contractors in order to confirm their continued availability in response to an emergency at Wallops Flight Facility. Ms. Dunn received verbal commitments from each contractor and was informed that written responses would follow.

Contractor	Contact
A&A Environmental	Scott Adkins
Clean Venture, Inc.	David P. Roesler
Industrial Marine Service, Inc.	Christa Salmon
Petro Chem	Chris Bowne
Reactive Management Corp.	George C. Walton

If there are any questions, please contact Ms. Susan Dunn at (757) 824-1832.

William B. Bott

Mailing Address: P.O. Box 1779
rfolk, VA 23501-1779
)ping Address: 1301 Marsh Street
.orfolk, VA 23501

24 Hours: (757) 543-5718
1-800-229-4671
Fax: (757) 543-4561

IMS
ENVIRONMENTAL
SERVICES

February 6, 2004

NASA
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Dear Mr. William Bott:

I have prepared the following contingency information per Susan Dunn's conversation with Wendy Risher.

The documentation provided will assist in compliance with the Oil Pollution Act of 1990 (OPA '90), specifically 33 CFR Part 154 – Coast Guard Facility Response Plan requirements, 40 CFR Part 112 – EPA Facility Response Plan requirements, EPA SPCC Plan requirements and 49 CFR Part 194 – RSPA on Shore oil pipelines, and the Oil Discharge Contingency Plan (ODCP) for the State of Virginia. The criteria for response resources and response time frames should not be interpreted to be performance standards because they are based on a set of assumptions that may not exist during an actual oil spill incident. Therefore, it should be understood that the resources and response times listed below are provided to assist the facility owner and operator to help plan to respond to an oil spill. Enclosed you will find a copy of our "Oil Spill Response Organization (OSRO)" classification from the Coast Guard.

Industrial Marine Services, Inc. (IMS) is an oil spill response contractor that provides the services listed in Attachment A. IMS can respond to Group I through Group V oils and non-petroleum oils. We have the following Hazwoper trained response personnel who can be made available for response to spills:

	Full Time	Available Through Written agreement
Supervisors	13	82
Technicians/Operators	39	121
Support/General Labor	7	138

IMS can provide Hazwoper training and outfitting for hundreds of "surge" laborers should that be required.

Attachment B is the current listing of equipment to which we have access for spill response activities.

The cited personnel, equipment and services are capable of being provided at or above the tier cap level of response within stipulated response times in specific geographical areas as follows:

Stipulated Response Times	**Specified Geographical Areas**	**Level of Response**
12 Hours	I	"Inland, Rivers & Canals", Shorelines of the states of DE, MD, NC, SC, VA, and WV
36 Hours	II	"Inland, Rivers & Canals", Shorelines of the states of DE, GA, MD, NJ, NC, PA, SC, VA and WV
60 Hours	III	"Inland, Rivers & Canals", Shorelines of the states of DE, GA, MD, NJ, NC, PA, SC, VA and WV
24 Hours		30,000 feet of boom "Inland" and "Near shore" Shoreline Protection in the states of DE, MD, NC, SC, and VA
24 Hours		25,000 feet of boom "Inland" and "Near shore" Shoreline Protection in the states of DE, MD, NC, SC, VA and WV

Shorter response times or other geographical areas may be contracted for on a continuous or case-by-case basis. IMS can be available for one-hour response to your facility by short term or long-term contracts placing personnel and equipment on "dedicated standby" at your facility, or in proximity to the transfer site.

IMS intends to commit these resources in the event of a spill and will offer its best efforts to do so under the circumstances then existing, including emergency response activities being provided to other clients. IMS will permit the U.S. Coast Guard to verify the availability of the response resources identified through tests, inspections and drills.

Currently, there will be no fee for listing IMS as a response organization in your plan.

To be effective, the company using it must acknowledge this document, and a copy showing that acknowledge must be received by IMS before it is effective. This document, with its attachments, must be incorporated by reference into the oil spill response plan(s) that rely on any of the listed IMS resources.

Very truly yours,

Christa Salmon

Christa Salmon
Manager of Sales and Marketing

Attachment: a) Listing of Services offered
b) Listing of Equipment
c) U.S. Coast Guard Classification

ACKNOWLEDGMENT

By my signature below, I represent that I am an authorized agent of the company relying on this document for the purpose of oil spill response planning and that the company acknowledges having reviewed the provisions of this document.

Please type or print:

Signer's Name: William B. Bott
Title: Environmental Group Leader
Signature: William B. Bott
Date: 6/21/2004
Company Name: NASA WFF
Phone Number: 757 824-1103
Facility/Vessel Covered: WFF

Please attach additional acknowledgments as required for each vessel or facility.

PetroChem
RECOVERY SERVICES

February 6, 2004

Mrs. Susan Dunn
EG&G / NASA Wallops Flight Facility
Building F-160 / Room W-158
Wallops Island, Virginia 23337

Dear Mrs. Dunn,

I would like to take this opportunity to introduce you to PetroChem Recovery Services, Inc., a full service environmental contractor based in Norfolk, Virginia.

PetroChem provides a full range of environmental services in the Mid-Atlantic region including:

Emergency Spill Response, Hazardous and Industrial Waste Disposal, Chemical Lab Pack Services, PCB Removal, Vacuum Truck Services, Environmental Site Assessments, Fuel Polishing, Tank Cleaning and Underground Storage Tank Closure/Removal, Confined Space Rescue Team and Environmental/Safety Training.

We maintain a twenty-four hour emergency phone number and our Spill Response Team is on call seven days a week so that we can quickly mobilize to the scene of an incident to begin clean-up operations. At this time, we offer our clients a retainer agreement for containment and mitigation of oil and hazardous material spills with **no fee** involved to establish the agreement. The purpose of this agreement is to provide our clients with a labor and equipment rate schedule effective for the two (2) year term of the agreement which will eliminate time consuming contractual negotiations during a spill incident.

In addition to providing Emergency Response services within our coverage area, we also provide this service on a nationwide basis through our office by coordinating and reviewing all response, clean-up and reporting activities for our clients through utilization of a pre-selected network of qualified Emergency Response subcontractors located in proximity to the incident.

If you have any questions or if we can assist you in any way, please do not hesitate to contact me at (800) 723-6951. Thank you for your consideration.

Sincerely,

Chris Bowne
Special Operations Manager

P.O. Box 1458, Norfolk, Virginia 23501
(757) 627-8791 • Fax (757) 640-1261 • 1-800-723-6951

PetroChem
RECOVERY SERVICES

RETAINER AGREEMENT FOR EMERGENCY SPILL RESPONSE SERVICES

THIS AGREEMENT by and between PetroChem Recovery Services, Inc. (PCRS) and **EG&G/NASA Wallops Flight Facility.** (Customer). PCRS agrees to provide on an emergency response basis; labor, equipment and supplies necessary to contain and mitigate oil and hazardous materials spills for Customer in accordance with the attached Rate Schedule dated February 1, 2004.

PCRS agrees that no increase in the prices set forth on the attached Rate Schedule shall be made for labor and equipment listed thereon during the term of this agreement. Customer agrees that PCRS may amend such Rate Schedule to add new types of equipment or materials by furnishing Customer a copy of any such amendments prior to providing any services based upon such changes.

PCRS reserves the right to subcontract for services if necessary to provide response to locations outside of the primary coverage areas of Southeastern Virginia and Northeastern North Carolina. In such cases, Customer will be billed for subcontractor costs + 15% for incident reporting, coordination and review.

1. **EMERGENCY RESPONSE:** PetroChem's Emergency Response Team is available on a twenty-four hour basis and can normally be on the scene of an incident within one hour of the initial call for assistance pending no unforeseen circumstances. A longer response time will be encountered if the scene is outside of the primary coverage area. If PCRS cannot respond within this time, it will notify the Customer within fifteen (15) minutes of initial call and will not be responsible for any damage or loss due to its inability to so respond.

2. **NOTICE TO AUTHORITIES:** Customer acknowledges that PCRS does not undertake to give or file any notices required by law to be given by Customer to any Governmental Agency or Authority unless authorized and instructed by Customer to perform such activities.

3. **WORK ORDERS:** A Work Order describing the specific location and type of work to be performed shall be signed by a representative of Customer prior to or upon arrival of PCRS on work scene.

4. **INDEMNIFICATION AND HOLD HARMLESS PROVISIONS:** Each party agrees to indemnify, defend and hold harmless the other party hereto and the other party's shareholders, directors, officers, employees and agents, from and against any and all claims, demands, causes of action and liabilities of any nature, whether for damages to property, business interests or persons arising out of or related to the performance of this Agreement and/or the conditions to which this Agreement pertains to the extent that any such claims, demands, causes of action and/or liability is attributable to the breach of contract, negligence or other fault of the indemnifying party. The indemnification by each party shall survive the termination of this Agreement.

5. **TERMINATION OF AGREEMENT:** This agreement shall be terminated upon the happening of any of the following events:

   a. Any default or breach of the terms and conditions of this agreement by the Customer or PCRS.
   b. Bankruptcy or insolvency of either of the parties hereto.
   c. Failure by Customer to pay any invoice rendered in accordance with payment terms set out below.
   d. Thirty (30) days written notice of termination by either party to the other.

6. **PAYMENT TERMS**: Payment to PCRS shall be due Net 30 days upon presentation of invoices to Customer and Customer agrees to make payment of such invoices in full when due, whether or not Customer has been paid by any insurance carrier or other party whom it may have a claim. Interest will accrue on all amounts unpaid after the expiration of 30 days from the due date. One and one-half (1.5%) Service Charge per month, which is any Annual Percentage Rate of 18% , over 30 days together with Attorney's fees amounting to 33% of the total amount due if incurred. Customer agrees to pay such interest and all expenses of collection.

7. **TERM OF AGREEMENT:** The term of this agreement shall remain in effect until **February 1 , 2006,** at which time a renewal agreement shall be submitted to Customer.

8. **RECEIPTS:** The undersigned parties hereby accept this agreement, acknowledge receipt of same and agree to be legally bound by its terms and provisions.

EG&G/NASA Wallops Flight Facility.	**PetroChem Recovery Services, Inc.**
William B. Bott	Christopher Haywood
NAME	NAME
SIGNATURE	SIGNATURE
Environmental Group Leader	Vice President
TITLE	TITLE

PETROCHEM PERMITS / LICENSES

Virginia Hazardous Waste Transporter ID # VAD057934176
North Carolina Hazardous Waste Transporter ID # VAD057934176
EPA Used Oil Transporter/Transfer Facility ID # VAD057934176
Regulated Medical Waste Transporter Registration # IWT0000010135
VA Class A Contractor's License #2701 037114A
Federal Employment ID #54-1207975

February 13, 2004

EG&G/ NASA Wallops Flight Facility
Building F-160, Rm W158
Wallops Island, VA 23337
Attn: Susan Dunn

Dear Susan,

Clean Venture Inc. would like to be on call as your emergency contractor in the event of a hazardous material or petroleum spill on land or water.

We will respond and supply the necessary supervision, manpower, and equipment to contain and clean up the spill. Our Federal EPA ID number is NJ0000027193; our Maryland Hazardous Waste Hauler's permit number is HWH-269; or Maryland Oil operations permit number is 90-OP-1675.

Our current Emergency Response Rate Sheets are enclosed.

Thank you for considering us as your emergency contractor, a copy of this letter is enclosed which can be signed and returned as an acknowledgement.

Sincerely,

CLEAN VENTURE, INC.

David P.Roesler CHMM
Operations Manager

Enclosure(s)

EG&G/ NASA Wallops Flight Facility agrees to name Clean Venture, Inc. as our first call emergency contractor for the purpose of securing services and pricing in the event of an emergency. This agreement shall remain effective for a period of one year from the date of signature.

Signed: _____ Date: 6-21-04

A & A ENVIRONMENTAL

March 24, 2004

Susan Dunn
EG&G/NASA Wallops Flight Facility
757-824-1832
757-824-1819 Fax
RE: Spill Response

Dear: Susan

A & A Environmental Services has been servicing the environmental needs of the Mid Atlantic Region since 1972. In August of 1998, an opportunity to open a new branch office on the DelMarVa peninsula became available due in large part to one of our competitors closing their Eastern Shore office. We identified a location for our new service hub and formally began operations that same month.

Our facility, here on the shore, is located in Salisbury, MD. We employ 12 trained Supervisors, Equipment Operators and Laborers/Cleaners of whom have completed their (40) hour training course in worker safety and environmental compliance as specified in Title 29 CFR Part 1910.120.

We are ready, willing and able to respond to any emergency. Although response times will vary with the time of day or day of the week, you could expect the first responder to be on site within 2 hours. Should the emergency and scope of cleanup be larger than what we would normally be able to handle, we could be assisted by our operations hubs located in Baltimore, MD; Harrisburg, PA, and Dumfries, VA. Our company personnel resources total close to 100 people. A& A Environmental Services are on call 24 hrs a day 7 days a week 365 days a year..

Should you have any questions or require any additional information, please do not hesitate to contact me at (410) 543-1559 or 1-800-411-3353.

Sincerely,

Scott Adkins
Operations Manager

317-B LEMMON HILL LA; • SALISBURY, MD • 21801
PHONE: 410-543-1559 • FAX: 410-543-9945

Reactives Management Corporation

1025 Executive Blvd., Ste 101
Chesapeake, VA 23320

e-mail: reactives@earthlink.net

Telephone Numbers:
Office: 757-436-1033 or 800-EPA-OSHA
Emergency: 757-498-2539
Fax: 757-548-2808

TO: Susan Dunn **COMPANY:** Wallops Island Flight Facility

DATE: February 6, 2004 **FROM:** George C. Walton

TELEPHONE: 757-824-1832 **FAX:** 757-824-1819

E-MAIL: __ **PAGE COUNT (including cover):** 2

MESSAGE: Emergency Response Contractor Information

As per our recent telephone conversation, this fax is the 2004 update on Reactives Management's spill and/ or emergency response organization. We have completed environmental response work at for NASA at WIFF, Greenbelt, and Langley Research Center.

AREAS OF EXPERTISE: Reactives Management has responded to incidents involving every DOT hazard class except radioactive material (Class 7). Most of our experience is with explosives (Class 1), gases (Class 2), and flammable solids (Class 4). Specific examples of past work include picric acid (Division 1.1) and dry nitrocellulose (Division 1.1), acetylene (Division 2.1), nitrogen dioxide (Division 2.3), peroxidized ether (Class 3), metal alkyls (4.2), and water reactive metals (Division 4.3). In addition, we have completed numerous equipment and building decontamination projects such as regulated medical waste removal (suicide by gunshot), removal of dioxin contamination in laboratories at CDC, Atlanta, and perchlorate acid fume hoods at universities from New York to Kansas City, the Norfolk Navy Shipyard, and the FDA laboratory in Cincinnati.

POINTS OF CONTACT: We can be contacted 24 hours per day, seven days per week.

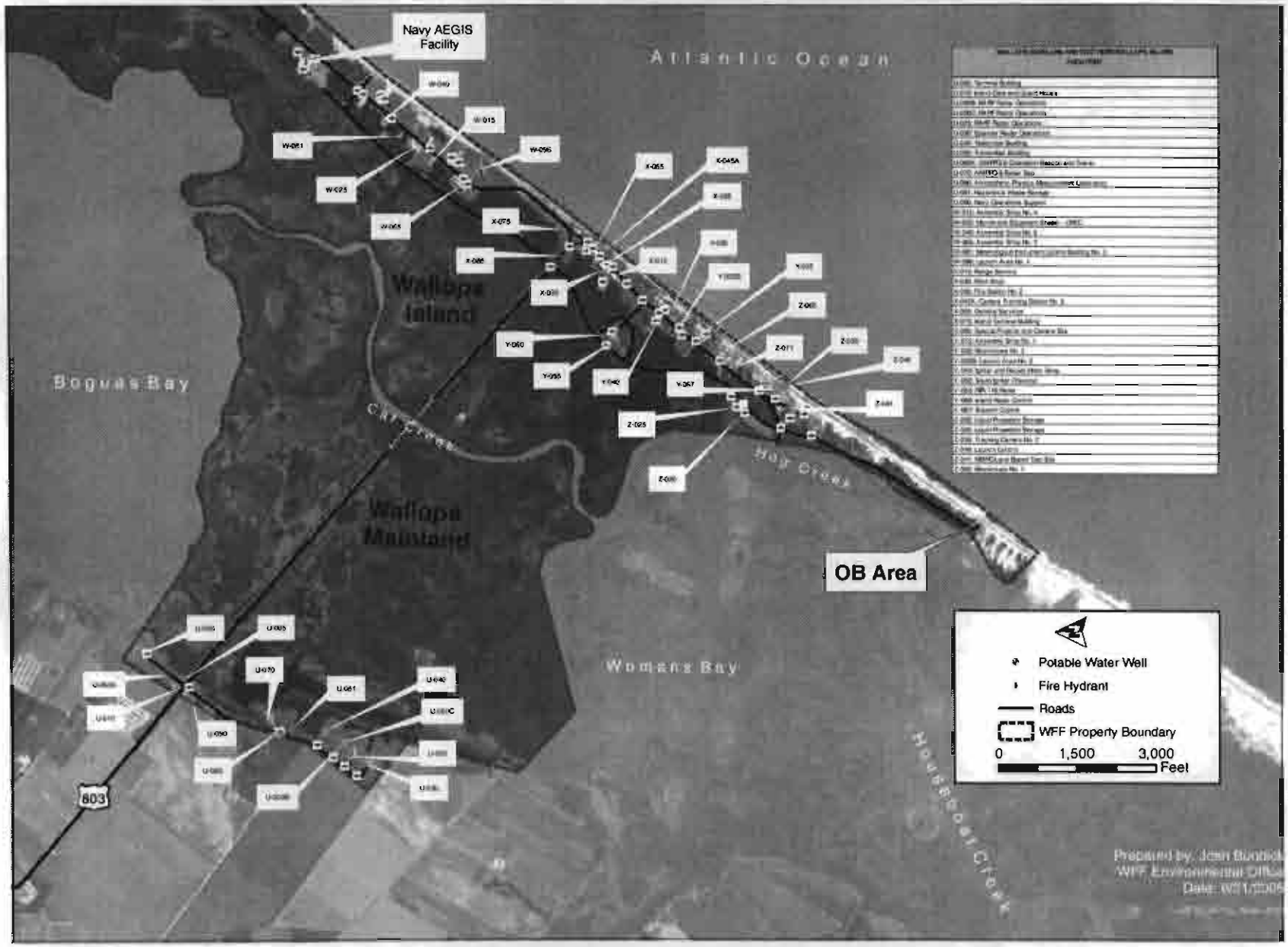
Reactives Management Corporation
1025 Executive Boulevard, Suite 101
Chesapeake, VA 23320

Office Telephone:	757-436-1033
Emergency Telephone:	**757-498-2539**
Fax Number:	757-548-2808
e-mail:	reactive@earthlink.net

SPECIAL ASSETS: Our response personnel include a Certified Safety Professional (CSP), a Certified Hazardous Materials Manager, Master Level (CHMM [ML]) and licensed Virginia blasters. In addition, we have Nomex® and Kevlar® fire and blast suppression equipment, vacuums with HEPA and ULPA filters, glove bags and boxes, non-sparking tools, and Levels A, B, and C personal protective equipment.

OTHER SERVICES: Reactives Management provides environmental audits, explosive and pyrotechnic safety inspections, accident investigations, and storm water management and Clean Air Act permit applications. In addition, we offer training for the full range of HAZWOPER classes, confined space entry, environmental sampling, hazardous materials transportation safety, and waste management compliance. We have specialized training programs in explosive and pyrotechnic handling, respiratory protection, and environmental compliance for managers and engineers.

Contingency Plan
Appendix 3
Maps


Navy AEGIS Facility
Atlantic Ocean
Wallops Island
Bogues Bay
Wallops Mainland
OB Area
Womans Bay
Potable Water Well
Fire Hydrant
Roads
WFF Property Boundary
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Feet
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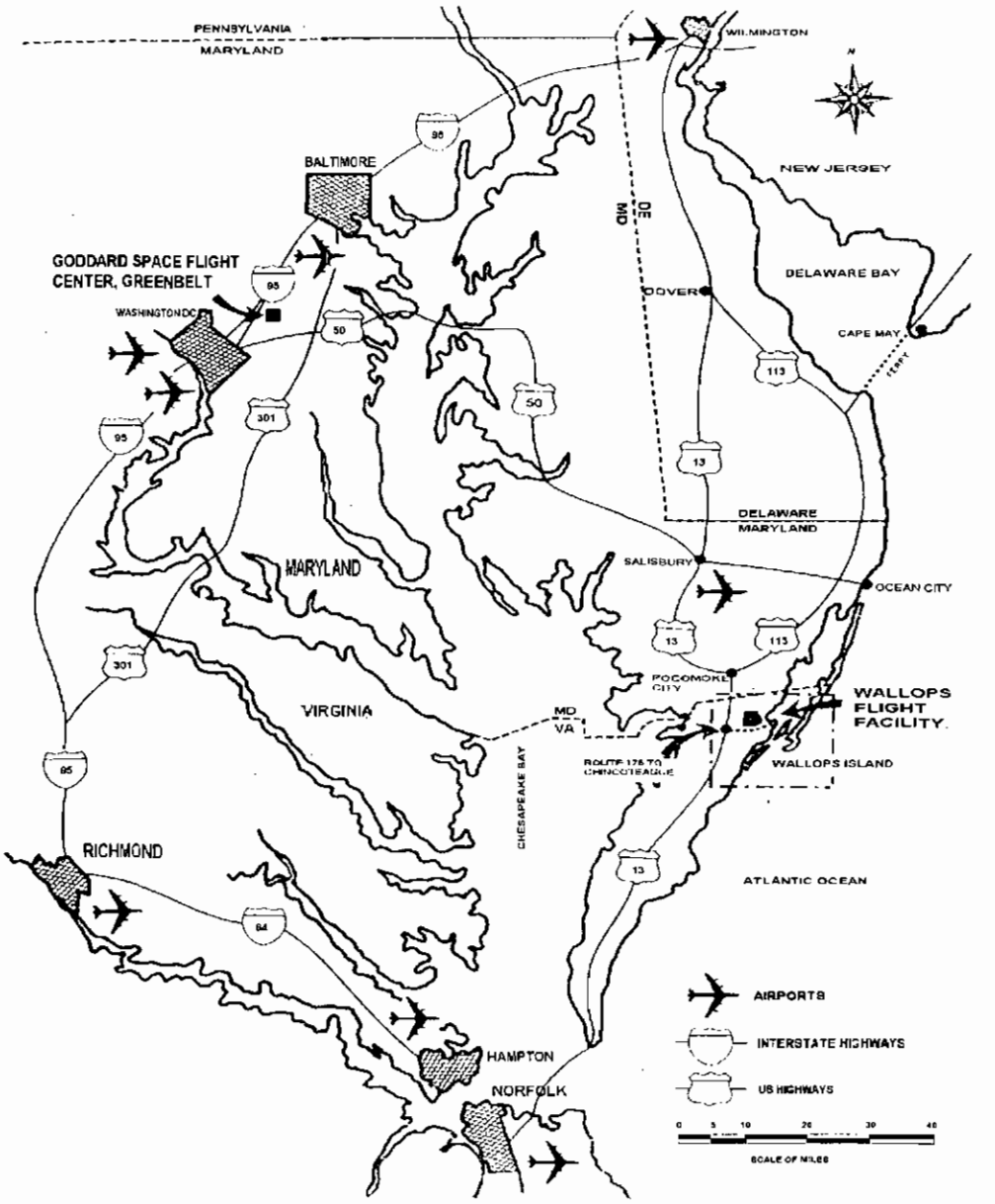
PENNSYLVANIA
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NEW JERSEY
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MD
GODDARD SPACE FLIGHT CENTER, GREENBELT
WASHINGTON DC
DOVER
DELAWARE BAY
CAPE MAY
FERRY
DELAWARE
MARYLAND
SALISBURY
OCEAN CITY
MARYLAND
POCOMOKE CITY
WALLOPS FLIGHT FACILITY
VIRGINIA
MD
VA
ROUTE 175 TO CHINCOTEAGUE
WALLOPS ISLAND
CHESAPEAKE BAY
RICHMOND
ATLANTIC OCEAN
HAMPTON
NORFOLK
AIRPORTS
INTERSTATE HIGHWAYS
US HIGHWAYS
SCALE OF MILES

Contingency Plan
Appendix 4
Rocket Motor Propellant Composition, Hazards, and MSDS

Table C-4: Chemical Composition of Rocket Motors to be Thermally Treated

Rocket Motor	Propellant Composition	Action
2.75" FFAR	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	(DPA) di-n-propyl adipate	Plasticizer
	Pb (lead) salicylate	Burn rate modifier
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Candelilla wax	Processing aid
	Monobasic copper salicylate	Burn rate modifier
Aries	(AP) Ammonium perchlorate	Oxidizer
	(PU) Polyurethane	A class of binder materials
	(Al) Aluminum	Metal fuel
Antares X259 IIA	(AP) Ammonium perchlorate	Oxidizer
	(HMX) "Her majesty's explosive", cyclotetra-methylenetetranitramine	Oxidizer
	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(Al) Aluminum	Metal fuel
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Resorcinol	Plasticizer
Apache	(AP) Aimmonium perchlorate	Oxidizer
TPG-3016D:	(PU) Polyurethane	A class of binder material
	(Al) Aluminum	Metal fuel
Arcas	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
	(PVC) Polyvinylchloride	Binder
	(DOA) Dioctyladipate	Plasticizer
Black Brant III	(AP) Ammonium perchlorate	Oxidizer
CARDE A24RX5:	(PU) Polyurethane	Binder
	(Al) Aluminum	Metal fuel
Black Brant VC	(AP) Ammonium perchlorate	Oxidizer
ANP-2872 JM mod 1:	(PPG) Polypropylene glycol	Binder
	(TEA) Triethanol amine	Stabilizer
	Poly 1,4-butylene glycol	Binder
	(TDI) Toluene diisocyanate	Curative
	(Al) Aluminum	Metal fuel
	Carbon black	Burn rate modifier
	(FeAA) Iron acetylacetate	Cure catalyst

Rocket Motor	Propellant Composition	Action
ANP-2872 JM mod 1 (con't):	(S) Sulfur	Catalyst
	(DOZ) Dioctyl azelate	Plasticizer
	(NDPA) n-phenyl-beta-napthylamine	Stabilizer
Cajun	T22:	
	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
Castor	TP-H-8038A:	
	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
Honest John	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
HYDAC	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
	Circo light oil	Plasticizer
	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	(PMAPO) bis 1-(2-methyl) aziridinyl phenyl phosphine oxide	Curative
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid
Javelin III	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
	Circo light oil	Plasticizer
	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	(PMAPO) bis 1-(2-methyl) aziridinyl phenyl phosphine oxide	Curative
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid
Lance	GCR-221:	
	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
M37A1 Spin Rocket	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(DEP) Diethyl phthalate	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer

Rocket Motor	Propellant Composition	Action
M37A1 Spin Rocket (con't)	(LBR) Lead beta-resorcylate	Burn rate modifier
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
	Candelilla wax	Processing aid
M57A1	(AP) Ammonium perchlorate	Oxidizer
	(HMX) "Her majesty's explosive," cyclotetra-methylenetetranitramine	
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(NC) Nitrocellulose	Binder / oxidizer
	(Al) Aluminum	Metal fuel
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Resorcinol	Plasticizer
Malemute	(PBHT) Polybutadiene hydroxy terminated	Binder
	(DDI) Desmodour diisocyanate	Curative
	(HX-752) Propylene imine product of isophthalic acid	Bonding agent
	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
Mk 70 Terrier	See: Terrier below	
Nihka	(PBHT) Polybutadiene hydroxy terminated	Binder
	(AP) Ammonium perchlorate	Oxidizer
	(Al) Aluminum	Metal fuel
Nike	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer/oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	*(DMP) Dimethylaminomethyl- substituted phenols	Curing agent
	*Pb (lead) stearate	Stabilizer
	*Graphite	Stabilizer
Orion	(AP) Ammonium perchlorate	Oxidizer
	(PU) Polyurethane	Class of binder materials
	(Ngu) Nitroguanidine	Oxidizer
Sargeant	(AP) Ammonium perchlorate	Oxidizer
	(S) Sulfur	Catalyst
	(LP-33) Polysulfide	Binder
	*(MgO) Magnesium oxide	Burn rate modifier
	(GMF)	Curative
	Nylon	Binder

Rocket Motor	Propellant Composition	Action
Sidewinder	(AP) Ammonium perchlorate	Oxidizer
	(RDX) "Royal daughter's explosive", cyclotrimethyl- enetrinitramine	Oxidizer
	(PBHT) Polybutadiene hydroxy terminated	Binder
	(DOA) Dioctyladipate	Plasticizer
	(DDI) Desmodour diisocyanate	Curative
	*(ZrC) Zirconium carbide	
	(HX-752) Propylene imine product of isophthalic acid	Bonding agent
	(Flexzone/DTBH) Phenylene diamine/hydroquinone	Bonding agent
Signal Flare	Phosphorus	Metal fuel
25" Spherical Motor	TP-L-3050:(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
Star 6B	TP-H-3237A:	
	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
	(PBCT) Polybutadiene carboxy terminated	Binder
Super Arcas	(AP) Ammonium perchlorate	Oxidizer
	(PVC) Polyvinylchloride	Binder
Super Loki	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
	(Al) Aluminum	Metal fuel
Talos	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Pb (lead) 2-ethyl hexoate	Burn rate modifier
Taurus	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
Terrier	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Pb (lead) 2-ethyl hexoate	Burn rate modifier
Tomahawk	(PBCT) Polybutadiene carboxy terminated	Binder
	(AP) Ammonium perchlorate	Oxidizer
	(Al) Aluminum	Metal fuel
	Ferric (iron) oxide	Burn rate modifier
Ute I	(AP) Ammonium perchlorate	Oxidizer
RPI-PAP-8:	(PS) Polysulfide	Binder

Rocket Motor	Propellant Composition	Action
VAM-20	Potassium Perchlorate	Oxidizer
	Polyester Resin	Binder
	Styrene	Binder
	Carbon Black	Catalyst
	Cobolt Octoate	catalyst
	Cumene Hydrogen Peroxide	Burn rate modifier
Viper	(AP) Ammonium perchlorate	Oxidizer
	*Hycar 1300, TM for various types of synthetic elastomers	
	(Al) Aluminum	Metal fuel
	Copper chromite	Burn rate modifier
	*(KClO4) Potassium perchlorate	Oxidizer
	(DOS) Dicotylsebacate	Plasticizer
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid
	Octylene oxide	
	Epon 812	Processing aid
	(ERL 2795) Epoxy resin	Binder
Zap	(AP) Ammonium perchlorate	Oxidizer
	(PBCT) Polybutadiene carboxy terminated	Binder
	(Al) Aluminum	Metal fuel
	Chromium 2-ethyl hexoate	Burn rate modifier
	(ERL 0510) Epoxy resin	Binder
	Lecithin	
	Ferric (iron) oxide	Burn rate modifier
	Substituted ferrocene	Burn rate modifier
	Dibutyl carbitol formal	Plasticizer
Zuni	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer/oxidizer
	(Al) Aluminum	Metal fuel
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Candelilla wax	Processing aid
	(DPA) Di-n-propyl adipate	Plasticizer
	Monobasic copper salicylate	Burn rate modifier

* The full name and actions of these were derived from Hawley's Condensed Chemical Dictionary.

Information on chemical constituents was developed by John Hopkins University, Applied Physics Laboratory in Laurel, Maryland.

Table C-5: Chemical Composition of Igniters to be Thermally Treated

Ignitor	Propellant Composition	Action
Antares	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	Aluminum	Metal fuel
	Ammonium Perchlorate	Oxidizer
	Boron Potassium nitrate	Oxidizer
Caster	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	Ammonium Perchlorate	Oxidizer
	Iron oxide	Burn rate modifier
	(DOS) Dicotylsebacate	Plasticizer
Altair	Same as Antares	
Orion	Polysulfide	Binder
	Quinone Dioxime	Curative
	Diphenly-Guanidine	Curative
	Sulfur	Catalyst
	Magnesium Oxide	Burn rate modifier
	Di(Butoxyethoxyet) Formal	Curative
	Iron Oxide	Burn rate modifier
	Ammonium Perchlorate	Oxidizer
	Boron Potassium nitrate	Oxidizer
Tomahawk	Same as Orion	
Malemute	T	
Black Brant III	Magnesium powder	Oxidizer
	Potassium Nitrate	Oxidizer
	Acaroid Resin	Binder
	Zinc Stearate	Stabilizer
Lance	T	
UTE	T	
Super Loki	Aluminum	Metal Fuel
	Cupric Oxide	Catalyst
Arcas	Boron Potassium Nitrate (Pellets)	Oxidizer
Javeline III	Aluminum	Metal Fuel
	Cupric Oxide	Catalyst
Aerojet Jr.	Potassium Perchlorate	Oxidizer
	Aluminum	Metal Fuel
	Vegetable Oil	Binder
15" Spherical	Ammonium Perchlorate	Oxidizer
	Aluminum	Metal Fuel
	Iron Oxide	Burn rate modifier
	(PBAA) Polybutidiene Acylic Acid	Binder
	Epoxy	Binder

T – Thermal Igniter

BLACK BRANT MOTOR

Black BRANT MOTOR

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List)	Use
26KS20000-BBV Motor with Nozzle	Sounding Rocket

Section I

Manufacturer's Name	Emergency Telephone Number
Bristol Aerospace Ltd.	204-344-5545
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-5545
	Date Prepared March 20, 1995
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Asbestos (See Note 1)	N/A	2.00ml	N/A	<1.20
Phenyl B-Naphthylamine (PBNA) (See Note 2)	N/A	N/A	N/A	<0.20
Black Brant Propellant Class 1.3C UN0186	N/A	N/A	N/A	85 to 90

Note 1: Asbestos is encapsulated within the motor and is not released during storage or operation. Interior of fired motors will contain surface asbestos which may exceed the percent specified and could be released by uncontrolled cutting, grinding, wire brushing, etc.

Note 2: PBNA is a constituent of the solid propellant. It is not released from the motor during storage and is completely consumed during operation.

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A
Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water	Appearance and Odour
Insoluble - Propellant contains Ammonium Perchlorate which is soluble in water.	Cylindrical - no odour.

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
N/A Propellant has auto ignition temperature of 275°C (528°F)		N/A	N/A

Extinguishing Media
None; self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires, move personnel from area.

Unusual Fire and Explosion Hazards
If initiated, material burns rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability			Conditions to Avoid
	Unstable		Avoid any possible sources of ignition. Observe temperature limits of product.
	Stable	X	

Incompatibility (Materials to Avoid)
Strong acids and bases.

Hazardous Decomposition or Byproducts
HCL, Al_2O_3, CO, CO_2, H_2

Hazardous Polymerization			Conditions to Avoid
	May Occur		
	Will Not Occur	X	

Section VI - Health Hazard Data

Route(s) of Entry:	Inhalation? No	Skin? No	Ingestion? No

Health Hazards (Acute and Chronic)
N/A

Carcinogenicity: U	NTP? N/A	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure	Medical Conditions Generally Aggravated by Exposure
If material burns, injuries to personnel may be serious and will involve burns, lacerations, shock and possible inhalation of fumes.	None known.

Emergency and First Aid Procedures
If material burns, trained personnel should treat victims.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
- Eliminate all ignition sources. - Structural fire fighters protective clothing does not provide adequate protection, if material burns. - Inspection required before use.	- Dispose of material in accordance with local legislation.
Precautions to be Taken in Handling and Storing	**Other Precautions**
Keep material away from impact, friction and high temperatures. Use precautions against electrostatic build up.	

Section VIII - Control Measures

Respiratory Protection (Specify Type)
If dust or fumes exist, use NIOSH approved respirators for dust or organic fumes.

Ventilation	Local Exhaust	Special
- Under normal conditions ventilation is not required. - If material burns structural fire fighter's self-contained breathing apparatus will provide reasonably adequate protection against toxic gases produced.	Not Required	Not Required
	Mechanical (General) Not Required	Other Not Required

Protection Gloves	Eye Protection
Latex or vinyl.	Safety Glasses

Other Protective Clothing or Equipment	Work/Hygiene Practices
Structural fire fighter's protective clothing will not provide adequate protection, against flames from an ignited motor.	- Minimize exposure to interior propellant. - Wash hands after exposure to material.

BLACK BRANT IGNITER

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List)	USE
1. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04862-3	1. Black Brant VC Rocket Motor High Altitude Igniter
2. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04850-1	2. Black Brant Igniter Kit 600-04005-1, Black Brant High Altitude Igniter
3. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-00339-1	3. Black Brant Igniter Assy 600-00335-1, Black Brant High Altitude Igniter

Section I

Manufacturer's Name Bristol Aerospace Limited	Emergency Telephone Number 204-344-3201
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-3211
	Date Prepared August 20, 2001
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
1) Boron Potassium Nitrate Pellets (BPN) 380 gms total weight 1.3L explosive UN 0359			Manufacturer suggests TLV of 10 mg/m^3.	
2) Asbestos Insulator		2f/cc asbestos	Insulator encapsulated in ablative sealant material	

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A

Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water Assembly is watertight. If seal broken BPN is water soluble.	Appearance and Odour Fully assembled and sealed - no odour.

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used) Igniter has auto ignition temperature of 221°C (430°F)	Flammable Limits N/A	LEL N/A	UEL N/A

Extinguishing Media
None self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires involving this material. If quantities are small and safety is not compromised an attempt to limit fire spread can be made.

Unusual Fire and Explosion Hazards
If initiated, material will burn rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability	Unstable		Conditions to Avoid Fire, flame and other ignition sources.
	Stable	X	

Incompatibility (Materials to Avoid)
BPN pellets are incompatible with strong oxidizers, or active fuels.

Hazardous Decomposition or Byproducts
Boric Oxide, Potassium Oxide, Nitrogen in the form of hot particles and gases.

Hazardous Polymerization	May Occur		Conditions to Avoid N/A
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry: N/A	Inhalation? N/A	Skin? N/A	Ingestion? N/A

Health Hazards (Acute and Chronic)
Sealed unit does not pose a health hazard. If opened dust from BPN pellets may irritate eyes, respiratory system.

Carcinogenicity: No	NTP? No	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure BPN Dust - irritation of eyes, nose, coughing, sneezing, nausea.	Medical Conditions Generally Aggravated by Exposure None known.

Emergency and First Aid Procedures
1) For irritation - remove to fresh air. Flush affected area with soap and water.

2) For burns - treat for burn, shock, lacerations and possible inhalation of combustion products.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
Eliminate all ignition sources, carefully clean-up spilled material. Place in conductive container.	Burn under approved controlled conditions.
Precautions to be Taken in Handling and Storing	**Other Precautions**
Store in approved magazine for 1.3 explosive in shipping container at ambient temperature and humidity.	N/R

Section VIII - Control Measures

Respiratory Protection (Specify Type)
In the event of a spill use NIOSH approved dust type respirator for dust exposure.

Ventilation	Local Exhaust	Special
N/R - sealed unit		N/R
	Mechanical (General)	Other N/R
Protection Gloves N/R		Eye Protection Safety glasses.
Other Protective Clothing or Equipment Flame resistant clothing	Work/Hygiene Practices If dust present (spill) wash clothing, hands, face.	

12A Dart

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor

Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

Identity (As Used on Label and List)
PWN-12A Robiusphere Dart (P/N 466-10)

Note: Blank spaces are not permitted. If any item is not applicable or no information is available the space must be marked to indicate that.

Section I

Manufacture's Name OSC Space Data Division	Emergency Telephone Number (602) 228-5772
Address (Number, Street, City, State, and ZIP Code) Meteorological Data Systems 1303 West 21st Street Tempe, Arizona 85282	Telephone Number for Information (602) 814-6800
	Date Prepared April 27, 1992
	Signature of Preparer (optional)

Section II - Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Boron Potassium Nitrate, $BKNO_3$, 2A Powder	U	5 mg/m^3	N/A	N/A
Cis-2-Butene (590-18-1)	N/A	N/A	N/A	N/A
Igniter Delay (S-326), Pyrotechnic Delay Train	N/A	N/A	N/A	N/A

Note: These assemblies are hermetically sealed within the wooden shipping containers.

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O = 1)	N/A
Vapor Pressure (mm Hg)	N/A	Melting point	N/A
Vapor Density (Air = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water
N/A

Appearance and Odor
N/A

Section IV - Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
N/A	N/A	N/A	N/A

Extinguishing Media: Water spray, Fog or Foam. CO_2, Dry Chemical

Special Fire Fighting Procedures: Remove all personnel from danger area. Reduce vapors with fog or fine water spray. Decomposition byproducts are toxic. Avoid the fumes. Fight fires only from a safe distance. Should units become engulfed in flames, use self-contained breathing apparatus and light fragment shield protection. DOD 45.26M, Chapter 10. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

Unusual Fire and Explosion Hazards: Once initiated, the Ignition Delay will explosively eject the 5 pound nose cone. Flammable gas may form mixtures with air an auto-ignite.

Published by THE BUREAU OF NATIONAL AFFAIRS, INC., Washington, D.C. 20037

Section V - Reactivity Data

Stability			
	Unstable		Conditions to Avoid
	Stable	X	Elevated temperatures and pressures. High impact.

Incompatibility (Materials to Avoid) NONE
Use normal storage in ordnance magazine.

Hazardous Decomposition of Byproducts
Oxides of Nitrogen, Carbon, Lead Vapors, CO/CO_2

Hazardous Polymerization			
	May Occur		Conditions to Avoid
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
	N/A	N/A	N/A

Health Hazards (Acute and Chronic)
N/A

Carcinogenicity	NTP?	IARC Monographs?	OSHA Regulated?
	N/A	N/A	N/A

Signs and Symptoms of Exposure
N/A

Medical Conditions
[illegible]mally Aggravated by Exposure

Emergency and First Aid Procedures
N/A

Section VII - Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled
Evacuate all personnel to a safe distance. Contact ordnance disposal personnel.

Waste Disposal Method
As determined by the local ordnance disposal personnel.

Precautions to Be Taken in Handling and Storing
These assemblies must be handled by personnel trained in ordnance device handling.

Other Precautions
Keep fire and flame away, handle each unit separately, do not collect in mass

Section VII - Control Measures

Respiratory Protection (Specify Type)
N/A

Ventilation		
	Local Exhaust N/A	Special N/A
	Mechanical (General) N/A	Other N/A

Protective Gloves	Eye Protection
N/A	Safety glasses are recommended.

Other Protective Clothing or Equipment
[illegible]lectrostatic control program.

Work/Hygienic Practices
[illegible]al hygiene practice, after handling these devices, wash hands prior to eating, drinking or smoking

USCPO 1998-491-529/45775

IMPROVED ORION ROCKET MOTOR

JHCS Custom Query Form

DOD Compontent: A

Tri-Service Coordination: N

NSN: 1337-00-484-855

Nomenclature: ROCKET MOTOR, M112

DODIC: V229

Inhabited Building Distance:

DOD Hazard Class/Division/Subdivision: 1 3

Compatibility Group: C

Label (First Label): 3

Label (Second Label):

UN Number: 0186

Label (Third Label):

Proper Shipping Name: ROCKET MOTORS

Technical Name:

DOT Explosive Registration Number: 8811544

High Explosive Wt-lbs	0.00000	HighExplosiveWt-kgs	0.000000
Net Propellant Wt-lbs	650.0000	Net Propellant WT-kgs	294.83511
Net Explosive Wt-lbs	650.0000	Net Explosive Wt-kgs	294.83511
Net Explosive QD Wt-lbs	650.0000	Net Explosive QD Wt-kgs	294.83511
Maximum Credible Event Wt-lbs		Maximum Credible Event Wt-kgs	

PN/Dwg1: PN/Dwg2: PN/Dwg3:

Remarks:

Date Changed: 9310

Last Action: C

Elements Chgd: OPQ

Record 101 of 490

MATERIAL SAFETY DATA SHEET MSDS D0059 Page 1 of 4

Latest Revision: May 29, 1990 Superseding: August 6, 1985

Thiokol Corporation
P.O. Box 707
Brigham City, UT 84302-0707

Emergency Phone No. (801) 863-8545
Product Information (801) 863-3325

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms:
TP-H1194 Malemute Propellant

II. PHYSICAL DATA

A. Appearance and Odor: Gray, rubbery, solid propellant with an aromatic odor.

B. Volatiles: None.

III. TYPICAL COMPOSITION

Hazardous Ingredients	Percent	TWA (PEL)	STEL (PEL)	TLV
Hydroxyl terminated polybutadiene polymer	*	NE	NE	NE
Dimeryl diisocyanate	*	NE	NE	0.005 ppm
Difunctional aziridine (HX-752)	*	NE	NE	NE
Aluminum powder**	*	5 mg/m^3	NE	5 mg/m^3
CAS No. 7429-90-5	EPA section 313 toxic chemical (1989)			
Ammonium perchlorate**	*	NE	NE	NE

* Percentages are confidential.
** Exposure potential is limited by physical form of material.
NE: Not established.

IV. HEALTH HAZARD DATA

A. Threshold Limit Value (TLV): Not known for cured material. As an uncured mixture, this material has a TLV of 0.005 ppm, due to the presence of dimeryl diisocyanate.

B. Effects of Overexposure

Inhalation: The diisocyanate contained in this mixture in the uncured state may cause serious lung damage and death if inhaled in large volume. HX-752 may also irritate the upper respiratory tract. There is evidence that HX-752 may be carcinogenic. Once cured, this material poses no known inhalation risk until it is burned.

Eyes: Diisocyanate in the uncured material will cause serious injury to the eyes if directly exposed.

Skin: Causes skin irritation in uncured state.

Ingestion: Highly toxic in uncured form. See Inhalation. Cured hazard is not known.

Existing conditions which may be aggravated: Uncured isocyanates may trigger severe reactions in people with asthma or other respiratory ailments.

V. EMERGENCY FIRST AID PROCEDURES

A. Inhalation: Contact physician. Give oxygen or artificial respiration if needed. For thermal burns contact physician.

B. Eyes: Flush immediately with water for at least 15 minutes. Contact physician.

C. Skin: Wash with soap and water. Contact physician.

D. Ingestion: Contact physician.

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: Not applicable.

B. Explosion Limits: Not applicable.

C. Extinguishing Media: Do not attempt to fight burning propellant. Water, CO_2 or foam may be used to restrict the spread of fire.

D. Special Fire Fighting Procedures: Propellant and igniter materials contain oxidizer and fuel. Do not fight fires involving this material. If ignited, thrust created while burning may give this propellant uncontrollable ballistic properties. Fire fighting should be limited to preventing the spread of fire.

E. Explosion Hazards: Static discharge, impact, friction and pinch points between hard surfaces can initiate propellant fires. Overpressures associated with rapidly burning propellant can be explosive-like, creating fireballs and shock waves.

VII. REACTIVITY DATA

A. Stability: Unstable.
Conditions to Avoid: Temperatures above 250°F, shock, impact, friction and static charge buildup.

B. Incompatibility (materials to avoid): Water-soaked propellant may evolve Hydrogen gas.

C. Hazardous Decomposition Products: CO, CO_2, HCl and NO_x.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

Protective Measures

A. Ventilation: General recommended for cured material. With uncured material, provide sufficient mechanical (general and/or exhaust) ventilation to keep vapors below the TLV.

B. Respiratory Protection: None required for cured propellant. For uncured propellant, a NIOSH/MSHA approved air purifying respirator is advised in the absence of proper environmental control. Engineering and/or administrative controls may be implemented to reduce exposure.

C. Protective Gloves: Wear nonporous gloves such as natural rubber or neoprene for handling.

D. Eye Protection: Chemical monogoggles in compliance with OSHA regulations are advised.

E. Other Protective Equipment: Flame resistant clothing is advised.

F. Other Precautions: Propellant should be controlled and handled only by personnel properly trained to handle pyrotechnic materials.

IX. HANDLING AND STORAGE PRECAUTIONS

Handling and Storage Precautions: Protect propellant from ignition sources, static charge buildup, mechanical shock, friction and temperatures above 250°F. Motor should only be fired when the environmental history is known, and aging and temperature limits set by design and aging studies have not been exceeded.

X. ENVIRONMENTAL PROTECTION

A. Precautions if Container is Damaged or Materials Spilled: Propellant must be protected from sources of ignition (see Section VI). If ignited, unpredictable ballistic properties should be anticipated, releasing pressure and spreading flaming, burning material over a wide area, and producing toxic decomposition fumes. Contact appropriate authorities.

B. Waste Disposal Method: This material is highly reactive and flammable. Dispose of in accordance with federal, state and local regulations.

For industrial use only. To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

MALEMUTE IGNITER

MATERIAL SAFETY DATA SHEET MSDS D0087

Latest Revision: January 31, 1986 Page 1 of 4

MORTON THIOKOL, INC.
PO BOX 524
Brigham City, UT 84302 Emergency Phone No. (801) 863-8545
Product Information (801) 863-3325

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms:
C-4 1st Stage Igniter
Malemute igniter

II. PHYSICAL DATA

A. Appearance: Metal cased igniter.

B. Volatiles: None.

III. TYPICAL COMPOSITION

A. Hazardous Ingredients	Percent	PEL	TLV
TP-H1137 Propellant:			
Hydroxyl terminated polybutadiene resin	*	NE	NE
Iron oxide**	*	NE	NE
Isophorone diisocyanate**	*	NE	0.01ppm(skin)
Difunctional Aziridine (HX752)	*	NE	NE
Powdered aluminum**	*	NE	10mg/m^3
Ammonium perchlorate**	*	NE	NE
Igniter granules (UIX 156-02):			
Boron**	*	NE	NE
Potassium Nitrate**	*	NE	NE
Insulation:			
Asbestos-filled Rubber**	*	2 fibers/cc (Asbestos 2 fibers/cc)	2 fibers/cc

*Company Proprietary
**Exposure potential is limited by physical form of material. Once cured, the isocyanate and aziridine are completely reacted.
NE Not Established

IV. HEALTH HAZARD DATA

A. Threshold Limit Value: None established. The TLVs listed above are for individual components in the uncured state. Exposure to the finished product is not known to be hazardous. Decomposition products are considered toxic.

B. Effects of Overexposure:

Inhalation: For burned out igniter, chronic respiratory conditions may result from asbestos fiber exposure. Decomposition products are known to cause breathing difficulty and respiratory damage.

Eyes: Not known. Decomposition products are irritating.

Skin: Not known

Skin Absorption. Not known

Ingestion: Not known.

V. EMERGENCY AND FIRST AID PROCEDURES

A. Inhalation (of decomposition products): Contact physician. Give oxygen or artificial respiration if needed.
B. Eyes: Contact physician.
C. Skin: Wash with soap and water. Contact physician.
D. Skin Absorption: Not applicable.
E. Ingestion: Contact physician.

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: Not applicable.

B. Explosion Limits: Not applicable.

C. Extinguishing Media: Do not attempt to extinguish.

D. Special Fire Fighting Procedures: This igniter contains DOT Class A explosives, oxidizers, and fuel. Fire fighting should be limited to evacuating an area proportional to the amount of propellant which may burn and preventing the spread of fire beyond the isolated area.

E. Explosion Hazards: Static discharge, impact, friction and pinch points between hard surfaces may initiate a conflagration or detonation. Overpressures associated with rapidly burning propellant can be explosive-like, creating fireballs and shock waves.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Temperatures above 250°F, shock, impact, friction, and static charge buildup.

B. Incompatibility (Materials to Avoid): Water soaked propellant may evolve explosive hydrogen gas.

C. Hazardous Decomposition Products: CO, CO_2, HCl, NO_x, unidentified organics.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

Ventilation: None required.

Respiratory Protection: For a fired motor, provide sufficient mechanical (general and/or local exhaust) ventilation to maintain asbestos exposure below TLV. If potential exists for exceeding the TLV of asbestos, a NIOSH/MSHA approved air purifying respirator is advised.

Protective Gloves: Impervious gloves are recommended.

Eye Protection: Safety glasses with side shields.

Other Protective Equipment: Clothing combinations which may create static discharges must be avoided. Flame resistant clothing is advised. If propellant is removed it should be contained in conductive containers.

IX. HANDLING AND STORAGE PRECAUTIONS

Buildings and transporting equipment must be protected from lightning and other forms of static discharge. Protect igniter from ignition sources, static charge buildup, mechanical shock or friction and temperatures above 250°F. Igniter should only be fired when the environmental history is known and aging and temperature limits set by design and aging studies have not been exceeded.

Other Precautions: Explosives contained in this igniter are federally controlled. Igniter should be controlled and handled only by personnel properly trained and authorized to handle explosive materials. This igniter must be stored according to the specifications referenced in the contract through which it was manufactured.

Note: This document pertains to the C-4 igniter as shipped from Morton Thiokol Wasatch Operations.

X. ENVIRONMENTAL PROTECTION

A. Precautions if Container is Damaged or Spilled: Igniter must be protected from sources of ignition (See Section VI). Contact appropriate authorities.

B. Waste Disposal Method: This igniter contains explosives. Fired motor residues may include asbestos-containing dust and char. Dispose of in accordance with federal, state, and local regulations.

For industrial use only. To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

MARK 12 TERRIER ROCKET MOTOR

MK 12 TERRIER

MATERIAL SAFETY DATA SHEET (MSDS)

Serial No. 3280
(Assigned by Code 04)

Identity (As Used on Label)	Trade Name(s)/Synonyms
Cast Double Base Propellant	MARK 12 TERRIER
Section I	
Manufacturer Naval Ordnance Station Indian Head, MD 20640-5000	Emergency Telephone Number (301)-743-4438 Telephone Number for information (301)-743-4484
Date Prepared 7/22/91	

Section II – Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED	% (optional)
Casting Powder				60 - 70
Casting Solvent				30 - 40

Section III – Physical/Chemical Characteristics

Impact Sensitivity (mm)		Specific Gravity (H2O)=1	
Friction Sensitivity (psig)		Heat of Explosion	
ESD Sensitivity (joules)		Evaporation Rate (Butyl Acetate=1)	

Solubility in Water: Non-Soluble

Appearance and Odor: Red or Black Grain, Sweet Odor

Section IV – Fire and Explosion Hazard Data

Flash Point (Method Used)		Autoignition Temperature	

Extinguishing Media: Water

Special Fire Figbting Procedures: Use extreme caution in fire-fighting situations. Self-contained breathing apparatus must be used.

Unusual Fire and Explosion Hazards: This material is a Class 1, Division 3 Explosive. This material gives off toxic fumes when burning.

NDW-NAVORDSTA 5100/11 (10/89)

Note: Blank Spaces are not permitted. If any item is nto applicable, or no information is available, the space must be marked to indicate that.

ak Rocket Motor, 1.3C, UN0186, PGII EX 8803651 NALC V298 NSN: 9937-LL-990-0145
NASA Modified Rocket Motor Mk12

NAVORDSTA
MATERIAL SAFETY DATA SHEET

CHEMICAL NAME N/A
SYNONYMS: N/A
FORMULA: N/A
TRADE NAME AND SYNONYMS: ABL - ABL 7362, ABL 7481 CASTING POWDERS
DATE OF PREPARATION/CHANGE: 12/22/87

REGULAR TELEPHONE NO. (301) 743-4484
EMERGENCY TELEPHONE NO. (301) 743-4438
CHEMICAL FAMILY Double Base Propellant
MOLECULAR WEIGHT N/A

I. PHYSICAL DATA

	References		References
BOILING POINT: @ 760 mm Hg. N/A		FREEZING POINT: N/A	
SPECIFIC GRAVITY (H2O = 1) 1.6-1.69 typical		VAPOR PRESSURE @ °C Negligible	
VAPOR DENSITY (AIR = 1) N/A		SOLUBILITY IN WATER, % BY WT @ °C Negligible	
PERCENT VOLATILES BY VOLUME Negligible		EVAPORATION RATE (BUTYL ACETATE = 1) N/A	
APPEARANCE AND ODOR Small Granular Solids			

II. HAZARDOUS INGREDIENTS

Material	%	PEL or TLV (UNITS)	References
* Nitrocellulose	65.36 - 84.40	- Not established	
* Nitroglycerine	10.80 - 19.00	- 0.2 ppm	
* 2-Nitrodiphenylamine	0.60 - 2.20	- Not established	
* Lead Salicylate	2.00 - 3.30	- 50 ug/m^3	
* Lead Beta Resorcylate	0.00 - 3.30	- 50 ug/m^3	
Lead 2-Ethyl Hexoate	0.00 - 2.60	- 50 ug/m^3	
Aluminum Powder	0.00 - 9.46	- 10 mg/m^3	
* Carbon Black	0.00 - 0.37	- 3.5 mg/m^3	
Graphite (Glaze)	0.04	- 3.5 mg/m^3	

III. FIRE AND EXPLOSION HAZARD DATA

		References
FLASH POINT (TEST METHOD) N/A	AUTOIGNITION TEMPERATURE 145°C	
FLAMMABLE LIMITS IN AIR, % BY VOLUME	LOWER N/A	UPPER N/A

EXTINGUISHING MEDIA: Self oxidizing, Deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in a very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

Prepared by: S. C. Hall
Date Prepared: 12-22-87

Approved by: P. B. McCollum
Date:

IV. HEALTH HAZARD DATA

		References
THRESHOLD LIMIT VALUE or PERMISSIBLE EXPOSURE LIMIT	Not established	See Section II
EFFECTS OF OVEREXPOSURE		
EMERGENCY AND FIRST AID PROCEDURES	EYES: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. If flushing water does not relieve irritation, seek medical attention. SKIN: Wash with soap and running water. INHALATION: Remove to fresh air. If symptoms listed above develop, seek medical attention	

V. REACTIVITY DATA

				References
STABILITY				
UNSTABLE	STABLE	CONDITIONS TO AVOID	Avoid open flame, sparks and heat.	Sax
	X			
INCOMPATIBILITY (MATERIALS TO AVOID)	Acid and bases (Organic and inorganic)			N/A
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of Nitrogen and Carbon			SAX
HAZARDOUS POLYMERIZATION				
MAY OCCUR	WILL NOT OCCUR	CONDITIONS TO AVOID	NONE	N/A
	X			

VI. SPILL OR LEAK PROCEDURES

		References
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction, impact and electrostatic discharge.	
WASTE DISPOSAL METHOD	Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.	

VII. SPECIAL PROTECTION INFORMATION

				References
RESPIRATORY PROTECTION (SPECIFY TYPE)	Selection of type respirator shall be lead exposure specified in accordance w/OPNAVINST 5100.23B, Cha.21, Par. 21004 (d)(2)			
VENTILATION	LOCAL EXHAUST	SPECIAL		
	MECHANICAL (GENERAL)	OTHER	Adequate Ventilation	
PROTECTIVE GLOVES	Cotton or leather	EYE PROTECTION	Safety glasses	
OTHER PROTECTIVE EQUIPMENT	Flame retardant coveralls and conductive shoes			

VIII. SPECIAL PRECAUTIONS

		References
PRECAUTIONARY LABELING	Nitrocellulose (flammable solid) Nitroglycerine (skin) Lead Salicylate; Lead Beta Resorcylate, Lead 2-Ethyl Hexoate Aluminum powder	
OTHER HANDLING AND STORAGE CONDITIONS	Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21°C (70°F) at 50% Humidity.	

IX. LABEL

DATE:

TRADE NAME:
Chemical Name or Common Name

DOUBLE BASE PROPELLANT

ABL 705, ABL 917, ABL 1362, ABL 1491, ABL 2434

DANGER!

EXTREMELY FLAMMABLE. SEVERE
FIRE AND EXPLOSIVE HAZARD.

KEEP AWAY FROM HEAT, SPARKS AND FLAME. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. AVOID BREATHING DUST AND VAPORS. DO NOT STORE IN DIRECT SUNLIGHT.

WHEN HANDLING WEAR SAFETY GLASSES, GLOVES AND PROTECTIVE CLOTHING. USE WITH ADEQUATE VENTILATION AND EMPLOY RESPIRATORY PROTECTION WHEN EXPOSED TO DUST AND VAPORS. WASH THOROUGHLY AFTER HANDLING.

EFFECTS OF OVEREXPOSURE:
CONTACT CAN CAUSE IRRITATION TO THE EYES AND SKIN. INHALATION OF DUST OR VAPORS CAN CAUSE IRRITATION TO MUCOUS MEMBRANES, DRYNESS OF MOUTH AND THROAT, HEADACHE, NAUSEA AND DIZZINESS.

FIRST AID PROCEDURES:

EYES:
IMMEDIATELY FLUSH WITH WATER. IF FLUSHING WITH WATER DOES NOT RELIEVE IRRITATION SEEK MEDICAL ATTENTION.

SKIN:
WASH WITH SOAP AND WARM WATER. REMOVE CONTAMINATED CLOTHING. IF IRRITATION DEVELOPS SEEK MEDICAL ATTENTION.

INHALATION:
REMOVE PERSON FROM CONTAMINATED AIR. IF SYMPTOMS LISTED ABOVE DEVELOP SEEK MEDICAL ATTENTION.

INGESTION:
SEEK MEDICAL ATTENTION.

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

MARK 70 TERRIER ROCKET MOTOR

MATERIAL SAFETY DATA SHEET NO: 3074***

THIOKOL CORPORATION
Tactical Operations
Huntsville Division
Huntsville, AL 35815-1506
Telephone: ~~205~~ 256/882-8000
Date Revised: July 27, 1989

5201

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms: MK 70 Propellant
B. Propellant Formulation: TPH 8238

II. PHYSICAL DATA

A. Appearance: Rubbery/solid/grey propellant.

III. HAZARDOUS INGREDIENTS

MATERIAL (Note 1)	CAS # (Note 2)	RTECS (Note 3)	PEL (Note 4)	TLV (Note 5)
Aluminum Powder	7429905	BD0330000	None	5 mg/m3
Ammonium Perchlorate	779089	SC7520000	None	None
Isophorone Diisocynate	4098719	NQ9370000	.005ppm (skin)	.005ppm (skin)
Dioctyl Adipate (Note 6)	103231	AU9700000	None	None
Hydroxyl Terminated Polybutadiene	6910295	None	None	None

NOTES:
1. The physical form of solid propellant limits exposure to the individual ingredients
2. Chemical Abstract Service Number
3. Registry of Toxic Effects of Chemical Substances
4. Permissible Exposure Limit - published by OSHA
5. Threshold Limit Value - published by ACGIH.
6. Suspected Animal Carcinogen - IARC

IV. HEALTH HAZARD DATA

A. Threshold Limit Value: See Section III.
B. Effects of Overexposure:
   1. Inhalation: Decomposition products could cause breathing difficulty and respiratory damage.
   2. Eyes: Decomposition products are extremely irritating.
   3. Skin: No known hazard.
   4. Skin Absorption: No known hazard.

C. Primary Route of Entry: Inhalation

V. EMERGENCY AND FIRST AID PROCEDURES

A. Inhalation: If decomposition products are inhaled, remove victim to fresh air. Obtain immediate medical attention.
B. Eyes: If irritated, flush with large quantities of water for at least 15 minutes, obtain immediate medical attention.
C. Skin: If burned, obtain immediate medical attention.
D. Ingestion: Obtain immediate medical attention.

VI. FIRE AND EXPLOSION HAZARD

A. Flash Point: Not Applicable
B. Explosive Limits: Not Applicable
C. Extinguishing Media: DO NOT ATTEMPT TO FIGHT FIRE INVOLVING AFTER PROPELLANT HAS BURNED OUT, water, CO2, or foam may be used to restrict the spread of fire.
D. Special Fire Fighting Procedures: DO NOT ATTEMPT TO FIGHT FIRE INVOLVING PROPELLANT. Propellant contains both oxidizer and fuel and cannot readily be extinguished. Fire fighting should be limited to preventing the spread of other fires.
D. Explosion Hazards: Static discharge, impact, friction, or pinch points between hard surfaces can initiate propellant fires and should be avoided.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Temperatures above 200 degrees F. Avoid shock, impact, friction, and static charge buildup.
B. Incompatibility (Materials to Avoid): Strong acids, alkalies.
C. Hazardous Decomposition Products: CO_2, CO, HCl, Al_2O_3, H_2, N_2
D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

A. Protective Measures: For handling a loaded rocket motor, wear cotton or other static-free clothing.
B. Handling and Storage Precautions: Protect propellant from static charge buildup, mechanical shock, impact, friction or temperatures over 200 degrees F. (See Section VII)
C. Other Precautions: This propellant is a DOT Class B Explosive and a Military Class 1.3 explosion hazard.
Access to propellant should be limited to personnel trained in the handling of pyrotechnic and explosive devices.

IX. ENVIRONMENTAL PROTECTION

A. Precautions if Component is Damaged: Damaged motor propellant must be protected from sources of ignition. (See Section VI.) Damaged propellant may be more susceptible to ignition.
B. Proper DOT Classification: EXPLOSIVE B
C. Waste Disposal Method: Dispose of in accordance with federal, state and local regulations.

FOR INDUSTRIAL USE ONLY. To the best of our knowledge, the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESSED OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

Prepared by: Wayne Throneberry — Date: 7/28/89
Wayne Throneberry,
Engineer

Approved by: E. J. Krupko — Date: 8/1/89
E. J. Krupko
Manager, Safety

MK 23 MOD 3 JATO

JHCS LINKS	JHCS MAIN MENU	JHCS DATA ELEMENTS	ESMAM	SENSITIVITY GROUPS
	JHCS CUSTOM QUERY	COMPATIBILITY GROUPS	USATCES	LOGOUT

Record 1 of 1	JHCS Data Item Detail

NSN:	1340-01-231-3984	DODIC:	J145

Nomenclature:	JET THRUST UNIT MK 23 MOD 3 SHIPPING CONDITION
Proper Shipping Name:	ROCKET MOTORS
Technical Name:	
DOT Registration (EX #):	8708594
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PG II

Inhabited Building Distance:		Shipping Label 1:	EXPLOSIVE 1.3C
DOD Hazard Class/Division/Subdivision:	1.3	Shipping Label 2:	
Compatibility Group:	C	Shipping Label 3:	
UN Number:	0186	Part/Dwg1	1255AS200
DOD Component:	NAVY	Part/Dwg2	
TRI-Service Coordination:	YES	Part/Dwg3	

WEIGHT	POUNDS	KILOGRAMS	TYPE OF WEIGHT
High Explosive Weight (HEW)	0.330750	0.150026	Class 1.1 Material
Net Propellant Weight (NPW)	110.00000	49.895176	Class 1.3 Material
Net Explosive Weight (NEW)	110.33100	50.045200	Transportation Qty
Net Explosive QD Weight (NEWQD)	110.33100	50.045315	Storage Quantity

Record 1 of 1

New Query

PROPELLANT

MSDS Propellant, Space Data Corp, 386-10

SPACE DATA -- SDC 386-10 - ROCKET MOTOR FUEL
MATERIAL SAFETY DATA SHEET
NSN: 134000F016457
Manufacturer's CAGE: 27555
Part No. Indicator: A
Part Number/Trade Name: SDC 386-10

General Information

Item Name: ROCKET MOTOR FUEL
Company's Name: SPACE DATA CORPORATION
Company's Street: 3380 SOUTH PRICE ROAD
Company's City: CHANDLER
Company's State: AZ
Company's Zip Code: 85248
Company's Emerg Ph #: (602) 899-6000
Company's Info Ph #: (602) 899-6000
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Date MSDS Prepared: 29MAR90
Safety Data Review Date: 12JUN91
MSDS Preparer's Name: BOB FISHER
Preparer's Company: SPACE DATA CORPORATION
Preparer's St Or P. O. Box: 3380 SOUTH PRICE ROAD
Preparer's City: CHANDLER
Preparer's State: AZ
Preparer's Zip Code: 85248
MSDS Serial Number: BKGPH
Net Propellant Weight-Ammo: 590 LBS

Ingredients/Identity Information

Proprietary: NO
Ingredient: POLY BUTADIENACRYLIC ACID COPOLYMER
Ingredient Sequence Number: 01
Percent: 12.40%
NIOSH (RTECS) Number: 1006308PA

Proprietary: NO
Ingredient: EPOXY
Ingredient Sequence Number: 02
Percent: 0.20%
NIOSH (RTECS) Number: 1000515EP

Proprietary: NO
Ingredient: FERRIC OCTOATE, IRON (3+) OCTANOATE
Ingredient Sequence Number: 03
Percent: 0.10%
NIOSH (RTECS) Number: 1006309FO
CAS Number: 3130-28-7

Proprietary: NO
Ingredient: MAPO, REGULAR
Ingredient Sequence Number: 04
Percent: 0.35%
NIOSH (RTECS) Number: 1006310MR

Proprietary: NO
Ingredient: AMMONIUM PERCHLORATE
Ingredient Sequence Number: 05
Percent: 68%
NIOSH (RTECS) Number: SC7520000
CAS Number: 7790-98-9

Proprietary: NO
Ingredient: ZL-496 (POLYURETHANE LAQUER)
Ingredient Sequence Number: 06
Percent: 3.09%
NIOSH (RTECS) Number: 1006311PL

Proprietary: NO
Ingredient: ALUMINUM (SARA III)
Ingredient Sequence Number: 07
Percent: 16%
NIOSH (RTECS) Number: BD0330000
CAS Number: 7429-90-5
OSHA PEL: 15MG/M3 DUST/5 FUME
ACGIH TLV: 10MG/M3 DUST; 9192

Physical/Chemical Characteristics

Fire and Explosion Hazard Data

Extinguishing Media: WATER
Special Fire Fighting Proc: TREAT FIRE AS CLASS I, DIVISION 3 FIRE HAZARD. CLASS B ROCKET MOTORS, HANDLE AS CLASS 1.3, MASS FIRE HAZARD.
Unusual Fire And Expl Hazrds: AUTOIGNITION TEMP: 275F.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): SPARK & FLAME
Hazardous Decomp Products: H2O/HYDROGEN CHLORIDE/CO/CO2/MAGNESIUM OXIDE/ALUMINUM OXIDE/SULFUR DIOXIDE/HYDROGEN SULFIDE/NITROGEN OXIDE/SULFUR OXIDE
Hazardous Poly Occur: NO

Health Hazard Data

Route Of Entry - Inhalation: NO
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: NO
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: PROPELLANT IS NOT LIKELY TO BE RELEASED FROM MOTOR. KEEP SPARK & FLAME PRODUCING ITEMS AWAY FROM PROPELLANT.
Waste Disposal Method: DISPOSE OF IN ACCORDANCE W/LOCAL, STATE, & FEDERAL REGULATIONS.
Precautions-Handling/Storing: HANDLE & STORE AS CLASS I DIVISION 3 ITEM. MOTOR SHOULD BE ELECTRICALLY GROUNDED WHEN NOT IN ITS SHIPPING CONTAINER.
Other Precautions: PROPELLANT IS NOT LIKELY TO BE RELEASED FROM MOTOR. KEEP SPARK & FLAME PRODUCING ITEMS AWAY FROM PROPELLANT.

Control Measures

Transportation Data

Disposal Data

Label Data

Label Required: YES
Label Status: G
Common Name: SDC 386-10
Special Hazard Precautions: N/K N/K
Label Name: SPACE DATA CORPORATION
Label Street: 3380 SOUTH PRICE ROAD
Label City: CHANDLER
Label State: AZ
Label Zip Code: 85248
Label Emergency Number: (602) 899-6000

MSDS Safety Information

FSC: 1377
NIIN: 00-244-1578
MSDS Date: 06/25/1992
MSDS Num: BPTXG
Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
MFN: 01
Responsible Party
Cage: 51998
Name: UNIVERSAL PROPULSION CO INC
Address: 25401 NORTH CENTRAL AVE
City: PHOENIX AZ 85027-7837
Info Phone Number: 602-869-8067
Emergency Phone Number: 602-869-8067;602-234-6663
Preparer's Name: N. WHITE
Published: Y

Contractor Summary

Cage: 51998
Name: UNIVERSAL PROPULSION CO
Address: 25401 N CENTRAL AVENUE
City: PHOENIX AZ 85027-7899
Phone: 602-516-3340

Item Description Information

Item Manager: NCB
Item Name: ROCKET MOTOR
Unit of Issue: EA
UI Container Qty: E

Ingredients

Name: COMPOSITE PROPELLANT-MIXTURE OF INGREDIENTS 2-10
% Wt: 2.53LBS

Name: CARBOXYL TERMINATED POLYBUTADIENE
% Wt: <10

Cas: 10099-74-8
RTECS #: OG2100000
Name: LEAD (II) NITRATE (1:2) (SARA III)
% Wt: 53.58
ACGIH TLV: 0.15 MG/M3 (PB)
EPA Rpt Qty: 100 LBS
DOT Rpt Qty: 100 LBS

Cas: 7778-74-7
RTECS #: SC9700000
Name: PERCHLORIC ACID, POTASSIUM SALT (1:1); (POTASSIUM PERCHLORATE)
% Wt: 15-20

Cas: 7429-90-5
RTECS #: BD0330000
Name: ALUMINUM (SARA III)
% Wt: 15-20
OSHA PEL: 15MG/M3 DUST;5 FUME
ACGIH TLV: 10MG/M3 DUST;5 FUME

Name: BORON POTASSIUM NITRATE; (IGNITION MATERIAL)
% Wt: 2 GM

Name: IGNITION PELLET
% Wt: 11

Name: PERCUSSION PRIMER ((1) PVU-1/A)
% Wt: 0.05 GM

Cas: 7439-92-1
RTECS #: OF7525000
Name: LEAD (SARA III). %: 36% BY WT OF EXPLOSIVES
% Wt: SEE ING
OSHA PEL: 0.05 MG/M3
ACGIH TLV: 0.15 MG/M3; DUST
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB

Cas: 7439-92-1
RTECS #: OF7525000
Name: LEAD; (LEAD COMPOUNDS). %: 57% BY WT OF EXPLOSIVES.
% Wt: SEE ING
OSHA PEL: 0.05 MG/M3
ACGIH TLV: 0.15 MG/M3, DUST
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB
==========
Health Hazards Data
==========
LD50 LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry Inds - Inhalation: YES
Skin: NO
Ingestion: NO
Carcinogenicity Inds - NTP: NO
IARC: YES
OSHA: NO
Effects of Exposure: NOTE: LEAD 7439-92-1 APPEARS ON THE NAVY LISTING OF OCCUPATIONAL REPRODUCTIVE HAZARDS. SEEK CONSULTATION FROM APPROPRIATE HEALTH PROFESSIONALS CONCERNING LATEST HAZARD LIST INFORMATION AND SAFE HANDLI NG AND EXPOSURE RECOMMENDATIONS (FP N).
Explanation Of Carcinogenicity: LEAD & LEAD COMPOUNDS: GROUP 2B (IARC).
Signs And Symptions Of Overexposure: SEE HEALTH HAZARDS.
Medical Cond Aggravated By Exposure: AVOID INHALATION OF PRODUCTS OF COMBUSTION.
First Aid: INGESTION: CALL MD IMMEDIATELY. INHALATION: REMOVE FROM EXPOSURE. SUPPORT BREATHING (GIVE ARTIFICIAL RESPIRATION/OXYGEN) (FP N). SKIN: FLUSH WITH COPIOUS AMOUNTS OF WATER (FP N). EYES: FLUSH WITH WATE R FOR AT LEAST 15 MINUTES (FP N).
==========
Handling and Disposal
==========
Spill Release Procedures: AN UNDAMAGED UNIT MAY BE PICKED UP AND RETURNED TO ORIGINAL CONTAINER.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Methods: IF UNIT IS DAMAGED OR NEEDS TO BE DISPOSED OF FOR ANY REASON,IT SHOULD BE DISPOSED OF BY PERSONNEL QUALIFIED TO DISP OF EXPLO AT AN APPRVD DISP SITE UNDER APPRVD CNDTNS. DISPOSE OF IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS (FP N).
Handling And Storage Precautions: HANDLE & STORE AS CLASS 1.3 COMPATIBILITY GROUP C EXPLOSIVE I/A/W DOD 4145.26M, FEDERAL, STATE & LOCAL LAWS. DO NOT EXPOSE TO HEAT OR OPEN FLAME.
Other Precautions: DO NOT EXPOSE TO ELECTRICAL DISCHARGE OF ANY SORT. DO NOT DROP OR ROUGH HANDLE.

Fire and Explosion Hazard Information

Extinguishing Media: USE MEDIA SUITABLE FOR SURROUNDING FIRE CONDITIONS (FP N). NONE ARE EFFECTIVE FOR LARGE FIRES.
Fire Fighting Procedures: WEAR NIOSH/MSHA APPROVED SCBA & FULL PROT EQUIP (FP N). DO NOT FIGHT FIRE. EVACUATE AREA UNTIL ROCKET MOTOR(S) BURN(S) OUT. ROCKET MOTOR(S) WILL BE PROPULSIVE.
Unusual Fire/Explosion Hazard: CLASSED AS DOT ROCKET MOTOR CLASS B EXPLOSIVE. NEW=2.56 LBS.

Control Measures

Respiratory Protection: NONE. WEAR NIOSH/MSHA APPROVED RESPIRATOR APPRORIATE FOR EXPOSURE OF CONCERN (FP N).
Ventilation: GENERAL VENTILATION SUFFICIENT TO KEEP AIRBORNE CONCENTRATIONS BELOW EXPOSURE LIMITS (FP N).
Protective Gloves: IMPERVIOUS GLOVES (FP N).
Eye Protection: CHEMICAL WORKERS GOGGLES (FP N).
Other Protective Equipment: FLAME RESISTANT CLOTHING RECOMMENDED.
Work Hygienic Practices: NORMAL PRACTICES.
Supplemental Safety and Health: SPECIFIC GRAVITY: (H*2O=1) (PROPELLANT).

Physical/Chemical Properties

Spec Gravity: 2.77(SUPP DATA)
Appearance and Odor: METAL PART. NO ODOR.

Reactivity Data

Stability Indicator: YES
Hazardous Decomposition Products: LEAD OXIDES.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: NOT RELEVANT.

Toxicological Information

Ecological Information

MSDS Transport Information

Regulatory Information

Other Information

Transportation Information

Responsible Party Cage: 51998
Trans ID NO: 60269
Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
MSDS Prepared Date: 06/25/1992
Review Date: 01/27/1993
MFN: 1
Multiple KIT Number: 0
Review IND: Y
Unit Of Issue: EA
Container QTY: E

Detail DOT Information

DOT PSN SC
DOT Proper Shipping Name: ROCKET MOTORS
Hazard Class: 1.3C
UN ID Num: UN0186
DOT Packaging Group: II
Label: EXPLOSIVE 1.3C
Special Provision: 109
Packaging Exception: NONE
Non Bulk Pack: 62
Bulk Pack: NONE
Max Qty Pass: FORBIDDEN
Max Qty Cargo: 220 KG
Vessel Stow Req: B

Detail IMO Information

IMO PSN Code: NDJ
IMO Proper Shipping Name: ROCKET MOTORS
IMDG Page Number: 1295
UN Number: 0186
UN Hazard Class: 1.3 C
IMO Packaging Group: -
Subsidiary Risk Label: -
EMS Number: 1-03
MED First Aid Guide NUM: *

Detail IATA Information

IATA PSN Code: VUX
IATA UN ID Num: 0186
IATA Proper Shipping Name: ROCKET MOTORS +
IATA UN Class: 1.3C
IATA Label: EXPLOSIVE
Packing Note Passenger: FORB
Max Quant Pass: FORB
Max Quant Cargo: 220 KG
Packaging Note Cargo: 130

Detail AFI Information

AFI PSN Code: VUX
AFI Proper Shipping Name: ROCKET MOTORS
AFI Hazard Class: 1.3C
AFI UN ID NUM: UN0186
AFI Packing Group: II
Special Provisions: P4, 109
Back Pack Reference: A5.73

HAZCOM Label

Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
Cage: 51998
Company Name: UNIVERSAL PROPULSION CO
Street: 25401 N CENTRAL AVENUE
City: PHOENIX AZ
Zipcode: 85027-7899
Health Emergency Phone: 602-869-8067;602-234-6663
Label Required IND: Y
Date Of Label Review: 08/24/1992
Status Code: C
Label Date: 08/24/1992

Origination Code: G
Chronic Hazard IND: Y
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: CAUTION
Respiratory Protection IND: YES
Health Hazard: None
Contact Hazard: None
Fire Hazard: Slight
Reactivity Hazard: Slight
Hazard And Precautions: HANDLE & STORE AS CLASS 1.3 COMPATABILITY GROUP C. EXPLOSIVE IN ACCORDANCE WITH DOD 4145.26M. DO NOT EXPOSE TO ELECTRICAL DISCHARGE OF ANY SORT. DO NOT DROP OF ROUGH HANDLE. ACUTE: NONE UNDER NORMAL H ANDLING. CHRONIC: NONE. CONTAINS LEAD WHICH IS A SUSPECT HUMAN CARCINOGEN.

==========

Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever expressly or implied warrants, states, or intends said information to have any application, use or viability by or to any person or persons outside the Department of Defense nor any person or persons contracting with any instrumentality of the United States of America and disclaims all liability for such use. Any person utilizing this instruction who is not a military or civilian employee of the United States of America should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation regardless of similarity to a corresponding Department of Defense or other government situation.

NIHCA IGNITOR

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List)	USE
1. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04862-3	1. Black Brant VC Rocket Motor High Altitude Igniter
2. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04850-1	2. Black Brant Igniter Kit 600-04005-1, Black Brant High Altitude Igniter
3. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-00339-1	3. Black Brant Igniter Assy 600-00335-1, Black Brant High Altitude Igniter

Section I

Manufacturer's Name	Emergency Telephone Number
Bristol Aerospace Limited	204-344-3201
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-3211
	Date Prepared August 20, 2001
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
1) Boron Potassium Nitrate Pellets (BPN) 380 gms total weight 1.3L explosive UN 0359			Manufacturer suggests TLV of 10 mg/m^3.	
2) Asbestos Insulator		2f/cc asbestos	Insulator encapsulated in ablative sealant material	

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A

Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A
Solubility in Water Assembly is watertight. If seal broken BPN is water soluble.		Appearance and Odour Fully assembled and sealed - no odour.	

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used) Igniter has auto ignition temperature of 221°C (430°F)	Flammable Limits N/A	LEL N/A	UEL N/A

Extinguishing Media
None self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires involving this material. If quantities are small and safety is not compromised an attempt to limit fire spread can be made.

Unusual Fire and Explosion Hazards
If initiated, material will burn rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability	Unstable		Conditions to Avoid Fire, flame and other ignition sources.
	Stable	X	

Incompatibility (Materials to Avoid)
BPN pellets are incompatible with strong oxidizers, or active fuels.

Hazardous Decomposition or Byproducts
Boric Oxide, Potassium Oxide, Nitrogen in the form of hot particles and gases.

Hazardous Polymerization	May Occur		Conditions to Avoid N/A
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry: N/A	Inhalation? N/A	Skin? N/A	Ingestion? N/A

Health Hazards (Acute and Chronic)
Sealed unit does not pose a health hazard. If opened dust from BPN pellets may irritate eyes, respiratory system.

Carcinogenicity: No	NTP? No	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure BPN Dust - irritation of eyes, nose, coughing, sneezing, nausea.	Medical Conditions Generally Aggravated by Exposure None known.

Emergency and First Aid Procedures
1) For irritation - remove to fresh air. Flush affected area with soap and water.

2) For burns - treat for burn, shock, lacerations and possible inhalation of combustion products.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
Eliminate all ignition sources, carefully clean-up spilled material. Place in conductive container.	Burn under approved controlled conditions.
Precautions to be Taken in Handling and Storing	**Other Precautions**
Store in approved magazine for 1.3 explosive in shipping container at ambient temperature and humidity.	N/R

Section VIII - Control Measures

Respiratory Protection (Specify Type)
In the event of a spill use NIOSH approved dust type respirator for dust exposure.

Ventilation	Local Exhaust	Special
N/R - sealed unit		N/R
	Mechanical (General)	Other N/R
Protection Gloves		**Eye Protection**
N/R		Safety glasses.
Other Protective Clothing or Equipment	**Work/Hygiene Practices**	
Flame resistant clothing	If dust present (spill) wash clothing, hands, face.	

NIKE ROCKET MOTOR

JHCS Database

DODIC:	V160
NSN:	1337-00-032-2462
Nomenclature:	ROCKET MOTOR, M5 M1M-14A
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8806858
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PGII

Inhabited Building Distance:		**Label (First Label):**	3
DOD Hazard Class/Division/Subdivision:	1.3	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0186	**Part/Dwg Number 1:**	8025075
DOD Component/ TRI-Service Coordination:	IY	**Part/Dwg Number 2:**	
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	755.00000	342.46234
Net Explosive Weight: (Transportation Qty)	755.00000	342.46234
Net Explosive QD Weight: (Storage Quantity)	755.00000	342.46234
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

ORION IGNITOR

Thiokol Corporation
Elkton Division
P.O. Box 241
Elkton, Maryland 21922-0241
Emergency Phone (410) 392-1000

MSDS 157B
TE-P-372-7

MATERIAL SAFETY DATA SHEET

MSDS NO. 157 Rev. B
Date Issued: 09/12/89
Date Revised: 07/23/93

Revised By: L. K. Hartwell
L. K. Hartwell

Approved By:
K. W. Phillips

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms: Orion Igniter (TE-P-372-7)

B. DOT Shipping Description and Classification: Igniter, rocket motor, Class B explosive, EX #8908180, UN0315, 1.3G.

II. PHYSICAL DATA

A. Appearance and Odor: Pyrotechnic material housed in a silica phenolic case with an aluminum closure. No odor.

B. Volatiles: None.

III. COMPOSITION

Hazardous Ingredients	Percent	OSHA PEL	ACGIH TLV
A. Propellant TP-E-8035 (0.4 lb)			
1. Thiokol Polysulfide Polymer (LP-33 base)	23.0	NE	NE
2. Magnesium Oxide	1.0	15mg/m^3(fume)	10mg/m^3(fume)
3. Iron Oxide	2.0	10mg/m^3(fume)	5mg/m^3(fume)
4. Ammonium Perchlorate	74.0	15mg/m^3(total) 5mg/m^3(resp.)	10mg/m^3(total) 5mg/m^3(resp.)
B. Boron Potassium Nitrate (3 gms) B,KNO_3, 2A Pellets	100.0	NE	NE

A. Threshold Limit Value: See Section III. [illegible] only pertain to materials when in raw form. Materials are contained within the propellant by a binder system.

B. Effects of Overexposure:
1. Respiratory: If igniter is activated, decomposition products can cause difficulty in breathing and respiratory damage.
2. Eyes: No known hazard unless activated. Decomposition products are irritating to the eyes.
3. Skin: Fired igniter residue may contain hydrochloric acid and other corrosive compounds which can cause skin irritation.
4. Skin Absorption: No known hazard.
5. Ingestion: No known hazard.
6. Other: N/A

V. EMERGENCY AND FIRST-AID PROCEDURES

A. Inhalation: If decomposition products are inhaled, remove victim to fresh air. Call a physician and/or emergency facility immediately.

B. Eyes: If irritated, flush with water and contact physician.

C. Skin: Thermal burns or reaction from exposure to decomposition products, flush with water for 15 minutes and call a physician.

D. Other: N/A

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: N/A

B. Explosive Limits: DOT Class B explosive.

C. Extinguishing Media: Do not attempt to extinguish an initiated igniter. Static discharge, impact, and friction can cause igniter to ignite internally and emit toxic fumes, shrapnel, and fire. CO_2, H_2O, or foam may be used to restrict fire from spreading after igniter has burned.

VI. FIRE AND EXPLOSION HAZARD DATA (continued)

D. Special Fire Fighting Procedures: Igniter contains pyrotechnic materials. Do not fight fires involving these materials. Evacuate area immediately if ignition occurs. Fire fighting should be limited to preventing the spread of other fires.

E. Explosion Hazards: Static discharge, impact, and friction can initiate igniter and should be avoided. Igniter and operators should be grounded when handling this device.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Ignition materials become unstable when exposed to temperatures above 200°F.

B. Avoid shock, impact, and static charge buildup.

C. Hazardous Decomposition Products: CO, CO_2, COS, $FeCl_2$, H_2, H_2S, MgO, SO_2, S_2, and N_2 are theoretical exhaust products.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

A. Protective Measures:
1. Ventilation: Initiated igniter will emit toxic fumes while burning. Firing area should be well ventilated before operators are exposed.
2. Respiratory Protection: If personnel are exposed to exhaust gases use a NIOSH/OSHA approved respirator with organic vapor/acid gas cartridges or positive pressure airline.
3. Protective Clothing: Acid-resistant gloves should be worn when handling decomposition products. Flame-resistant lab coats or coveralls, safety glasses, and safety shoes are recommended when handling explosives.

B. Handling and Storage Precautions: Protect igniter from ignition sources and elevated temperatures (above 200°F).

C. Other Precautions: Live igniters are DOT Class B Explosive. Access to this igniter should be limited to authorized personnel trained in the handling of pyrotechnic devices.

IX. ENVIRONMENTAL PROTECTION

A. Precautions if Component is Damaged: Damaged igniter must be protected from sources of ignition. If ignition occurs, toxic fumes, shrapnel, and fire may be emitted. Contact appropriate authorities.

B. Waste Disposal Method: Dispose of in accordance with federal, state and local regulations.

C. Fired igniter cases should be inspected and determined propellant-free before disposal.

WARNING:	Manufactured with 1,1,1-trichloroethane, a substance which harms public health and environment by destroying ozone in the upper atmosphere.

"To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely.

NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESSED OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS."

Sargent Rocket Motor

JHCS Database

DODIC:	V187
NSN:	1337-00-889-2074
Nomenclature:	ROCKET MOTOR, M100 MGM 29
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8806880
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PGII

Inhabited Building Distance:		**Label (First Label):**	3
DOD Hazard Class/Division/Subdivision:	1.3	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0186	**Part/Dwg Number 1:**	1039072
DOD Component/ TRI-Service Coordination:	IY	**Part/Dwg Number 2:**	10102215
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	5900.0000	2676.1958
Net Explosive Weight: (Transportation Qty)	5900.0000	2676.1958
Net Explosive QD Weight: (Storage Quantity)	5900.0000	2676.1958
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

M37A1 Spin Motor

JHCS Database

DODIC:	J203
NSN:	1340-00-981-1250
Nomenclature:	ROCKET MOTOR, M37A1 FOR 762MM ROCKET
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8811664
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.1C UN 0280 PGII

Inhabited Building Distance:		**Label (First Label):**	1
DOD Hazard Class/Division/Subdivision:	1.1	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0280	**Part/Dwg Number 1:**	
DOD Component/ TRI-Service Coordination:	AN	**Part/Dwg Number 2:**	
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	1.930000	0.875434
Net Explosive Weight: (Transportation Qty)	1.930000	0.875434
Net Explosive QD Weight: (Storage Quantity)	1.930000	0.875434
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

MATERIAL SAFETY DATA SHEET (MSDS)

Serial No. 3280
(Assigned by Code 04)

Identity (As Used on Label)	Trade Name(s)/Synonyms
Cast Double Base Propellant	MARK 11 TALOS
Section I	
Manufacturer Naval Ordnance Station Indian Head, MD 20640-5000	Emergency Telephone Number (301)-743-4438 Telephone Number for information (301)-743-4484
Date Prepared 7/22/91	

Section II – Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED	% (optional)
Casting Powder				60 – 70
Casting Solvent				30 – 40

Section III – Physical/Chemical Characteristics

Impact Sensitivity (mm)		Specific Gravity (H2O)=1	
Friction Sensitivity (psig)		Heat of Explosion	
ESD Sensitivity (joules)		Evaporation Rate (Butyl Acetate=1)	

Solubility in Water: Non-Soluble

Appearance and Odor: Red or Black Grain, Sweet Odor

Section IV – Fire and Explosion Hazard Data

Flash Point (Method Used)		Autoignition Temperature	

Extinguishing Media: Water

Special Fire Fighting Procedures: Use extreme caution in fire-fighting situations. Self-contained breathing apparatus must be used.

Unusual Fire and Explosion Hazards: This material is a Class 1, Division 3 Explosive. This material gives off toxic fumes when burning.

NDW-NAVORDSTA 5100/11 (10/89)

Note: Blank Spaces are not permitted. If any item is nto applicable, or no information is available, the space must be marked to indicate that.

NAVORDSTA
MATERIAL SAFETY DATA SHEET

CHEMICAL NAME N/A
SYNONYMS: N/A
FORMULA: N/A
TRADE NAME AND SYNONYMS: ABI [redacted] ABI 1362 ABI 1481 CASTING POWDERS
DATE OF PREPARATION/CHANGE: 12/22/87
REGULAR TELEPHONE NO. (301) 743-4484
EMERGENCY TELEPHONE NO. (301) 743-4438
CHEMICAL FAMILY Double Base Propellant
MOLECULAR WEIGHT N/A

I. PHYSICAL DATA

	References		References
BOILING POINT: @ 760 mm Hg. N/A		FREEZING POINT: N/A	
SPECIFIC GRAVITY (H2O = 1) 1.6-1.69 typical		VAPOR PRESSURE @ °C Negligible	
VAPOR DENSITY (AIR = 1) N/A		SOLUBILITY IN WATER, % BY WT @ °C Negligible	
PERCENT VOLATILES BY VOLUME Negligible		EVAPORATION RATE (BUTYL ACETATE = 1) N/A	
APPEARANCE AND ODOR Small Granular Solids			

II. HAZARDOUS INGREDIENTS

Material	%	PEL or TLV (UNITS)	References
* Nitrocellulose	65.36 - 84.40	- Not established	
* Nitroglycerine	10.80 - 19.00	- 0.2 ppm	
* 2-Nitrodiphenylamine	0.80 - 2.20	- Not established	
* Lead Salicylate	2.00 - 3.30	- 50 ug/m3	
* Lead Beta Resorcylate	0.00 - 3.30	- 50 ug/m3	
Lead 2-Ethyl Hexoate	0.00 - 2.60	- 50 ug/m3	
Aluminum Powder	0.00 - 9.46	- 10 mg/m3	
* Carbon Black	0.00 - 0.37	- 3.5 mg/m3	
Graphite (Glaze)	0.04	- 3.5 mg/m3	

III. FIRE AND EXPLOSION HAZARD DATA

References

FLASH POINT (TEST METHOD) N/A
AUTOIGNITION TEMPERATURE 145°C
FLAMMABLE LIMITS IN AIR, % BY VOLUME LOWER N/A UPPER N/A

EXTINGUISHING MEDIA: Self oxidizing, Deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in a very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

NAVORDSTA 8000/2 (6/86) TEST

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

Prepared by: [signature]
Date Prepared: 3/7/88

Approved by: [signature]
Date: [illegible]

NAVORDSTA MATERIAL SAFETY DATA SHEET

IV. HEALTH HAZARD DATA

		References
THRESHOLD LIMIT VALUE or PERMISSIBLE EXPOSURE LIMIT	Not established	See Section II
EFFECTS OF OVEREXPOSURE		
EMERGENCY AND FIRST AID PROCEDURES	EYES: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. If flushing water does not relieve irritation, seek medical attention. SKIN: Wash with soap and running water. INHALATION: Remove to fresh air. If symptoms listed above develop, seek medical attention	

V. REACTIVITY DATA

STABILITY				References
UNSTABLE	STABLE	CONDITIONS TO AVOID	Avoid open flame, sparks and heat.	Sax
	X			
INCOMPATIBILITY (MATERIALS TO AVOID)	Acid and bases (Organic and inorganic)			N/A
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of Nitrogen and Carbon			SAX
HAZARDOUS POLYMERIZATION				
MAY OCCUR	WILL NOT OCCUR	CONDITIONS TO AVOID	NONE	N/A
	X			

VI. SPILL OR LEAK PROCEDURES

		References
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction, impact and electrostatic discharge.	
WASTE DISPOSAL METHOD	Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.	

VII. SPECIAL PROTECTION INFORMATION

				References
RESPIRATORY PROTECTION (SPECIFY TYPE)	Selection of type respirator shall be lead exposure specified in accordance w/OPNAVINST 5100.23B, Cha.21, Par. 21004 (d)(2)			
VENTILATION	LOCAL EXHAUST		SPECIAL	
	MECHANICAL (GENERAL)		OTHER	Adequate Ventilation
PROTECTIVE GLOVES	Cotton or leather	EYE PROTECTION	Safety glasses	
OTHER PROTECTIVE EQUIPMENT	Flame retardant coveralls and conductive shoes			

VIII. SPECIAL PRECAUTIONS

		References
PRECAUTIONARY LABELING	Nitrocellulose (flammable solid) Nitroglycerine (skin) Lead Salicylate, Lead Beta Resorcylate, Lead 2-Ethyl Hexoate Aluminum powder.	
OTHER HANDLING AND STORAGE CONDITIONS	Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21°C (70°F) at 50% Humidity.	

NAVORDSTA
MATERIAL SAFETY DATA SHEET

IX. LABEL

DATE:
PAGE: 3 of 3

TRADE NAME:
Chemical Name or Common Name

DOUBLE BASE PROPELLANT

ABL 705, ABL 917, ABL 1362, ABL 1491, ABL 2434

DANGER!

EXTREMELY FLAMMABLE. SEVERE
FIRE AND EXPLOSIVE HAZARD.

KEEP AWAY FROM HEAT, SPARKS AND FLAME. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. AVOID BREATHING DUST AND VAPORS. DO NOT STORE IN DIRECT SUNLIGHT.

WHEN HANDLING WEAR SAFETY GLASSES, GLOVES AND PROTECTIVE CLOTHING. USE WITH ADEQUATE VENTILATION AND EMPLOY RESPIRATORY PROTECTION WHEN EXPOSED TO DUST AND VAPORS. WASH THOROUGHLY AFTER HANDLING.

EFFECTS OF OVEREXPOSURE:
CONTACT CAN CAUSE IRRITATION TO THE EYES AND SKIN. INHALATION OF DUST OR VAPORS CAN CAUSE IRRITATION TO MUCOUS MEMBRANES, DRYNESS OF MOUTH AND THROAT, HEADACHE, NAUSEA AND DIZZINESS.

FIRST AID PROCEDURES:

EYES:
IMMEDIATELY FLUSH WITH WATER. IF FLUSHING WITH WATER DOES NOT RELIEVE IRRITATION SEEK MEDICAL ATTENTION.

SKIN:
WASH WITH SOAP AND WARM WATER. REMOVE CONTAMINATED CLOTHING. IF IRRITATION DEVELOPS SEEK MEDICAL ATTENTION.

INHALATION:
REMOVE PERSON FROM CONTAMINATED AIR. IF SYMPTOMS LISTED ABOVE DEVELOP SEEK MEDICAL ATTENTION.

INGESTION:
SEEK MEDICAL ATTENTION.

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

Taurus Rocket Motor

JUL-25-1995 09:35 FROM TO 9104824341 P.02

Taurus

MATERIAL SAFETY DATA SHEET

(631)

HERCULES

CHEMICAL NAME N/A
SYNONYMS: N/A
FORMULA: N/A
TRADE NAME AND SYNONYMS: Propellant NOSIH-AA-2 Standard

REGULAR TELEPHONE NO. (703)639-7294
EMERGENCY TELEPHONE NO.
CHEMICAL FAMILY Double-Base Propellant
MOLECULAR WEIGHT ---

I. PHYSICAL DATA

BOILING POINT, 760mm. Hg N/A	FREEZING POINT N/A
SPECIFIC GRAVITY (H2O = 1) 1.6170	VAPOR PRESSURE @ °C Negligible
VAPOR DENSITY (AIR = 1) N/A	SOLUBILITY IN WATER, % BY WT @ °C Negligible
PERCENT VOLATILES BY VOLUME N/A	EVAPORATION RATE (BUTYL ACETATE = 1) less than 1

APPEARANCE AND ODOR Flat sheet, brownish in color

II. HAZARDOUS INGREDIENTS

MATERIAL	%	TLV (UNITS)
Nitrocellulose (Flammable solid)	51.0	Not established
Nitroglycerin (skin)	38.6	0.05 PPM
2-Nitrodiphenylamine	2.0	Not established
Di-n-Propyl Adipate	1.6	Not established
Triacetin	2.7	Not established
Lead - Copper - Resorcylate - Salicylate	4.0	Not established
Candelilla Wax	0.1	Not established

Note: *OSHA PEL = 0.20 PPM (ceiling)

III. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (TEST METHOD) N/A		AUTOIGNITION TEMPERATURE	396.5oF
FLAMMABLE LIMITS IN AIR, % BY VOLUME	LOWER N/A		UPPER N/A

EXTINGUISHING MEDIA: Self-oxidizing; deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

HERCULES INCORPORATED
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

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IV. HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE	Not established. See Section II
EFFECTS OF OVEREXPOSURE	Throbbing headache and upset stomach
EMERGENCY AND FIRST AID PROCEDURES	Eyes: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. Call a physician. Skin: Wash with soap and running water. Inhalation: Remove to fresh air. Treat any irritation symptomatically. Call a physician.

V. REACTIVITY DATA

STABILITY		
UNSTABLE	STABLE	
	X	CONDITIONS TO AVOID: Avoid open flame, sparks and heat

INCOMPATIBILITY (MATERIALS TO AVOID)	Acids and bases (organic and inorganic)
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of nitrogen and carbon

HAZARDOUS POLYMERIZATION		
MAY OCCUR	WILL NOT OCCUR	
	X	CONDITIONS TO AVOID: None

VI. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction impact and electrostatic discharge.
WASTE DISPOSAL METHOD	Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.

VII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE)	Not required.			
VENTILATION	LOCAL EXHAUST: --		SPECIAL: --	
	MECHANICAL (GENERAL): --		OTHER:	Adequate ventilation
PROTECTIVE GLOVES	Cotton or Leather		EYE PROTECTION:	Safety glasses
OTHER PROTECTIVE EQUIPMENT	Flame retardant coveralls and conductive shoes			

VIII. SPECIAL PRECAUTIONS

PRECAUTIONARY LABELING	Nitrocellulose (flammable solid) Nitroglycerin (skin) Lead-Copper-Resorcylate-Salicylate
OTHER HANDLING AND STORAGE CONDITIONS	Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21°C (70°F) at 50% humidity

MATERIAL SAFETY DATA SHEET

MSDS:
DATE:
PAGE: 3 of 3

TRADE NAME: PROPELLANT NOSIH-AA-2 STANDARD

IX SPECIAL PRECAUTIONS
PRECAUTIONARY LABELING:

Labeled and packaged in accordance with the Hazardous Materials Regulations of the Department of Transportation for Class B Explosives.

WARNING! FLAMMABLE Solid
Keep away from heat, sparks, and open flame.
Keep containers closed.
Use with adequate ventilation

FIRST AID:

EYES: In case of contact, immediately flush with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. Call a physician.

SKIN: Wash with soap and running water.

INHALATION: Remove to fresh air. Treat any irritation symptomatically. Call a physician.

OTHER HANDLING AND STORAGE CONDITIONS:
Storage also must conform to local, state and Federal Regulations including OSHA - 29CFR 1910.109 and BATF, 27CFR55, Subpart K.

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Viper IIA Rocket Motor

SECTION I Trade Name: VIPER III
Common Name: ROCKET MOTOR

Manufacturer's Name: UNIVERSAL PROPULSION CO., INC.
Address: 25401 NORTH CENTRAL AVENUE
PHOENIX, AZ 85027-9801

Emergency Telephone No.: 24 HOUR 602-234-6663 Date Received:
Information Telephone No.: 602-869-8067 Date Prepared: 07/08/91
Preparer: W. Roberts

Chemical Name: NA

Supplier's Generic Name: NA

Synonyms: NA

Hazard Class: EXPLOSIVE

Other Identifying Data: UN 0186, PROPER SHIPPING NAME= ROCKET MOTORS

Explosive Class = 1.3C, COMPETENT AUTHORITY CA-9212010, EX-8805252.

N.E.W. = 57.5 lbs

NFPA-704 =

HMIS =

This product contains a toxic chemical or chemicals subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372. Those chemicals are: Dibutyl Phthalate, CAS #84-74-2, 2.8% by weight.

SECTION II - HAZARDOUS INGREDIENTS/IDENTIFY INFORMATION

Chemical Name	OSHA-PEL (ppm)	ACGIH-TLV (ppm)	CAS Number	Percent
Polysulfide Rubber			NDA	<18
DiButylphthalate	5MG/M3	5MG/M3	NDA	<3
Magnesium Oxide 15mg/m3dust	5MG/M3	10MG/M3	NDA	<1
Sulfur			NDA	<.1
Diphenylguanidine (DPG)			NDA	<.2
Aluminum	5MG/M3	5MG/M3	NDA	<2
Ammonium Perchlorate			NDA	77

NOTE: If PEL or TLV is followed by the letter M, value is Mg/Cubic Meter

TTS kit

51205-1 & -2

Part Number:	NFPA Rating	
51205-1 51205-2	2	(Keyword - Re: Health Hazard - Toxicity) Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURER'S NAME:	Universal Propulsion Company	REGULAR TELEPHONE NO.: EMERGENCY TELEPHONE NO.:	707-422-1880 800-424-9300
ADDRESS:	P.O. Box KK, Fairfield, CA 95433-0659		
TRADE NAME:	Flexible Confined Detonating Cord (FCDC)		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT Note: The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
X-Cord®, 2.5 grains/ft; Lead Sheath HNS II (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Lead (Tubing)	20062-22-0 7439-92-1	>1 >1	PEL-TWA = Not listed, Mfg. recommends 1.5 mg/m³ PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
Booster Cup, Loaded HNS I (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Aluminum (Booster Cup)	20062-22-0 7429-90-5	>1 >1	PEL-TWA = Not listed, Mfg. recommends 1.5 mg/m³ PEL-TWA = 5.0 mg/m³ (Respirable)
Note: Net Explosive Weight (N.E.W.)/ unit = 3.683 grams		100%	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	Low	EVAPORATION RATE (Butyl Acetate = 1)	NA

APPEARANCE AND ODOR: Lead sheathed detonating cord confined within a red and white nylon braid . Unit has a metallic tip attached to each end. No odor.

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	**FLAMMABLE LIMITS**	**Lower:** NA	**Upper:** NA

SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device may expel shrapnel. May rupture in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

HNS:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of HNS from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream HNS can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of HNS does occur.

Skin Absorption: Slight to moderate dermal absorption

Eye contact: Redness and irritation, possible keratitis and cataract inducement

Ingestion: Once the ingested HNS passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Aluminum (Dust or Fume):

Inhalation: The respiratory effects caused by aluminum include: coughing; increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen; sense of tightness in the chest due to spasmodic contraction of the bronch); difficult or labored breathing (dyspnea); and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis). Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD) which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovasculer effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Lead: ***Warning:*** **This product contains lead, which is listed as a *California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.***

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system. hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

EMERGENCY FIRST AID PROCEDURES

Eyes: Flush with water for 20 minutes. Call physician.

Skin: Wash immediately with cold water, then thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Mechanical shock, static electricity, heat, flame or sparks
	Stable	X	
INCOMPATIBILITY (Materials to Avoid):	Alkalis, acids, corrosives, and strong oxidizers		
HAZARDOUS DECOMPOSITION PRODUCTS:	Lead, lead oxides, antimony, antimony oxides, aluminum, aluminum oxides, hydrogen, nitrogen, nitrogen oxides, carbon monoxide, carbon dioxide, and other carbonaceous combustion by-products.		
HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

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SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA Waste Codes D003 and D008.

Fired Units/Debris: Dispose as a characteristically Toxic Hazardous Waste, EPA Waste Code D008.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.

VENTILATION	**LOCAL EXHAUST:** Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels of TLV/PEL/TWA.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES: Normal: Leather Spill: PBI or leather gloves as outer shells with nitrile gloves as inserts.		**EYE PROTECTION:** Safety glasses as a minimum. Blast shields where necessary.

OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg) to prevent electrostatic discharge ignition.

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or side packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store units in a properly sited and maintained magazine. Reference BATF, OSHA, DoD 4145.

PREPARED BY: Universal Propulsion Company — Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0659

ISSUE DATE: 11-01-95

REVISION DATE: 11-01-95, 10-18-96, 9-19-97, 9-21-98

References:

Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doulls: Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1996.

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Part Number:	NFPA Rating:	
51202-1	2	(Keyword - Re: Health Hazard - Toxicity) Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Combustible
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURERS NAME:	Universal Propulsion Company	REGULAR TELEPHONE NO.: EMERGENCY TELEPHONE NO.:	707-422-1880 800-424-9300
ADDRESS:	P.O. Box KK, Fairfield, CA 94533-0659		
TRADE NAME:	Manifold Assembly		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT Note: The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
X-Cord®, 10.0 grains/ft.; Aluminum Sheath RDX Lead Tubing	 121-82-4 7439-92-1	 >1 >1	 PEL-TWA = 1.5 mg/m³ PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
Booster Cup, Loaded RDX Aluminum (Booster Cup)	 121-82-4 7429-90-5	 >1 >1	 PEL-TWA = 1.5 mg/m³ PEL-TWA = 5.0 mg/m³ (Respirable)
Note: The Net Explosive Weight(NEW)/unit =up to 0.30 grams		100%	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H,O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	NA	EVAPORATION RATE (Butyl Acetate = 1)	NA

APPEARANCE AND ODOR: Metallic block with an input and output port. No odor

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	**FLAMMABLE LIMITS**	**Lower:** NA	**Upper:** NA

SPECIAL FIRE FIGHTING PROCEDURES: Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Uncontained initiation of this device may expel shrapnel. May rupture or explode in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Aluminum (Dust or Fume)

Inhalation: The respiratory effects caused by aluminum include: coughing; increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen; sense of tightness in the chest due to spasmodic contraction of the bronchi; difficult or labored breathing (dyspnea); and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis). Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

RDX:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of RDX from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream, RDX can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of RDX does occur.

Skin Absorption: Slight to moderate dermal absorption.

Eye contact: Redness and irritation, possible cataract inducement

Ingestion: Once ingested, RDX passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Lead: ***Warning: This product contains lead, which is listed as a California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.***

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible. Slight to moderate

Eye Contact Irritation. Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

EMERGENCY FIRST AID PROCEDURES:

Eyes: Flush with water for 20 minutes

Skin: Flush exposed area with cold water for 10 min., then wash thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Mechanical shock, static electricity, heat, flame or sparks
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Alkalis, acids, corrosives, and strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Aluminum, aluminum oxides, carbon monoxide, carbon dioxide, other carbonaceous by-products, nitrogen, nitrogen oxides, and hydrogen.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed meterial with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations.

Unfired devices / units: Dispose as a characteristically Reactive Hazardous Waste, EPA waste code D003.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

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SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.		
VENTILATION	**LOCAL EXHAUST:** Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels or TLV/PEL/TWA.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES:	**Normal:** Leather **Spill:** PBI or leather gloves as outer shells with nitrile gloves as inserts.	**EYE PROTECTION:** Safety glasses as a minimum. Blast shields where necessary.
OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps (Wrist and Leg) to prevent electrostatic discharge ignition		

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or slide packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store units in a properly sited and maintained magazine. Reference BATF, OSHA, DoD 4145

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533

ISSUE DATE: 7-17-96

REVISION DATE: 9-24-98

References:

Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
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Casereti and Doull's Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1996.

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Part Number:	NFPA Rating:	(Keyword - Re: Health Hazard - Toxicity)
51203-4	2	Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURER'S NAME:	Universal Propulsion Company	**REGULAR TELEPHONE NO.:**	707-422-1880
		EMERGENCY TELEPHONE NO.:	800-424-9300
ADDRESS:	P.O. Box KK Fairfield, CA 94533-0659		
TRADE NAME:	Safe & Arm Device		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT Note: The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
Electric Detonator			
Zirconium	7440-67-7	>1	PEL-TWA = 5.0 mg/m³
Potassium Perchlorate	7778-74-7	>1	PEL-TWA = 5.0 mg/m³ (Respirable)
Lead Azide	13424-46-9	>1	PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
RDX	121-82-4	>1	PEL-TWA = 1.5 mg/m³
NOTE: Net Explosive Weight (NEW)/unit = .080 grams		100 %	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	Insoluble	EVAPORATION RATE (Butyl Acetate = 1)	NA
APPEARANCE AND ODOR: Metallic device containing a detonator. No odor.			

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	FLAMMABLE LIMITS	Lower: NA	Upper: NA
SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.		
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device may expel shrapnel. May rupture or explode in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.		

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Lead Azide
(As Inorganic Lead)

Warning: This product contains lead, which is listed as a California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

RDX:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of RDX from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream, RDX can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of RDX does occur.

Skin Absorption: Slight to moderate dermal absorption

Eye contact: Redness and irritation possible cataract inducement

Ingestion: Once ingested, RDX passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Zirconium:

Inhalation: Irritation to nose, throat, and upper respiratory tract. Possible decrease in the forced expiratory volume (FEV 1) and vascular congestion and lung hemorrhages.

Skin Contact: Mild to moderate irritation.

Skin Absorption: NA

Eye contact: Mild to moderate irritation.

Ingestion: Severe irritation of the mouth, throat, and esophagus; gastroenteritis

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure;

Potassium Perchlorate:

Inhalation:	Irritation of the respiratory tract and possible pneumoconiosis. Possible methemoglobinemia.
Skin Contact:	Irritation, local oxidizing of skin.
Skin Absorption:	NA
Eye contact:	Irritation, conjunctivitis, and possible corneal damage.
Ingestion:	Gastroenteritis, possible methanoglobenimia

EMERGENCY FIRST AID PROCEDURES

Eyes:	Flush with water for 20 minutes. Call physician.
Skin:	Wash immediately with cold water, then thoroughly with soap and water
Inhalation:	Move to fresh air, call physician
Ingestion:	Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Heat, sparks, flame, friction and mechanical shock
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Strong acids, bases, oxidizers, and strong reducing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon dioxide, carbon monoxide, other carbonaceous by-products, nitrogen, nitrogen oxides, potassium, potassium oxides, potassium chloride and chlorates, hydrogen, hydrogen chloride, zirconium, zirconium oxides, zirconium chloride and chlorates, lead, lead oxides, lead chloride and chlorates and chlorine.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking or exposed, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA waste codes D003 and D008.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

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SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.

VENTILATION	**LOCAL EXHAUST:** Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels or TLV/PEL/TWA.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES:	**Normal:** Leather **Spill:** PBI or leather gloves as outer shells with nitrile gloves as inserts.	**EYE PROTECTION:** Safety glasses as a minimum. Blast shields where necessary.

OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg) to prevent electrostatic discharge ignition.

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or slide packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store assemblies in a properly sited and maintained magazine. Reference BATF, OSHA, DoD 4145

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0659

ISSUE DATE: 6/8/01

REVISION DATE: 6/8/01

References:

Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Caserett and Doull's Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1998.

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Part Number:	NFPA Rating:	
51204-1	2	(Keyword - Re: Health Hazard - Toxicity) Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURER'S NAME:	Universal Propulsion Company	REGULAR TELEPHONE NO.	707-422-1880
		EMERGENCY TELEPHONE NO.	800-424-9300
ADDRESS:	P.O. Box KK	Fairfield, CA	94533-0659
TRADE NAME:	Thrust Termination System		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT	CAS #	% by Weight	HAZARD DATA
JETCORD®,200 gr/ft; Copper Sheath HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Copper Tubing	20062-22-0 7440-50-8	>1 >1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³ PEL-TWA = 0.1 mg/m³ (fume)
Transfer Booster Booster Cup, Loaded HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Aluminum (Booster Cup)	20062-22-0 7429-90-5	>1 >1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³ PEL-TWA = 5.0 mg/m³
X-Cord®, 45.0 grains/ft (Lead Sheath) HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Lead Tubing	20062-22-0 7439-92-1	>1 >1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³ PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
NOTE: Net Explosive Weight (NEW)/unit = .060 grams		100 %	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	NA	EVAPORATION RATE (Butyl Acetate = 1)	NA
APPEARANCE AND ODOR: Rectangular shaped composite retainer, black in color, containing copper sheathed linear shaped charge. No odor.			

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	FLAMMABLE LIMITS	Lower: NA	Upper: NA
SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area to safe distance. Use a self contained, full-face, breathing apparatus in the positive pressure mode to contain incipient or resulting fire.		
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device will expel shrapnel. Will rupture in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.		

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: No exposure is normally possible unless the unit is damaged and leaking contents or the unit is initiated. Then exposure to hazardous ingredients is possible. No health hazard data is available on the mixture of materials as mixed in this device, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Copper (as dust or fume):

Inhalation: Irritation to upper respiratory tract. Possible metal fume fever 24-48 hrs after exposure. Characterized by chills, fever, aching muscles, dryness in the throat and mouth, and headache. Possible pulmonary edema and lung damage. Possible hepatomegaly and development of jaundice due to liver damage. Possible headache, vertigo, and drowsiness due to interaction with the CNS. Possible degenerative changes to the basal ganglia of the brain. Possible ventricular extrasystoles, tachycardia, and occasional unifocal bigeminy with acute exposures. Possible kidney damage due to necrosis of the tubular cells as indicated by hematuria, glycosuria, cylindruria, and proteinuria. Possible hemolytic anemia and methemoglobinemia.

Skin Contact: Irritation. Possible itching, pruritic dermatitis, erythema, dermatitis, and allergic contact dermatitis.

Skin Absorption: NA

Eye contact: Irritation. Possible conjunctivitis and keratitis. Possible corneal discoloration and necrosis.

Ingestion: Possible gastric and intestinal mucosa erosion. Possible hepatomegaly and development of jaundice due to liver damage. Possible headache, vertigo, and drowsiness due to interaction with the CNS. Possible degenerative changes to the basal ganglia of the brain. Possible ventricular extrasystoles, tachycardia, and occasional unifocal bigeminy with acute exposures. Possible kidney damage due to necrosis of the tubular cells as indicated by hematuria, glycosuria, cylindruria, and proteinuria. Possible hemolytic anemia and methemoglobinemia.

HNS:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of HNS from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream HNS can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of HNS does occur.

Skin Absorption: Slight to moderate dermal absorption

Eye contact: Redness and irritation, possible cataract inducement

Ingestion: Once the ingested HNS passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Lead:

Warning: This product contains lead, which is listed as a California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: No exposure is normally possible unless the unit is damaged and leaking contents or the unit is inflated. Then exposure to hazardous ingredients is possible. No health hazard data is available on the mixture of materials as mixed in this device, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Aluminum: (Dust or Powder)

Inhalation: The respiratory effects caused by aluminum include: coughing; increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen; sense of tightness in the chest due to spasmodic contraction of the bronchi; difficult or labored breathing (dyspnea) and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis). Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

EMERGENCY FIRST AID PROCEDURES:

Eyes: Flush with water for 20 minutes

Skin: Flush exposed area with cold water for 10 minutes, then wash thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Heat, static electricity, shock, and friction, open flames.
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Strong acids, bases, oxidizing agents, halogens, reducing agents, and organics

HAZARDOUS DECOMPOSITION PRODUCTS: Copper, copper oxides, aluminum, aluminum oxides, lead, lead oxides, hydrogen, nitrogen, nitrogen oxides, carbon monoxide, carbon dioxide, and other carbonaceous compounds.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

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SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA waste codes D003 and D008.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH/MSHA approved respirator if action levels or TWA/PEL/TLV levels are met or exceeded.

VENTILATION	**LOCAL EXHAUST:** Should be used during test firing of units in need to maintain airborne contaminents at or below their respective action levels or TLV/PEL/TWA levels.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES: Normal: Leather or PBI or both. Spill: PBI or leather gloves as outer shells with nitrile gloves as inner shells.		**EYE PROTECTION:** Safety glasses as a minimum, Blast shields if necessary.

OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg), conductive shoes to ensure that static charges are being drained off of your body.

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or side packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store assemblies in a properly sited and maintained magazine in accordance with BATF, OSHA, DoD,

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0659

ISSUE DATE: 8/31/98

REVISION DATE: 8/31/98, 12/19/98

References:

Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doulls; Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1996.

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APPENDIX C

CERTIFICATES OF ANALYSES

EG&G TECHNICAL SERVICES INCORPORATED

Client Sample ID: TAURUS

HPLC

Lot-Sample #...:	H2K060267-001	Work Order #...:	FCHR51AA	Matrix.....:	SOLID
Date Sampled...:	11/26/01	Date Received..:	11/05/02		
Prep Date.....:	11/15/02	Analysis Date..:	11/21/02		
Prep Batch #...:	2318216				
Dilution Factor:	2				
% Moisture.....:		Method.....:	SW846 8332		

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Nitroglycerin	6.2	5.0	mg/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1-Chloro-3-nitrobenzene	110	(70 - 130)

METHOD BLANK REPORT

HPLC

Client Lot #...: H2K060267 Work Order #...: FC3PF1AA Matrix.....: SOLID
MB Lot-Sample #: H2K140000-216

Prep Date.....: 11/15/02
Analysis Date..: 11/21/02 Prep Batch #...: 2318216
Dilution Factor: 1

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD
Nitroglycerin	ND	2.5	mg/kg	SW846 8332

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1-Chloro-3-nitrobenzene	112	(70 - 130)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

HPLC

Client Lot #...: H2K060267 Work Order #...: FC3PF1AC-LCS Matrix.....: SOLID
LCS Lot-Sample#: H2K140000-216 FC3PF1AD-LCSD
Prep Date.....: 11/15/02 Analysis Date..: 11/21/02
Prep Batch #...: 2318216
Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Nitroglycerin	92	(70 - 130)			SW846 8332
	92	(70 - 130)	0.91	(0-25)	SW846 8332

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1-Chloro-3-nitrobenzene	108	(70 - 130)
	110	(70 - 130)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

LABORATORY CONTROL SAMPLE DATA REPORT

HPLC

Client Lot #...: H2K060267 Work Order #...: FC3PF1AC-LCS Matrix.....: SOLID
LCS Lot-Sample#: H2K140000-216 FC3PF1AD-LCSD
Prep Date.....: 11/15/02 Analysis Date..: 11/21/02
Prep Batch #...: 2318216
Dilution Factor: 1

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCENT RECOVERY	RPD	METHOD
Nitroglycerin	25.0	23.1	mg/kg	92		SW846 8332
	25.0	22.9	mg/kg	92	0.91	SW846 8332

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
1-Chloro-3-nitrobenzene	108	(70 - 130)
	110	(70 - 130)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

EG&G TECHNICAL SERVICES INCORPORATED

Client Sample ID: TOMAHAWK

General Chemistry

Lot-Sample #...: H2K060267-002 Work Order #...: FCHTC Matrix.....: SOLID
Date Sampled...: 11/26/01 Date Received..: 11/05/02
% Moisture.....:

PARAMETER	RESULT	RL	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Perchlorate	49000	1000	ug/kg	EPA-DW1 314.0	12/12/02	2350196

Dilution Factor: 25

METHOD BLANK REPORT

General Chemistry

ent Lot #...: H2K060267 Matrix.....: SOLID

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Perchlorate		Work Order #: FEW121AA		MB Lot-Sample #:	H2L160000-196	
	ND	40.0	ug/kg	EPA-DW1 314.0	12/12/02	2350196
		Dilution Factor: 1				

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

General Chemistry

Client Lot #...: H2K060267 Matrix.....: SOLID

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Perchlorate		Work Order #: FEW121AC LCS Lot-Sample#: H2L160000-196			
	95	(85 - 115)	EPA-DW1 314.0	12/12/02	2350196
		Dilution Factor: 1			

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

LABORATORY CONTROL SAMPLE DATA REPORT

General Chemistry

Client Lot #...: H2K060267 Matrix.....: SOLID

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCNT RECVRY	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
Perchlorate		Work Order #: FEW121AC		LCS Lot-Sample#: H2L160000-196			
	1000	945	ug/kg	95	EPA-DW1 314.0	12/12/02	2350196
		Dilution Factor: 1					

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

MATRIX SPIKE SAMPLE EVALUATION REPORT

General Chemistry

ient Lot #...: H2K060267 Matrix.....: SOLID
ate Sampled...: 11/20/02 Date Received..: 11/22/02

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
						% Moisture.....: 22	
Perchlorate		WO#: FDPE51AC-MS/FDPE51AD-MSD				MS Lot-Sample #: H2K220234-007	
	81	(80 - 120)			EPA-DW1 314.0	12/12/02	2350196
	87	(80 - 120)	6.7	(0-20)	EPA-DW1 314.0	12/12/02	2350196
		Dilution Factor: 1					

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Results and reporting limits have been adjusted for dry weight.

MATRIX SPIKE SAMPLE DATA REPORT

General Chemistry

ient Lot #...: H2K060267 Matrix.....: SOLID
ate Sampled...: 11/20/02 Date Received..: 11/22/02

PARAMETER	SAMPLE AMOUNT	SPIKE AMT	MEASRD AMOUNT	UNITS	PERCNT RECVRY	RPD	METHOD	PREPARATION-ANALYSIS DATE	PREP BATCH #
							% Moisture.....: 22		
Perchlorate			WO#: FDPE51AC-MS/FDPE51AD-MSD				MS Lot-Sample #: H2K220234-007		
	ND	386	314	ug/kg	81		EPA-DW1 314.0	12/12/02	2350196
	ND	386	335	ug/kg	87	6.7	EPA-DW1 314.0	12/12/02	2350196

Dilution Factor: 1

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Results and reporting limits have been adjusted for dry weight.

Analytical Report For 312057

for

EG & G Technical Services, Inc.

Project Manager : Monica Borowicz

Project Name : T-2 Sampling

December 17, 2003

GPL

Laboratories

GPL Laboratories, LLLP Certifies that the test results meet all requirements of the NELAC Standards unless otherwise noted.

Reviewed by, Project Manager	Approved by, Laboratory Director

202 Perry Parkway Gaithersburg, MD 20877 Phone (301) 926-6802 Fax: (301) 840-1209
www.gplab.com

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-004-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: CLP_SOLIDS
Date Analyzed: 12/10/2003
Time Analyzed: 15:00
Analysis Batch: 65127

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Percent Solids	92	1.0	%		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-001-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: IAAP
Date Analyzed: 12/16/2003
Time Analyzed: 09:23
Analysis Batch: 65228

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Nitrocellulose	120	15	mg/kg		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-004-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: SW1010
Date Analyzed: 12/11/2003
Time Analyzed: 00:00
Analysis Batch: 65124

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Flash Point	BQL	20	DC	U	1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-003-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method: SW3010A
Prep Date: 12/13/2003
Prep Time: 00:00
Prep Batch: 64136

Analytical Method: SW6010B_TCLP
Date Analyzed: 12/16/2003
Time Analyzed: 00:27
Analysis Batch: 15866

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Lead	14000	100	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-002-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method: EXT_SW8330
Prep Date: 12/11/2003
Prep Time: 00:00
Prep Batch: 64095

Analytical Method: SW8330
Date Analyzed: 12/12/2003
Time Analyzed: 21:03
Analysis Batch: 65231

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Nitroglycerine	440000	10000	ug/kg		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-004-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: SW9014R
Date Analyzed: 12/11/2003
Time Analyzed: 16:00
Analysis Batch: 65214

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Cyanide, Reactive	0.070	0.020	mg/kg		1

Summary of Analytical Results

Client ID: T-2
GPL ID: 312057-001-004-1/1
Matrix: SOIL
Date Collected: 12/03/2003
Date Received: 12/04/2003

Prep Method:
Prep Date:
Prep Time:
Prep Batch:

Analytical Method: SW9034R
Date Analyzed: 12/15/2003
Time Analyzed: 12:30
Analysis Batch: 65212

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Sulfide, Reactive	BQL	9.6	mg/kg	U	1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : T-2 Sampling

Date Printed December 17, 2003

GPL ID	Client ID
312057-001-001-1/1	T-2
312057-001-002-1/1	T-2
312057-001-003-1/1	T-2
312057-001-004-1/1	T-2

ATTACHMENT II.GG

CLOSURE PLAN

ATTACHMENT II.GG - CLOSURE PLAN

Wallops Flight Facility intends to continue to operate the hazardous waste Open Burning area until the facility ceases operation. It is, therefore, not possible to state an exact year for closure of the Open Burning hazardous waste treatment area. When operations cease or the need for the permitted site, or portion thereof, no longer exists, closure will be implemented in accordance with Closure Plan; Exhibit II.GG-1.

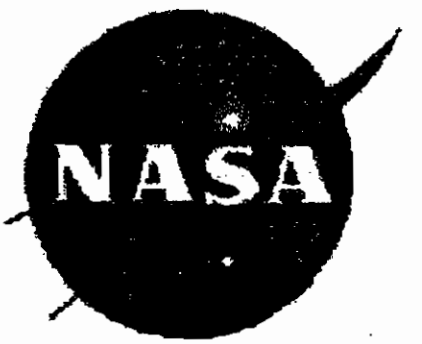
EXHIBIT II.GG-1

CLOSURE PLAN

CLOSURE AND POSTCLOSURE PLAN

Resource Conservation and Recovery Act Treatment Storage and Disposal Facility– Open Burning Area

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA



EPA ID # VA7800020888

August 2005

CLOSURE AND POSTCLOSURE PLAN

National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia

Prepared by:

EG&G Technical Services, Inc.
Wallops Island, VA 23337

THIS REVISION SUPERSEDES ALL PREVIOUS EDITIONS OF THE WALLOPS FLIGHT FACILITY CLOSURE AND POSTCLOSURE PLAN

EPA ID # VA7800020888

August 2005

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1.0 INTRODUCTION

In accordance with the Virginia Hazardous Waste Management Regulations (VHWMR), as codified in the Virginia Administrative Code, Title 9, Agency 20, Chapter 60 (9 VAC 20-60-12), the Resource Conservation and Recovery Act (RCRA) regulations, the Hazardous and Solid Waste Amendments (HSWA) of RCRA, and the Virginia Department of Environmental Quality (DEQ), *Draft Guidance Manual for Closure Plans For Hazardous Waste Management Facilities*, dated September 28, 2001, National Aeronautics and Space Administration (NASA) Goddard Space Flight Center's (GSFC's) Wallops Flight Facility (WFF) submits this closure and postclosure plan for the Open Burning (OB) area, as part of its permit application for a RCRA Part B permit. The Wallops Flight Facility (WFF) is located on Wallops Island, Virginia, and operates under interim status, Subpart X Miscellaneous Units, Open Burning using United States Environmental Protection Agency (EPA) identification (ID) number VA7800020888. WFF is also a large quantity generator.

This closure plan is designed to achieve final closure of the OB area hazardous waste management units (HWMUs). The OB area will have achieved clean closure, when all hazardous waste or hazardous waste constituents of concern (HCOCs) have been removed from the HWMUs to levels such that direct contact with any parts of the HWMU or any HCOCs that remain after closure will not pose a threat to human health and/or the environment, nor adversely impact any environmental media in excess of the DEQ established exposure levels.

Achievement of clean closure will be demonstrated by the systematic removal of hazardous wastes, by decontamination of the equipment, structures, and soils and subsoils (if needed), and by comparison of the HCOCs in the sample compliance data to one of the three decontamination standards in this closure plan.

If this facility is unable to attain clean closure for the hazardous waste management units, an amended closure plan and postclosure plan will be submitted to the DEQ for approval to provide for closure with hazardous waste closed in-place, and for the postclosure care and use of the property, respectively.

2.0 CLOSURE PERFORMANCE STANDARDS

This closure plan has been developed to ensure that closure activities will be conducted in such a manner that the OB area will not require any post-closure maintenance and control. This closure plan describes the work to be conducted to ensure that the OB area HWMUs are closed in a manner that:

1. Minimizes the need for further maintenance or control;
2. Controls, minimizes, or eliminates, to the extent necessary to prevent threats to human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated run-off, or waste deposition products to the ground,

3. Surface waters, or the atmosphere;
4. Complies with the closure requirements of 40 CFR Parts 264 and 265, as applicable; and
5. Meets the requirements of the VHWMR, as codified in 9 VAC 20-60-264.

This closure plan requires the removal of any soil and residual contamination present in or around the burn units and the burn pad to the extent that the remaining soil and residual contaminants do not pose an unacceptable threat to human health and the environment. It also requires the safe and effective disposal of contamination, contaminated run-off, or waste decomposition products to the soil, groundwater, surface water, or atmosphere.

Achievement of clean closure will be demonstrated by the systematic removal of hazardous wastes, by decontamination of the equipment, structures, and soils and subsoils (if needed), and by comparison of the HCOCs in the sample compliance data to one of the three decontamination standards in this closure plan.

The OB area will be considered clean closed, requiring no further closure activities if one of the following conditions is met:

1. The concentrations of HCOCs in the compliance samples are below the method detection limits of the analytical test methods,
2. The concentrations of HCOCs in the compliance samples are below or not statistically different from the background sample levels, or
3. The concentrations of HCOCs in the compliance samples are at or below DEQ approved risk-based levels.

If performance standards 1, 2, or 3 are achieved, the OB area soil will be considered to be clean closed. If the standards cannot be achieved, the structures and soils may be removed and disposed of at a regulated treatment facility as a means to comply with the closure requirements of VHWMR and RCRA.

3.0 FACILITY DESCRIPTION, LOCATION, AND BACKGROUND

GSFC's WFF is owned and operated by NASA. It is located in Virginia on the Atlantic Coast of the Delmarva Peninsula (Appendix A, Figure A-1) approximately 64 kilometers (40 miles) southeast of Salisbury, Maryland, and 113 kilometers (70 miles) north of the Chesapeake Bay Bridge - Tunnel. Chincoteague Island, Virginia, is approximately 8 kilometers (5 miles) east of the Main Base.

The Main Base facilities were constructed in 1941 through 1958 by the Government as a Navy base for flight operations and for Naval ordnance testing. In 1959, the Navy closed the base and NASA acquired the Main Base. Since 1959, NASA has demolished obsolete buildings, renovated other buildings for adaptability to their missions, and constructed new facilities. In 1945, the National Advisory Committee for Aeronautics purchased 34 hectares (85 acres) of land on the southern portion of Wallops Island and leased 405 hectares (1000 acres) from a group

of sportsmen who used the island for fishing and hunting. An operating base was established on Wallops Island by the Langley Field Research Center, which included the construction of a launch site. Historically, research at Wallops was concentrated on obtaining aerodynamic data at transonic and low supersonic speeds, as part of the effort to penetrate the sound barrier of flight. Today, WFF (NAICS Code 927110) is used primarily to obtain scientific data about the atmosphere and the space environment, conduct aeronautical research, and perform space and terrestrial applications experiments.

The WFF is a complex of three separate land areas known as the Main Base, the Mainland, and Wallops Island. WFF is a facility of the Goddard Space Flight Center located in Greenbelt, Maryland.

The Main Base is a land area of 902 hectares (2,230 acres), bordered on the east by 6 kilometers (4 miles) of marshland, which separates it from Chincoteague Island. This area contains Wallops Headquarters, Administrative Offices, tracking facilities, a range control center, rocket and fuel storage depots, rocket vehicle inspection facilities, several support shops, an approved Federal Aviation Administration airport, military family housing units, and bachelor's quarters.

The Mainland and Wallops Island jointly comprise a land area of 1740 hectares (4,300 acres), and are located approximately 11 kilometers (7 miles) southeast of the Main Base. Wallops Island is connected to the Mainland by a causeway and bridge that cross 3 kilometers (2 miles) of salt marsh, which is interlaced with small creeks and is bisected by the Intracoastal waterway. Wallops Island is approximately 11 kilometers (7 miles) long and 0.8 kilometers (0.5 miles), in width at its widest point. Wallops Island borders the Atlantic Ocean on the east, and the Chincoteague inlet on the north. Wallops Island was joined with Assawoman Island to the south when the inlet between them was closed by a storm in 1986. The inlet was temporarily reopened in 1987 but has since filled in and remains closed today. Large and small scale topographic maps can be found in Appendix A, Figures A-2 and A-3, respectively.

The Mainland provides a site for long-range radar, communications, and optical tracking installations. Wallops Island contains the OB area, launch sites, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, U. S. Navy facilities, tracking facilities, and other related service support facilities. In 2003, an Unmanned Aerial Vehicle (UAV) runway was built on the access road just north of the OB area.

The Mainland and Wallops Island operate as a large quantity generator under EPA ID number VA7800020888. NASA was issued this number in 1988. NASA stores hazardous waste generated under this EPA ID number at Building U-81, a less-than-90-day accumulation area. This building is located on Wallops Mainland. NASA has been using the OB area since 1972. In 1988, NASA submitted a RCRA Part B Permit Application and since then has been operating under interim status.

For further information, please contact the Environmental Group Lead at NASA Goddard Space Flight Center, Wallops Flight Facility, Building F-160, Code 250.W, Wallops Island, Virginia, 23337 or by telephone at (757) 824-1103 or (757) 824-1718 or fax at (757) 824-1819.

4.0 OPEN BURNING AREA DESCRIPTION, LOCATION, AND BACKGROUND

4.1 Site Geology and Hydrogeology

Located within the Atlantic Coastal Plain physiographic province, WFF is underlain by approximately 2,135 meters (7,000 feet) of sediment that lies atop crystalline basement rock. The sedimentary section, ranging in age from Cretaceous to Quaternary period, consists of a thick sequence of nonmarine deposits overlain by a much thinner sequence of marine sediments. The two uppermost stratigraphic units at WFF are the Yorktown Formation and the overlying Columbia Group sediments, which are not subdivided into formations.

The southern end of Wallops Island consists of nearly level to steep, very deep, moderately well to excessively drained, Fisherman Assateague fine sands complex. The area relies on natural drainage patterns to intercept and divert flow. The maximum elevation of the southern end of Wallops Island is 4.3 meters (14 feet) above mean sea level.

The sedimentary sequence below WFF contains one major confined aquifer (Yorktown) and an unconfined water table aquifer (Columbia). The Columbia Aquifer typically occurs between 6 and 18 meters (20 and 60 feet) below the ground surface, and is primarily composed of medium-grained sands with intermittent clay lenses.

The Yorktown Aquifer is found at depths of approximately 30 meters (100 feet) below the ground surface and is confined by a clay/silt layer, approximately 6 to 9 meters (20 to 30 feet) thick. It is composed of three separate Miocene units, with the primary water-bearing unit occurring between 67 and 82 meters (220 and 270 feet) below the ground surface.

The Wallops Island's unconfined surface aquifer (Holocene beach sands) drains groundwater vertically from 1 to 2 meters (3 to 6 feet) until meeting the water table, then flows down-gradient to either interior marshes or the ocean. Recharge to the water table aquifer is through direct infiltration of rainwater, and through gains from Hog Creek and the adjoining marshes. Recharge to the Miocene Aquifer is from the central portions of the Eastern Shore in Maryland. Flow gradients on Wallops Island vary in direction relative to seasonal and tidal influences on head pressure. During the winter and spring when water levels in the marshes and Hog Creek are high, increasing head pressure on the west side of the fresh water lens induces flow to the east. During the dry summer and fall months, hydraulic head pressure on the west side of the site equalizes with that produced by the ocean, and an equilibrium condition is established during periods of peak low and high tides. As the tide rises, the head pressure on the east shore rises and an increase in the hydraulic gradient is created inducing flow to the west. This east-west gradient equalizes as high tide approaches causing a reduction in gradient to near zero. As the tide falls the reverse situation occurs resulting in an easterly flow during mid to peak low tide.

The net result of these fluctuations in flow gradients causes lateral flow to the east and west with moderate flow to the north and south during peak high and low tides.

Seven monitoring wells were installed in September 1998. Data used to characterize the water table aquifer was collected from slug tests conducted on monitoring well 1. The test results indicated a hydraulic conductivity (K) of 30 meters per day (100 feet per day) and a transmissivity of 0.004 square meters per second (0.046 square feet per second). Groundwater flow is generally to the northeast.

4.2 Open Burning Area

Open Burning is considered the safest treatment method for hazardous waste rocket motors and igniters and is conducted in a manner to minimize impacts to the environment. The rocket motors and igniters are considered hazardous waste because they meet the characteristic of reactivity (D003). HCOCs are discussed in Section 6.0. The OB area (Appendix A, Figures A-4 and A-5), located on the shoulder of the dike road at the southwestern corner of Wallops Island, consists of three subunits (ground embedded cylinders) and one open burn pad assembly. Subunits 1 and 3 are vertical steel cylinders made from Taurus rocket motor casings (Appendix A, Figure A-6,). Subunits 1 and 3 are 0.6 meters (1.9 feet) in diameter, stand 0.8 meters
(2.6 feet) above the ground surface, and are embedded 2.3 meters (7.5 feet) below the ground and filled with concrete as indicated in Appendix A, Figure A-6. Subunit 2 is a vertical steel cylinder made from a Nike rocket motor casing. Subunit 2 is 0.4 meters (1.4 feet) in diameter, stands 1.1 meters (3.5 feet) above the ground surface, and is embedded 2.2 meters (7.1 feet) below the ground surface. Subunit 2 also is filled with concrete as indicated in Appendix A, Figure A-6. . Subunit 4 (Figure A-8) is 0.7 meters (2.4 feet) in diameter, stands 1.10 meters (3.6 feet) above the ground surface, and is embedded 3.1 meters (10.2 feet) below the ground surface. The subunits 1, 2, and 3 were constructed around 1989. Subunit 4 was installed in 2012, while Subunit 3 was removed in 2012.

The open burn pad assembly (Appendix A, Figure A-7) is a 4.6 meters (15 feet) square by 46 centimeters (18 inches) thick concrete pad with a steel plate in the center for motor head attachment. The unit is equipped with a burn pad cover and is surrounded by a berm. Four cable tie downs are used to stabilize the motors. The pad was constructed around 1996.

The OB area is within the 100-year floodplain. The subunits are covered when not in use to prevent entry and accumulation of precipitation. The subunits also have concrete bases to prevent contact between constituents, subsurface soils, and groundwater. A berm and cover for the pad has been designed and will be in use prior to the permit approval. Runoff, which should not come in contact with contaminated media, is directed across the access road to the east and north and across vegetation to the south and west. Runoff is not collected and does not impact other drainage structures on the Island. Runoff from the OB area infiltrates into the sandy soil surrounding the units. Since the OB area will not have a point source or a storm water collection system, a Virginia Pollutant Discharge Elimination System (VPDES) Permit is not required.

Any rocket motor treated at the OB area, follows guidelines and measures, which have been approved by the WFF Safety Office. The rocket motor and igniter are placed inverted into a cylinder or attached to the pad motor head assembly. The igniter is set off by a battery hook-up

behind a protective barrier. The distance between the barrier and burning area is specified in a ground safety plan prepared for each rocket motor type. Burned motors and igniters are inspected for visible signs of untreated material. If untreated material is present in the motor, then the motor is reignited or the material removed and reignited on the burn pad.

Occasionally, propellant is removed from a motor(s) when modifications are required. Propellant (not in a motor casing), ash, residue, or ejected material are placed on the burn pad in a burn pan. A squib igniter is fabricated, and the material is ignited. Any unburnable material is containerized, sampled for characterization, if necessary, and any hazardous waste is disposed of through WFF's hazardous waste disposal contractor.

4.3 Past Releases

On March 10, 1992, six Nike rocket motors were prepared for OB at the rocket motor disposal site on the south end of the island. These motors, which were manufactured in 1959, had been contaminated with sea water during the January storm which hit Wallops Island. Two of the six motors were prepared for open burning and at approximately 1430, the first motor was ignited without incident. Upon ignition of the second motor an anomaly occurred which resulted in the motor being ejected from the subunit. This motor hit the pavement in the vicinity of the tube from which it had been ejected and came to rest approximately 50 meters south of the tube in the marsh/beach area. There were no personnel injuries nor significant property damage as a result of this anomaly. It should be noted that all necessary safety precautions were followed and all environmental restrictions adhered to during these disposal operations. The technicians also indicated several small brush fires were started by this motor. One fire was unique in that it was started approximately 150 meters west of and behind the barricade. All fires were extinguished by Damage Control, which, according to standard operating procedure, was stationed behind the barricade. These fires were most likely the result of burning propellant being ejected from the motor. Procedures were modified to prevent reoccurrence of this anomaly.

5.0 OVERVIEW OF CLOSURE PROCEDURES

The WFF OB area is subject to the closure requirements of the VHWMR and RCRA regulations, under 40 CFR Part 264, (or Part 265 for Interim Status facilities), Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities.

The OB subunits and burn pad (HWMUs) will be closed in accordance with the closure performance standards (Section 2.0) and closure requirements for a Subpart X hazardous waste treatment facility.

This closure plan is designed to provide documentation of the closure of the OB area subunits and burn pad in accordance with the VHWMR and RCRA. Any hazardous waste constituents remaining after closure will not adversely impact any environmental media in excess of the DEQ established exposure levels and that direct contact with any constituents remaining from the site will not pose a threat to human health and/or the environment.

The closure procedures require that all wastes, waste residues, aggregates, soils, wastewaters, and rinseates that are generated from the closure activities of the HWMUs be segregated and stored in separate containers, and representatively sampled and tested to assure compliance with the VHWMR and RCRA. All wastes, wastewaters, rinseates, soils, and residues related with the closure of the HWMUs will be stored on-site in temporary storage containers in accordance with regulations. No waste piles will be created during closure activities. Waste debris, soils, and residues will be stored in large roll-off containers, if needed.

The Regional Office of DEQ will be notified of the temporary (less-than-90-day) storage of hazardous waste and other wastes associated with closure at the OB area. The Regional Office will be notified a minimum 45 days prior to commencement of closure activities.

In accordance with the EPA's Contained-in Policy, contaminated environmental debris or media is subject to regulation under RCRA if they contain hazardous waste. Contaminated residues and environmental media contain hazardous waste when the following occurs:

- When the residues or media (e.g., soil, aggregate, wastewaters, etc.) exhibit a characteristic of hazardous waste in accordance with 40 CFR Part 261, Subpart C, Characteristics of hazardous Waste, § 261.20.
- When a residue, waste, or wastewater removed from a regulated unit, which manages a listed waste under 40 CFR Part 261, Subpart D, Lists of Hazardous Wastes, contains a hazardous constituent from Part 261 Appendix VI or VIII.
- When the media are contaminated with concentrations of hazardous waste constituents that are above health or risk based levels.

Any soil, subsoil, and equipment contaminated with listed hazardous waste and any leachate from the HWMUs are required to be managed as a hazardous waste only if the concentration of HCOCs exceeds the risk level in accordance with the VHWR and RCRA. That is, any soils, subsoils, sediments, materials, wastewaters, or equipment contaminated with hazardous waste constituents are required to be disposed in a permitted hazardous waste landfill, unless demonstrated by testing that they are nonhazardous in accordance with specified decontamination standards of the approved closure plan and the VHWMR and RCRA regulations.

The demonstration by testing includes the analyses for all HCOCs specified in the approved closure plan and analyses to demonstrate that the materials are not characteristic hazardous waste.

All soils, subsoils, sediments, materials, wastewaters, or leachate or other wastes generated during closure that are demonstrated to be hazardous must be treated or disposed so to comply with 40 CFR Part 268, Land Disposal Restrictions, Subpart D, Treatment Standards, § 268.40, Applicability of Treatment Standards.

All waste materials generated in the closure process that are demonstrated as non-hazardous are required to be disposed of as a solid waste in accordance with the VHWMR. Disposal of all nonhazardous wastes will require documentation of disposal from the authority regulated under the Virginia Solid Waste Management Regulations (VSWMR).

Wastewaters generated in the closure process that are demonstrated as nonhazardous are required to be disposed to a publicly or privately owned wastewater treatment plant regulated by the Clean Water Act (CWA) or equivalent. Disposal of all nonhazardous wastewaters will require documentation of prior approval for disposal, and documentation of disposal from the authority regulated under the CWA.

Hazardous waste is not stored at the OB area. No hazardous waste will be stored in the OB area at closure. When permitted, the maximum amount of propellant to be disposed of per year is 68 metric tones (75 tons). To date, the maximum amount of propellant burned in a year has been 20 metric tones (22 tons) in 1998. The design capacity of 4.0 metric tones (4.4 tons) is based on the propellant weight of 4 Black Brant V rocket motors being burned in one day.

The rocket motors and igniters are considered hazardous waste because they meet the characteristic of reactivity (D003). In 40 CFR 261.23 (a) (6&7) reactivity is defined as follows:

> It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
> It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR173.53 or a Class B explosive as defined in 49 CFR 173.88.

Rocket motors treated at the OB area are reactive because they are Class 1.1 (formerly designated Class A) through 1.3 (formerly designated Class B) explosives. Further discussion can be found in Section 4.0 and Section 6.2.

Since hazardous waste is not stored at the OB area, hazardous waste requiring removal would be limited to contaminated soil, structures, waste residues, wastewaters, and rinseates. All hazardous waste will be managed in accordance with the VHWMR and RCRA and a Health and Safety Plan will be developed for the facility closure.

A decontamination area will be set up prior to dismantling of facility structures. The area will also be used for all nondisposable sampling equipment decontamination. The area will be sufficiently sized and sloped to allow the decontamination of the OB subunits, subunit covers burn pad cover and large equipment. All structures, wastewaters, rinseates, soils, and residues will be characterized in accordance with Section 14.0 and disposed of in accordance with the VHWMR, RCRA, and Land Disposal Restrictions (LDR) to a permitted TSD if found to be a hazardous waste. The steel cylinders will be extracted from the ground and placed in the decontamination area. The cylinders will be steamed cleaned and allowed to air dry. The steel cylinders will be characterized, demilitarized, and if found to be nonhazardous, recycled as scrap metal.

No decontamination waters will be allowed to collect in the decontamination area. Water from steam cleaning and decontamination will be collected in drums and characterized. If the decontamination waters are not a hazardous waste and meet the permit requirements of WFF's wastewater treatment plant, it will be treated there.

The concrete burn pad and pans will be sampled to characterize the material prior to disposal. The discrete grab samples will be scraped and cored from the concrete pad. If it is determined that the pad is nonhazardous, the concrete will be disposed of in a sanitary or construction landfill. If the sample results indicate that the material is hazardous, then an attempt will be made to decontaminate the burn pad. The burn pans will be characterized and disposed of as hazardous waste. At this point, the pad will be removed from the ground and placed in the decontamination area. The pad will be double washed and rinsed. After the material has air-dried a second series of grab samples will be collected and analyzed. If the material remains hazardous the pad will be broken up, containerized, and disposed of as hazardous waste. Wash and rinse waters will be collected and disposed of as hazardous waste.

If soil excavation is necessary due to contamination, the soil will be excavated to the predetermined depth via the sample analysis. The excavated soil shall be appropriately containerized (i.e., in drums or roll-off containers) and sampled for appropriate waste classification. If the soil is deemed to be a hazardous waste, the soil will need to be managed and disposed as hazardous waste. If the soil is not deemed hazardous waste, then the excavated soil will be disposed of in accordance with VSWMR.

The OB area will have achieved clean closure, when all hazardous waste or hazardous waste HCOCs have been removed from the HWMU to levels such that direct contact with any parts of the HWMU or any HCOCs that remain after closure will not pose a threat to human health and/or the environment, nor adversely impact any environmental media in excess of the DEQ established exposure levels.

Achievement of clean closure will be demonstrated by the systematic removal of hazardous wastes, by decontamination of the equipment, structures, and soils and subsoils (if needed), and by comparison of the HCOCs in the sample compliance data to one of the three decontamination standards in this closure plan.

The OB area will be considered clean closed, requiring no further closure activities if one of the following conditions is met:

1. The concentrations of HCOCs in the compliance samples are below the method detection limits of the analytical test methods,
2. The concentrations of HCOCs in the compliance samples are below or not statistically different from the background sample levels, or
3. The concentrations of HCOCs in the compliance samples are at or below DEQ approved risk-based levels.

If performance standards 1, 2, or 3 are achieved, the OB area soil will be considered to be clean closed. If the standards cannot be achieved, the structures and soils may be removed and disposed of at a TSD facility as a means to comply with the closure requirements of VHWMR and RCRA.

6.0 HAZARDOUS CONSTITUENTS OF CONCERN

6.1 Maximum Waste Inventory

NASA does not store hazardous waste at the OB area. No hazardous waste will be stored in the OB area at closure. When permitted, the maximum amount of propellant to be disposed of per year is 68 metric tones (75 tons). To date, the maximum amount of propellant burned in a year has been 20 metric tones (22 tons) in 1998. The design capacity of 4.4 tons is based on the propellant weight of 4 Black Brant V rocket motors being burned in one day.

6.2 Hazardous Waste Determination

The rocket motors and igniters are considered hazardous waste because they meet the characteristic of reactivity (D003). In 40 CFR 261.23 (a) (6&7) reactivity is defined as follows:

> It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
> It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR173.53 or a Class B explosive as defined in 49 CFR 173.88.

Rocket motors treated at the OB area are reactive because they are Class 1.1 (formerly designated Class A) through 1.3 (formerly designated Class B) explosives.

All residues, debris, soils, wastes, wastewaters, etc., that are generated during closure will be analyzed for TCLP constituents in addition to the required testing of established HCOCs to establish whether the wastes generated are hazardous waste or nonhazardous.

6.3 Analytical Procedures

Each type of rocket motor and igniter varies in the type and quantity of reactive constituents. The percent composition of the chemicals is proprietary/classified information and not provided in most cases by the manufacturer. Material Safety Data Sheets are included in Appendix B. The (HCOCs) are those hazardous constituents historically managed at the OB area and the HWMUs, which are identified in RCRA under 40 CFR Part 261, Appendix VII, Basis For Listing Hazardous Wastes, and Appendix VIII, Hazardous Constituents. Groundwater monitoring parameters are based upon constituents required in the *Open Burn/Open Detonation Groundwater Monitoring Plan* (GMP). The HCOCs for closure of HWMUs are listed in Table 1 along with the respective analytical test method.

All samples collected pursuant to this closure plan will be analyzed for all hazardous constituents of concern (HCOC) specified in Table 1. All analytical methods are in accordance with *SW-846, Test Methods for Evaluating Solid Waste, Third Edition*, 1986, EPA as updated (SW-846).

Table 1
Hazardous Constituents of Concern Analytical Test Methods Table

Hazardous Constituent	SW-846 Method	PQL/EQL*	MDL*
Toluene di isocyanate (TDI)	8270	20ug/L/660ug/kg	20ug/L/660 ug/Kg
Resorcinol	8270	20ug/L/660ug/kg	20ug/L/660ug/Kg
Lead	6010B	10ug/L/1.0mg/kg	2.2ug/L/0.16mg/kg
Diethyl phthalate (DEP)	8270	10ug/L/330ug/kg	4.86ug/L/184ug/kg
Nitroglycerin	8332/8330	1.0mg/L/ 5000ug/kg	0.115mg/L/ 501ug/kg
Perchlorate	EPA DW1 314.0	4.0ug/L/8ug/kg	0.795ug/L/ 0.12ug/kg
Cyanide, total	9014R/9010B	0.005mg/L/ 0.25mg/kg	0.002mg/L 0.12mg/kg
Phenols	9065	0.05mg/L 5mg/kg	0.028mg/L 2.22mg/KG
Nitrates	EPA 353.2	0.05mg/L	0.025mg/L
Nitrites	EPA 354.1	0.02mg/L	0.0012mg/L
Ammonia	EPA 350.3/EPA 350.2	1.0mg/L/ 5mg/kg	0.026mg/L/ 2.26mg/kg

*In accordance with SW-846, the definitions of a PQL/EQL and MDL are as follows:

EQL - The estimated quantitation limit (EQL) is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the MDL. However, it may be nominally chosen within these guidelines to simplify data reporting. For many analytes, the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve. Sample EQLs are highly matrix-dependent. The EQLs in SW-846 are provided for guidance and may not always be achievable.

MDL – The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix type containing the analyte.

6.4 Lab Selection

The laboratory performing sample analysis will be a laboratory regularly engaged in performing

hazardous waste profile analyses and will use only approved EPA methods for the type of analysis required. Laboratory reports will provide PQLs/EQLs and the MDLs for each parameter and medium tested. Furthermore, the laboratory shall have a comprehensive Quality Assurance / Quality Control (QA/QC) Program in place. NASA will notify DEQ of the selected laboratory and submit the laboratories QA/QC Plan prior to the start of closure activities at the OB area.

7.0 QUALITY ASSURANCE/QUALITY CONTROL PLAN AND PROCEDURES

7.1 Quality Assurance/Quality Control

The facility and laboratory performing the analytical testing will follow quality assurance and quality control (QA/QC) procedures consistent with Chapter one of SW-846. SW-846, Chapter One, Section 3.4.1, Control Samples, specifies the following:

> Control samples are QC samples that are introduced into a process to monitor the performance of the system. Control samples, which may include blanks (e.g., trip, equipment, and laboratory), duplicates, spikes, analytical standards, and reference materials, can be used in different phases of the data collection process beginning with sampling and continuing through transportation, storage, and analysis.
>
> Each day of sampling, at least one field duplicate, and one equipment rinseate should be collected for each matrix sampled. If this frequency is not appropriate for the sampling equipment and method, then the appropriate changes should be clearly identified in the quality assurance project plan (QAPP). When samples are collected for volatile organic analysis, a trip blank is also recommended for each day that samples are collected. In addition, for each sampling batch (20 samples of one matrix type), enough volume should be collected for at least one sample so as to allow the laboratory to prepare one matrix spike and either one matrix duplicate or one matrix spike duplicate for each analytical method employed. This means that the following control samples are recommended:
>
> - Field duplicate (one per day per matrix type)
> - Equipment rinseate (one per day per matrix type)
> - Trip blank (one per day, volatile organics only)
> - Matrix spike (one per batch [20 samples of each matrix type])
> - Matrix duplicate or matrix spike duplicate (one per batch)

As recommended by DEQ, a field blank will also be collected (one per day per matrix type).

Additional control samples may be necessary in order to assure data quality to meet the project-specific data quality objectives.

The QA/QC samples will be handled the same as all other environmental samples. Sample labeling, chain-of-custody, sample preservation, etc., will be discussed in Section 8.0.

The appropriate QA/QC samples, sample data, and laboratory data, and laboratory QA/QC control procedures specified within the closure plan will be discussed and summarized in the closure report as it pertains to the demonstration of closure.

All of the QA/QC laboratory data will be included with all other field and sampling data and will be provided in an Appendix of the Closure Report.

8.0 CLOSURE SAMPLING AND ANALYSES PLAN

8.1 Field Procedures

Field and laboratory activities for all sample collection and handling shall be done in accordance with SW-846 and as noted in the following sections. Prior to the sampling event, a laboratory will be contracted to perform the analytical requirements, and necessary materials obtained to perform the sampling. Sampling personnel will wear a new pair of gloves for each sample collected.

8.1.1 Instrument Calibration

All field analytical instruments shall be calibrated before each event and on each day of the event according to the manufacturer's specifications. The standards used for calibration shall be documented in the field logbook. Instruments shall also be thoroughly cleaned with deionized water between calibration standards and samples.

8.1.2 Sample Containers

All sample containers will be new and contaminant free. The sample containers will be provided by the laboratory. The containers to be used for samples for hazardous constituent analyses will be selected based on guidance found in SW-846.

8.1.3 Sample Labeling

All sample labeling will be done in the field with indelible/waterproof ink. Any error will be crossed out with a single line, dated, and initialed. Each sample container will be labeled with the following information:

- Site name
- Sample identification number
- Sample location with grid coordinates tied to established survey location. The sample location will have xyz coordinates denoting plan locations and depth.
- Date and time of collection
- Type of preservation
- Analysis required

- Sample type (grab, composite)
- Sample matrix (soil, water, other)
- Any other information pertinent to the sample

8.1.4 Data Collection

A field logbook shall be utilized which contains the following information at a minimum:

- Project for which the sample is being collected
- Date and time
- Name of collector(s)
- Source of sample (including name, location, and sample type)
- Deviations from Sampling Plan or Standard Operating Procedures
- Pertinent field data (pH, temperature, conductance, depth of sample, weather conditions, etc.)
- Unique sample or log number
- Sampling techniques

8.1.5 Sample Preservation

Each sample will be placed into an appropriate and properly labeled sample container. All samples will be kept in a cooler and maintained at 4°C during shipment to the laboratory and until analyses are performed.

8.1.6 Chain-of-Custody Control

Strict chain-of-custody procedures will maintained for all samples. A chain-of-custody form will be completed for each set of samples collected. The form is maintained as a record of sample collection, transfer, and receipt by the laboratory. Custody of samples will be maintained and documented from the time of sample collection to the completion of analysis. The laboratory conducting the sample analysis will provide chain-of-custody documentation. The chain-of-custody will be included in the final closure report as an appendix.

8.2 HWMU Sampling

8.2.1 Soil and Subsoil Sampling

The soil sampling area size for the purposes of soil sampling to determine clean closure is defined as the area affected by a release at the site. Based on historical information, a 5-meter (15-foot) radius area around the subunits was impacted by waste constituents. A more conservative 9-meter (30-foot) radius around the cylinders will be used at closure. Motors placed in the cylinders are approximately 2 meter (6 feet) above the soil surface. The tallest motor attached to the burn pad is approximately 6 meters (17 feet) above ground surface. The

additional height and its affect on the trajectory of ejected material have been calculated and the potential impact area determined to be a 13-meter (42-foot) radius area around the burn pad. The sample locations will be chosen based upon simple random sampling using a statistical sampling strategy, biased sampling (for known hot spots) or, alternatively, every grid node may be sampled. Please note, if random sampling is performed then the random number table used, in addition to the sampling locations, shall be provided to the DEQ with the closure certification report. For random sampling, the appropriate number of samples needed will be determined depending on the surface area size and possible statistical method to be used.

A grid will be established, over the OB area. The size and number of grid locations will be determined based on approximate surface area and in accordance with sampling procedure outlined in SW-846. Sampling at a minimum of eight different soil sampling locations shall be obtained in the vicinity of the OB subunits and pad, and beneath the subunits and pad once they have been removed. Soil samples shall be obtained from the surface layer, the 0-15 centimeter (0-6 inch) layer, the 15-30 centimeter (6-12 inch) layer, the 30-46 centimeter (12-18 inch) layer, and the 46-61 centimeter (18-24 inch) layer. Soil samples will be collected using EPA standard operating procedures. The collection of soil samples will for volatile organic compounds and heavy metals analyses will follow SW-846. All sampling equipment will be decontaminated between samples to avoid cross-contamination at the various depths. Equipment decontamination shall be per the requirements of Section 13.1.

Should soil contamination be detected beneath a HWMU that exceeds the closure plan clean closure decontamination standards, then the horizontal extent of potential contamination outside the HWMU boundary will be evaluated by systematic soil sampling. The initial soil sampling scheme of the closure plan will be laterally extended beyond the initial sampling plan design by sampling in incremental 1 meter (3.3 feet) distances in each direction of the original HWMU sample grid until soil contamination is either not detected or is shown to be in compliance with the closure plan decontamination standards and performance standards.

In the above expanded soil sampling scheme, eight randomly selected sample locations will be established at the perimeter of each incremental 1 meter (3.3 feet) distance outside the original designated HWMU area; the eight random samples will include two samples per side. Sampling protocol (including sample depths and analyses) will follow procedures established for the initial soil sampling design of the HWMU.

The soil sampling data from each extended 1 meter (3.3 feet) sampling zone will not be statistically manipulated to allow a dilution effect of the original sample data or any subsequent extended 1 meter (3.3 feet) sampling zone. That is, each set of sampling data from each additional 1 meter (3.3 feet) of extended sampling area will be statistically evaluated separately from the original data set and any subsequent data sets created by the incremental 1 meter (3.3 feet) sampling protocol noted above.

Should excavation be required, removed soil shall be containerized in drums or roll-off containers. Sampling from such containers for characterization prior to disposal shall consist of

multiple grab samples composited into one. All solid and hazardous wastes will be characterized in accordance with 40 CFR Parts 264, 265, and 268 and Section 14.0 prior to disposal.

8.2.2 Runoff Sampling

After analyzing the topography, a minimum of five samples will be taken from the receiving stormwater ditch which could have received runoff from the burn pad prior to the construction of its berm and cover. The random sampling methodology is satisfactory to select sediment sample locations. The sediment sampling protocols (including sample depths and analyses) will follow procedures established for the soil sampling design of the HWMU. Sediment samples should be from the 0-15 centimeter (0-6 inch) layer, the 15-30 centimeter (6-12 inch) layer.

8.2.3 Groundwater Sampling

Groundwater data generated via the GMP will be utilized to evaluate the groundwater at closure.

8.2.4 Wash and Rinseate Sampling

Verification of the decontamination of HWMU structures and equipment involves the collecting final rinseate water samples from the structure and collecting separate final rinseate from each individual piece of equipment of the HWMU. The final rinseate is to utilize analyte-free (deionized) water.

The final rinseate samples are taken after all of the hazardous wastes have been removed from the unit structure and the individual equipment. Also, after the HWMU and equipment have been cleaned, pressure washed, steam cleaned, and rinsed, etc., in accordance with the decontamination procedures specified in Section 13.0. The final rinseate of each HWMU structure and each piece of equipment are to be individually sampled and tested for the HCOCs to determine whether the HWMU structure and individual equipment meets the decontamination standards.

Wash waters and rinse waters from the HWMU and equipment will be combined in common containers and tested to establish the proper method of disposal. All wastes, washwaters, and rinse waters generated during closure will be sampled as discrete samples and tested for HCOCs and for TCLP parameters to characterize the waste for disposal in accordance with regulations.

8.2.5 Structures Sampling

The discrete grab samples will be scraped and cored from the concrete pad. A minimum of five samples shall be taken from the concrete. Sampling will be performed to characterize the waste as a hazardous waste. All solid and hazardous wastes will be characterized in accordance with 40 CFR Parts 264, 265, and 268 and Section 14.0 prior to disposal.

8.3 Background Sampliug

All background samples will be collected using EPA standard operating procedures. Background samples will be labeled, collected, handled, preserved, and shipped in a manner identical to the closure compliance samples of the same mediums. All QA/QC procedures discussed in Section 7 will be followed for the background samples. These samples will be analyzed for the HCOCs, as listed in Table 2, and in accordance with the requirements of SW-846. All sampling equipment will be decontaminated between samples to avoid cross-contamination at the various depths per the requirements of Section 13.

8.3.1 Background Soil Samples

The background locations shall be selected in an area uncontaminated by site operations and from an area containing soils geologically similar to the compliance sample soils. The proposed location shall be submitted to the DEQ for approval prior to sampling.
Soil borings will be used to verify and document the nature and properties of the background soils in comparison with soils and subsoils from the HWMU. Discrete soil samples will be collected from each boring. A geologist will be present on-site during the sampling to insure that the background soils collected are representative of the soils.

A minimum of eight discrete sampling locations will be used. Background samples will be obtained from the surface layer, the 0-15 centimeter (0-6 inch) layer, the 15-30 centimeter (6-12 inch) layer, the 30-46 centimeter (12-18 inch) layer, and the 46-61 centimeter (18-24 inch) layer.

8.3.2 Background Rinseate Samples

Background rinseate samples will be taken from the water supply which is the source of wash water and rinseate water in the decontamination of the HWMUs. If the potable water source is to be used for decontamination, then potable water will be collected from the cold water tap after running the tap fully open for a minimum period of 5 minutes.

Background final rinseate samples may also be taken from a background structure which is of similar construction materials to the HWMU structure, if the background structure has not been impacted by the facility's HWMUs operations and HCOCs managed at the facility site. The final rinseate samples from a background structure will be taken after decontamination by washing and rinsing in the same manner as the HWMUs undergoing closure.

8.3.3 Background Groundwater

Background groundwater will be as stated in the GMP.

8.4 Report Content

Laboratories will provide a report that includes the following, at a minimum:

1. Title page
2. Sample analysis request form, field chain of custody
3. Internal chain-of-custody
4. Date and time of analysis, name of analyst and analyte
5. Method summary
6. Sample data
   a. analytical reports
   b. method detection limits (MDL)
   c. practical quantitation limits (PQL)
7. Quality control summary
   a. duplicate
   b. matrix spike
   c. matrix spike duplicate
   d. blank
   e. laboratory control spike, if applicable
   f. surrogate recovery summary forms
8. Sample holding time(s)
9. Signature by qualified professional

A summary of results compiled by chemical component will be provided in the form of a data summary table. The summary results should include as a minimum: parameter (chemical component), analytical method, PQLs, MDLs, sample number, results, and units. A qualified professional shall sign the summary of results table. Non-detected analytes should be reported as the detection limit with the code "U" or specified as not detected (ND). Analytes detected above the detection limit, but below the quantitation limit (PQL, etc.), should be reported as an estimated concentration with the code "J". Analytical results shall be received as hard copy and electronically (i.e. Excel spreadsheet).

9.0 HEALTH AND SAFETY PLAN FOR CLOSURE ACTIVITIES

All personnel performing closure activities at the site shall be appropriately trained in accordance with all applicable Occupational Safety and Health Administration (OSHA) regulations. A Health and Safety Plan (HSP) meeting all applicable OSHA requirements must be developed for

these closure activities. All personnel performing closure activities will be trained in the requirements of the HSP and the HSP will be provided to them prior to initiation of closure activities. Personnel will be required to sign the HSP indicating that they have read and understand it. The HSP will be available at all times when closure related activities are taking place.

The HSP shall designate a Site Safety Officer that will be present during all closure activities. The HSP shall provide steps for appropriate selection of personal protective equipment and for decontamination of personnel. The decontamination area shall be staged prior to closure activities commencing. The required notifications of the start of closure activities shall be made to the DEQ and appropriate local authorities. The boundaries of the closed OB area will be defined, cordoned off, and posted to prevent unauthorized entry of site personnel during closure activities. Note, entry to the site by the surrounding population is unlikely due to the presence of round-the-clock security at Wallops Island and badge requirements that prevent unauthorized entry. However, to insure no unauthorized entry during these closure activities, "NO ENTRY" signs shall be posted to minimize the possibility of unauthorized entry. The equipment decontamination area will be established and constructed as described in Section 13.0.

10.0 CLEAN CLOSURE DECONTAMINATION STANDARDS

The OB area will be closed in accordance with the VHWMR and RCRA, 40 CFR Part 264, Subpart G, §264.111, Closure Performance. The OB area will have achieved clean closure, when all hazardous waste or hazardous waste constituents (HCOCs) have been removed from the HWMU to levels such that direct contact with any parts of the HWMU or any HCOCs that remain after closure will not pose a threat to human health and/or the environment, nor adversely impact any environmental media in excess of the DEQ established exposure levels. Achievement of clean closure is demonstrated by the systematic removal of hazardous wastes, by decontamination of the equipment, structures, and soils and subsoils (if needed). Also, by comparison of the HCOCs in the sample compliance data to one of the three decontamination standards in this closure plan.

The OB area will be considered clean closed, requiring no further closure activities if one of the following conditions is met:

1. The concentrations of HCOCs in the compliance samples are below the method detection limits of the analytical test methods,
2. The concentrations of HCOCs in the compliance samples are below or not statistically different from the background sample levels, or
3. The concentrations of HCOCs in the compliance samples are at or below DEQ approved risk-based levels.

If performance standards 1, 2, or 3 are achieved, the OB area soil will be considered to be clean closed. If the standards cannot be achieved, the structures and soils may be removed and disposed of at a regulated treatment facility as a means to comply with the closure requirements

of VHWMR and RCRA.

10.1 Analytical Nondetection

The analytical test methods with the lowest practical quantitation limit or estimated quantitation limit (PQL/EQL) for each HCOC must be used for the nondetection criterion to be the basis for clean closure.

In the rinseate, if a HCOC sample is above the detection limit, the performance standard will still be met if the HCOC is less than or equal to that of the corresponding HCOCs concentration in the equipment blank, field blank, raw water, or trip blank.

If soil and subsoil sample results analytical nondetection for all of the HCOCs analyzed using the approved test methods and detection limits, then the specific sample locations showing the nondetection will be deemed to be uncontaminated. If all soil and subsoil compliance samples result in nondetection for all HCOCs, then the soils and subsoils will meet the clean closure decontamination standard.

If soil and subsoil samples detect the presence of HCOCs, then the facility may demonstrate clean closure by one of the following:

1. Statistical comparison of the compliance samples HCOCs to the background levels HCOCs,
2. Risk assessment evaluation of the HCOCs present in the samples, or
3. Further decontamination (soil removal) and soil sampling to demonstrate achievement of nondetection levels or risk-based levels acceptable to the DEQ.

10.2 Statistical Comparison to Background

A background statistical comparison will be employed to determine if adequate decontamination has been achieved for decontamination of the HWMUs and, removal of contaminated soils or concrete. Background samples and compliance samples will be collected for the statistical comparison in accordance with Section 8.0.

The statistical comparison will satisfy the following performance standards:

1. The significance level will be no less than 5 percent throughout the statistical evaluation.
2. Determination of the minimum number of samples, treatment of outliers, and treatment of non-detected values will follow the *Interim Guidance Document on the Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities,* EPA, April 1989; and *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Draft Addendum to the Interim Guidance,* EPA, June 1992.

3. The sampling results satisfy the assumptions associated with the selected statistical method(s) including the minimum number of background/compliance samples and the distribution of data points.
4. Normality of the sample analytical results will be demonstrated for all of the HCOCs by the use of Probabilty Plots and the Shapiro Wilk test as specified in Chapter 1 of the EPA document *Statistical Analysis of Groundwater Monitoring Data at the RCRA Facilities Addendum to Interim Final Guidance*, July 1992.
5. If the statistical comparisons indicate that there is no significant difference between the background and/or risk-based sampling results, the compliance sampling results are deemed to pass the background and/or statistical comparison, and the decontamination/closure is deemed to be adequate.

Statistical comparison of hazardous constituent concentrations in rinseate or soil samples to those of uncontaminated background samples may be made by the following procedures as specified below:

10.2.1 Upper Tolerance Limits Procedure

The tolerance limit method may only be used when the raw background data and the compliance data are normally distributed or the log transformation of the raw background data and the compliance data are normally distributed. Using the data from the analyses of the eight background samples, an upper tolerance limit (UTL) for each HCOC will be calculated as:

$$UTL = x + (K_{95}(0.95,n) * s)$$

Where: x = the mean of the measured values.
s = the standard deviation of the measured values.
k = k-factor for one sided tolerance limit test.

The parameter $K_{95}(0.95,n)$ establishes the confidence interval for the UTL such that there is a 95 percent chance that at least 95 percent of the time, the actual constituent background concentration will be below the this upper bound. The table, K-Factors for One Sided Normal Tolerance Limits, identifies the value of this parameter as a function of n. The value of K for eight samples (n = 8) is 3.188.

The results of the analyses of the rinseate samples from the containment area or piece of equipment will be compared to the appropriate UTL for all HCOCs analyzed in accordance with this closure plan. If the concentration of every analyte in a sample is below the appropriate UTL, that item will meet the clean closure decontamination standard.

The results of the analyses of each soil sample will be compared to the appropriate UTL for all HCOCs in accordance with this closure plan. If the concentration of every analyte from all depths of a soil sample is below the appropriate UTL, that sampling location will be deemed to be uncontaminated. Should all soil samples be uncontaminated in this fashion, the soil will have met the clean closure decontamination standard. Should some soil samples demonstrate

contamination, further soil sampling and removal will be conducted pursuant to Section 8 of this closure plan.

10.2.2 Alternate Statistical Procedure

If the background data is not normally or log-normally distributed, then an alternate non-paramctric statistical procedure must be used.

A non-parametric Analysis of Variance (ANOVA) procedure such as the Kruskal-Wallis Test or the Wilcoxon Rank-Sum Test will be used. For the above procedures, at least eight soil samples from the HWMU and eight soil samples from the background soils will be compared. Decontamination of an area will be demonstrated by no significant statistical difference for data of all HCOCs between background and the HWMUs.

10.3 Risk Assessment for Closure

As an alternative to decontamination standards specified in 10.1 and 10.2 above, or in conjunction with, the concentrations of HCOCs detected may be compared to risk-based standards in an attempt to demonstrate that the detected concentrations do not pose an unacceptable level of risk to human health and the environment

All risk assessments will be conducted in accordance with the DEQ documents titled *Guidance for Development of Health Based Cleanup Goals Using Decision Tree/Risk Exposure and Analysis Modeling System (REAMS) Program, 1994, and Risk-Based Methodology, as amended by the DEQ*, along with other risk-based guidance provided by the DEQ.
The risk goals/performance standards will be a hazard index of 1.0 for non-carcinogens and an individual carcinogenic risk of I x 10^{-06} and cumulative carcinogenic risk of I x 10^{-04}. This risk assessment will be conducted assuming a future residential use of the property.

If the HWMU cannot meet the residential risk closure standards, then NASA may propose to modify this closure plan for industrial risk-based closure. An industrial land-use scenario may be used in derivation of the risk-based closure standards; however, limitation on land use will be placed on the property deed if the facility is closed by such standards. If industrial scenario for risk-based closure is necessary, the facility shall notify DEQ.

10.4 Alternative to Decontamination Standards

As an alternative to further decontamination procedures (at any time in the closure procedures), NASA may elect to demolish any or all portions of the OB area and manage them as hazardous waste prior to transporting offsite for disposal at a permitted hazardous waste TSD facility.

If the above alternative to demonstrate clean closure is selected, then:

1. Sampling and analysis of underlying soils prescribed by the closure plan will be conducted to demonstrate clean closure.

2. Prior to implementation of this alternative, WFF shall submit a proposed soil sampling plan and amendment to the closure plan to DEQ for approval. Formal approval of the soil sampling plan and associated amendment to the closure plan by the DEQ will be required before implementation of this alternative.

11.0 HWMU WASTE INVENTORY REMOVAL AND MANIFESTS TO A TSD

The removal, transportation, treatment, storage, or disposing of all hazardous waste at the OB area will be conducted in accordance with the VHWMR and RCRA, under 40 CFR Part 264, Subpart G, § 264.112. The accumulation of hazardous waste will be carried out in accordance with RCRA, 40 CFR Part 262, §262.34, and that the accumulation period will be less than 90 days. The 90-day accumulation period will begin the day the waste is generated. Hazardous waste generated by the closure activities needs to be stored in a designated storage area or accumulation areas on-site. The DEQ Regional Office will be notified 15 days prior to the facility use of any new accumulation areas.

11.1 Inventory Removal Summary Table

NASA does not store hazardous waste at the OB area. No hazardous waste will be stored in the OB area at closure. All hazardous waste in the OB area during closure will be the result of closure or decontamination activities.

The OB area closure report will provide a summary table of information related to the hazardous waste inventory removal from subunits 1, 2, 3 and the burn pad. The closure report inventory removal summary table for each HWMU undergoing closure will include the following information:

1. A table title such as, HWMU OB Area – Hazardous Waste Inventory Removal Summary.
2. A description of the hazardous waste by chemical name and hazardous waste codes.
3. The amount of hazardous waste removed under each shipment (e.g., 20, 55-gallon drums, 2, 20 cu yd roll-off containers, etc.).
4. The corresponding inventory removal listing, which shows the number and size of the containers removed, the EPA hazardous waste code numbers on all of the containers shipped, and the dates of shipment to an off-site TSD. (This information must correspond with the information on the manifests. Copies of the manifests will be provided in an appendix of the closure report.)

11.2 Off-site TSD

The closure report shall identify the off-site TSD facility name, address, EPA ID Number, telephone number, and facility contact that will be used for disposal or treatment of the hazardous wastes removed during closure.

12.0 DECONTAMINATION OR DISPOSAL OF HWMUS – EQUIPMENT, STRUCTURES, AND SOILS

12.1 Demolition, Removal and Disposal of the OB Units

Prior to beginning the decontamination process, a pre-wash equipment sample blank should be collected by running deionized water through the decontamination equipment (high-pressure washer, steam equipment, etc.). Samples should be taken from the decontamination equipment spray nozzle, etc.

After high-pressure washing and rinsing the HWMUs a final rinseate sample will be collected from each HWMU. In addition a post-rinse sample should be collected from the high pressure washing equipment by pouring deionized water over the surface area of the equipment similar to the pre-wash equipment sample blank.

A decontamination area will be set up prior to dismantling of facility structures. The area will also be used for all nondisposable sampling equipment decontamination. The area will be sufficiently sized and sloped to allow the decontamination of the OB subunits. The steel cylinders will be extracted from the ground and placed in the decontamination area. The cylinders will be steamed cleaned and allowed to air dry. The subunit covers and burn pad cover will also be steam cleaned and allowed to air dry. No decontamination waters will be allowed to collect in the decontamination area. Water from steam cleaning will be collected in drums and characterized in accordance with Section 14. After wastewater characterization is complete, the material will be properly disposed. If the wastewater is determined to be hazardous, the material will be disposed to a permitted hazardous waste TSD facility.

The concrete burn pad will be sampled to characterize the material prior to disposal. Characterization of the pad will be in accordance with the VHWMR. The discrete grab samples will be scraped and cored from the concrete pad. The material will be analyzed for the same waste constituents as the soil samples. If it is determined that the pad is nonhazardous, the concrete will be disposed of in a sanitary or construction landfill. If the sample results indicate that the material is hazardous, an attempt will be made to decontaminate the burn pad. At this point, the pad will be removed from the ground and placed in the decontamination area. The pad will be double washed and rinsed. After the material has air-dried a second composite sample will be collected and analyzed. If the material remains hazardous the pad will be broken up, containerized, and disposed of as hazardous waste. Wash and rinse waters will be collected and disposed of as hazardous waste.

The burn pans will be characterized and disposed of as hazardous waste.

After removal of the OB subunits 1, 2, 3, and the burn pad, an independent Virginia registered professional engineer will thoroughly inspect the containment surface for cracks, gaps or other migration pathways through which contamination may have potentially migrated to the soils underneath and adjacent to the units. All cracks in the containment will be identified and

included on the site survey for determining sampling locations in underlying soil.

As an alternative to further decontamination procedures, at any time in the closure procedures, the facility may elect to demolish any or all portions of the OB subunits or pad and manage them as hazardous waste (if necessary) prior to transporting off-site. Should this alternative be selected, a soil sampling plan and closure plan amendment will be submitted to DEQ for approval. Prior to removing the structure for disposal, the location of any cracks, gaps previously identified, will be marked for sampling of the underlying soil.

12.2 Excavation Plan

Should it be determined that removal of soils and concrete is required to achieve clean closure, demolition and disposal of the concrete structure and the underlying/adjacent soils will be performed in accordance with the following procedures:

1. WFF will procure an excavation contractor who will supply a HSP and furnish evidence that all employees have been trained to demolish and dispose of the concrete structure as outlined in Section 10.0 and the HSP.
2. The decontamination zone and work zone will be cordoned off and set up per the procedures in the HSP.
3. The contractor will demolish and excavate the affected concrete and soils. The decontamination procedures described in this plan will be utilized during all excavation activities.

12.2.1 Conditions That Trigger Excavation

Soils and subsoils which fail the statistical and/or REAMS risk-based analysis decontamination standards will be excavated to a depth where the soils and subsoils demonstrate compliance with the decontamination standards.

12.2.2 Vertical Extent of Excavation

The vertical extent of contamination should be established based upon the following:

1. The vertical extent of excavation will be based upon the extent of contamination that will be established by systematic vertical sampling of migration pathways and data evaluation using the clean closure decontamination standards (refer to Section 10.0). The proposed vertical sampling protocol and depths should be delineated.
2. Typically, the soil sampling depth intervals should be provided from the bottom of the HWMU structure to a depth of 1 meter (3.3 feet) below the structure. The typical soil sampling intervals beneath a HWMU are: the 0-15 centimeter (0-6 inch) layer, the 15-30 centimeter (6-12 inch) layer, the 30-46 centimeter (12-18 inch) layer, and the 46-61 centimeter (18-24 inch) layer.

3. If sampling and analyses of soils and/or sediments shows HCOCs at levels which exceed all decontamination standards, then the soil and/or sediment will be removed to the bottom depth of the first 15 centimeter (6 inch) sample interval which shows compliance with the decontamination standards. That is, excavation of soils will be to the bottom of the first clean sample depth interval. This ensures removal of all soil/sediment that are shown not to meet the clean closure standards.
4. If the initial sampling does not show compliance with decontamination standards at the deepest depths of the initially proposed sampling scheme (e.g. 2-ft), then additional vertical samples will be taken until samples show levels of HCOCs within the decontamination standards.
5. If soil or sediment contains HCOCs above the decontamination standards specified in Section 10.0 of this closure plan, soil or sediment excavation will be conducted down to maximum depth of one of the following:
   a. The bottom of the first soil sampling interval depth where sampling analytical data indicates compliance with the decontamination standards (clean closure conditions).
   b. The local seasonal high water table if less than 1.5 meters (5 feet). The seasonal high water table depth will be established with concurrence from the Office of Waste Permitting, DEQ.
   c. The local bedrock, if less than 1.5 meters (5 feet).
6. If soil contamination exists above the decontamination standard at depths greater than 1.5 meters (5 feet), either DEQ will be formally notified for the potential need to amend the approved closure plan or to close the HWMU with hazardous waste closed in-place in accordance with the applicable regulations for the HWMU in the VHWMR.

12.2.3 Horizontal Extent of Excavation

The horizontal extent of contamination should be established based upon the following:

1. The horizontal extent of excavation will be based upon the extent of contamination that will be established by systematic sampling of migration pathways and data evaluation using the clean closure decontamination standards in Section 10.0.
2. If soils are contaminated beneath the HWMU which need removal to comply with decontamination standards and regulations, and if the secondary containment is insufficient to prevent runoff from the HWMU, the horizontal extent of the contamination will need to be determined.
3. Some sampling plans include soil sampling of an area outside the actual HWMU boundary by inclusion of a buffer area outside the HWMU (e.g., 2 - 3 feet) to assess the horizontal extent of the contamination outside the HWMU. The adequacy of the soil sampling plan to determine the horizontal extent of contamination should be based upon the nature of the site and the operations and management of the HWMU undergoing closure.

4. If the horizontal extent of the contamination is to be evaluated by a sampling scheme that includes a buffer zone outside the HWMU area proper, excavation will be conducted to include the buffer zone outside the HWMU boundary.

12.2.4 Storage, Treatment, and Disposal of the Excavated Soil, Subsoils, Construction Debris,and/or Residues

The excavated soils, subsoils, construction debris, and residues should be stored in large roll-off containers. The sampling and analytical testing protocol for all soils, subsoils, sediments, debris, and residues are provided in this plan (See Section 5.0, Overview of Closure Procedures, and Section 8.0, Closure Sampling and Analyses Plan) to establish the proper means of disposal to comply with the VHWMR and RCRA.

12.2.5 Backfilling Areas of Excavation

Any areas of excavation will be backfilled with clean fill or soil to the original grade of the site prior to termination of closure activities. In addition, the site will also be seeded and vegetative cover established, where appropriate for the site, or reclaimed to similar conditions of the surrounding area.

Backfilling and reclamation of a HWMU site will not occur until the DEQ performs the closure site inspection and formally approves the clean closure of the HWMUs.

13.0 TEMPORARY DECONTAMINATION AREAS AND PROCEDURES

The decontamination wash waters (wastewaters), rinseates, soils, and residues collected in the decontamination areas will be managed as potentially contaminated with hazardous waste and tested for the HCOCs and TCLP constituents, as specified in this closure plan. The proper management of the wastes generated from the closure activities will be based on the requirements specified in Section 14.0.

Any disposable items, such as protective clothing, sampling equipment, filters, clean-up materials, decontamination liner materials, etc., will be containerized and disposed of as hazardous waste.

13.1 Small Equipment

A decontamination area will also be set up for all non-disposable sampling equipment decontamination. The area will be set up on plastic and down gradient of the closure units. All nondisposable sampling equipment will be decontaminated between each sample. An area for cleaning equipment will be established as close as possible to the work area. A layer of plastic will be placed on a level surface. Buckets or other appropriate containers will be used for capturing the rinseate and holding the wash-water during the cleaning process.

The equipment shall be decontaminated, as follows:

The decontamination procedures for sampling equipment (*EPA Region IV, Standard Operating Procedures and Quality Assurance Manual*, 1986), will be as follows:

1. Remove loose material by brushing or scraping. The material removed will be properly containerized and disposed of in accordance with all applicable state and federal hazardous and solid waste regulations.
2. The equipment will then be washed with a non-phosphate detergent. All decontamination wash waters will be collected and containerized for proper disposal in accordance Section 14.0 of this closure plan.
3. Rinse with tap water, rinse with methanol or propanol, then rinse with distilled or de-ionized water. These decontamination rinse waters will be collected and containerized for proper disposal in accordance with Section 14.0 of this closure plan.
4. If metal contamination is present, a rinse with 10 percent nitric acid will also be needed. This acid rinse will be followed by another distilled or de-ionized water rinse. This rinseate shall be collected and containerized for proper disposal in accordance with Section 14.0 of this closure plan.
5. Equipment will be allowed to air dry then stored in aluminum foil or plastic bags to prevent contamination.

In addition, the following procedures shall be established for the proper decontamination of personal protective equipment (PPE).

1. PPE will be decontaminated between uses/areas, and upon completion of work.
2. All decontamination will take place in the temporary decontamination area.

13.2 Large Equipment

If, during closure activities, the use of heavy equipment is necessary (i.e., soil boring sampling or soil removal), such as a backhoe or a hollow-stem auger drill, a temporary decontamination area for this heavy equipment will be constructed. The area will be graded to at least a 2 percent slope toward one corner. A berm constructed of sand bags, or equivalent material, will be placed around the edges. The area will be lined with a plastic liner to prevent infiltration of decontamination wafers into the underlying soils. The liner must be able to sustain the stress caused by moving of heavy equipment in and out of the area. The decontamination waters must drain to an appropriate container; no accumulation of liquids on the liner is allowed. This collected liquid will be tested for appropriate disposal (see Section 14.0). All decontamination shall occur in the decontamination area constructed and waste generated will be properly handled in accordance with all applicable state and federal hazardous and solid waste regulations. The decontamination procedures for heavy equipment are:

1. Heavy equipment used to remove contaminated soil will be decontaminated by appropriate abrasive methods (i.e., scraping and/or brushing). The material removed will

be properly containerized and disposed of in accordance with all applicable state and federal hazardous and solid waste regulations.

2. Equipment will then be cleaned with a high-pressure wash. A non-phosphate detergent shall be used. All decontamination wash waters will be collected and containerized for proper disposal in accordance Section 14 of this closure plan.
3. The heavy equipment will then be rinsed with water, rinsed with methanol or propanol, and then rinsed with distilled or de-ionized water. This decontamination rinseate will be collected and containerized for proper disposal in accordance with Section 14.0 of this closure plan
4. If heavy metal contamination is present, a rinse with 10 percent nitric acid may also be needed. This acid rinse will be followed by another water rinse. These rinse waters shall be collected and containerized for proper disposal in accordance with Section 14 of this closure plan.
5. Equipment will be allowed to air dry then covered in plastic sheeting to prevent contamination.

14.0 MANAGEMENT, CHARACTERIZATION, AND DISPOSAL OF CLOSURE GENERATED WASTES

All closure generated wastes will be segregated from one another and stored in separate containers. No waste piles will be created. All wastes will be stored on site for less than 90 days. NASA will notify DEQ at least 15 days prior to establishing a new waste accumulation area.

14.1 Disposal of Hazardous Waste

Any disposable items, such as protective clothing, sampling equipment, filters, clean-up materials, decontamination liner materials, etc., will be containerized and disposed of as hazardous waste.

All wastes generated from closure of the HWMUs (including but not limited to soil and concrete) will be managed as residues or media that is potentially contaminated with hazardous waste. Hazardous waste are required to be disposed in a permitted hazardous waste landfill or a RCRA TSD facility, unless demonstrated by testing that they are nonhazardous in accordance with specified decontamination standards of the approved closure plan and testing requirements for generated wastes specified in the VHWMR and RCRA.

Contaminated residues and/or environmental media contain hazardous waste when the following occurs:

1. When the residues or media (e.g., aggregate, wastewaters, soil, and groundwater, etc.) exhibit a characteristic of hazardous waste in accordance with 40 CFR Part 261, Subpart C, Characteristics of hazardous Waste, § 261.20.

2. When a residue, waste, or wastewater removed from a regulated unit, which manages a listed waste under 40 CFR Part 261, Subpart D, Lists of Hazardous Wastes, contains a hazardous constituent from Part 261 Appendix VI or VIII.

3. When a contaminated media (i.e., debris, soil, sediments, or groundwater) are contaminated with concentrations of hazardous waste constituents that are above health or risk-based levels.

The demonstration by testing includes the analyses for all HCOCs or underlying hazardous constituents (UHCs) managed at the facility that are identified in Part 261, Appendix VI and VIII, and an analyses to demonstrate that the waste or media does not exhibit a hazardous characteristic in accordance with Part 261, Subpart C, Characteristics of Hazardous Waste. This includes demonstration of compliance with the characteristics of ignitability, corrosivity, and reactivity and the toxicity characteristic.

All wastes (solids and liquids) generated during closure that are demonstrated to be hazardous must be disposed in a permitted hazardous waste landfill or a RCRA permitted TSD facility. Disposal of regulated wastes must comply with 40 CFR Part 268, Land Disposal Restrictions, Subpart D, Treatment Standards, § 268.40, Applicability of Treatment Standards, § 268.49, Alternative LDR Treatment Standards for Contaminated Soil, and comply with § 268.48, Universal Treatment Standards, for Wastewaters and Non-wastewaters.

Disposal of all hazardous wastes will require manifest documentation of shipment to a permitted TSD. Transportation of hazardous waste generated during closure activities will be in accordance with the VHWMR and require a transporter with a current Hazardous Waste Transporter Permit.

14.2 Disposal of Nonhazardous Solid Wastes

All waste materials (other than nonhazardous wastewaters) generated in the closure process that are demonstrated as nonhazardous are required to be disposed of as a solid waste in accordance with the VHWMR. Disposal of all nonhazardous wastes will require documentation of disposal from the authority regulated under the VSWMR.

14.3 Nonhazardous Wastewaters

Wastewaters generated in the closure process that are demonstrated as nonhazardous are required to be disposed to a publicly or privately owned wastewater treatment plant regulated by the Clean Water Act (CWA) or equivalent. Disposal of all non-hazardous wastewaters will require documentation of prior approval for disposal, and documentation of disposal from the authority regulated under the CWA.

14.4 Reusable Equipment

All reusable equipment that is used in the decontamination and closure process, including the large equipment, wet-dry vacuum, pressure washers, steam cleaners, sampling equipment, shovels, buckets, brooms, etc., will be thoroughly washed with a detergent solution, rinsed twice with clean water, rinsed with methanol or propanol and then rinsed with distilled water. A final rinseate using analyte free deionized water will be collected and tested for compliance with decontamination standards or the items will be disposed of as hazardous wastes.

15.0 CLOSURE COST ESTIMATE WITH SUPPORTING CALCULATIONS

Federal Government installations are exempt from the financial requirements of the hazardous waste regulations; therefore, Section 15.0 does not apply.

16.0 FINANCIAL ASSURANCE FOR CLOSURE

Federal Government installations are exempt from the financial requirements of the hazardous waste regulations; therefore, Section 16.0 does not apply.

17.0 SCHEDULE FOR CLOSURE

When the decision is made to close the OB area, NASA will notify DEQ in writing at least 45 days prior to the closure commencement date. NASA will complete closure within 180 days of the approval, unless an extension per 40 CFR 264.113 or 265.113 is approved.

If closure will exceed 180 days, NASA will submit a petition at least 30 days prior to the deadline of the closure period. A petition will be submitted if and only if any one of the following conditions is met:

1. Closure activities require longer than 180 days.
2. There is reasonable likelihood that another owner/operator will recommence operation of the unit within one year.
3. Closure would be incompatible with continued operations

Within 90 days after receiving the final volume of hazardous or non-hazardous wastes, NASA will remove from the unit or facility, or dispose of all hazardous wastes off-site, in accordance with this closure plan. Hazardous wastes generated during closure will only be accumulated for less than 90 days.

Within 60 days following the 180 day closure period, NASA will submit the closure certifications. The complete closure schedule is found in Appendix C.

18.0 CLOSURE PLAN AMENDMENT, CONTINGENT CLOSURE, AND POSTCLOSURE PLANS

18.1 Closure Plan Amendment

Amendment of the closure plan will be in accordance with the requirements of the regulations under 40 CFR Part 264 or Part 265 Subpart H, § 264.112 or § 265.112. These regulations specify the following requirements:

1. The written notification or request to the Director, DEQ, must include a copy of the amended closure plan for review and approval.
2. A written notification or a modification request to the Director, DEQ, must be submitted to authorize a change in the approved closure plan whenever the following occurs:
   a. Changes in operating plans or facility design that affect the closure plan.
   b. There is a change in the expected year of closure.
   c. In conducting partial or final closure activities, unexpected events require a modification of the approved closure plan.
3. The owner or operator must submit a written request for a permit modification including a copy of the amended closure plan for approval at least 60 days prior to the proposed change in facility design or operation, or no later than 30 days after an unexpected event has occurred which has affected the closure plan.
   a. If an unexpected event occurs during the partial or final closure period, the owner or operator must request a modification no later than 30 days after the unexpected event.
   b. The Director will approve, disapprove, or modify the amended plan in accordance with the procedures in parts 124 and 270.
4. In accordance with the authority under § 264.112(c)(4), the Director may request modifications to the closure plan under the conditions described in 264.112(c)(2).

If amendment of the closure plan is required to close a HWMU with hazardous wastes closed in-place," NASA is required to close the HWMU in accordance with the closure requirements of a landfill. In these circumstances, the closure plan will need to be modified or amended to reflect the closure requirements of a landfill and postclosure plan must be developed to comply with the postclosure care requirements specified under § 264.310 or § 265.310.

18.2 Postclosure Plan

NASA will make all attempts to close the OB area in a condition of acceptable environmental standards and in accordance with the VHWMR. Once a determination is made that the site cannot clean close per this closure plan, NASA will submit a contingent closure plan and a contingent postclosure plan to DEQ within 60 days. If the site cannot demonstrate clean closure,

the site will be closed under a contingent closure plan. Under this plan, the site will be closed as a landfill with the waste remaining in place and a cap installed to inhibit contaminant migration. Postclosure monitoring will be in accordance with the contingent postclosure plan. This program will continue for 30 years unless otherwise noted by the Executive Director. In the event that clean closure is unattainable, a revised closure plan will be required to address the appropriate closure and postclosure requirements based on the conditions determined at the time of closure.

19.0 CERTIFICATION OF CLOSURE BY OWNER/OPERATOR AND PROFESSIONAL ENGINEER (P. E.)

Closure certification and the closure report will be in accordance with the following certification requirements, which are delineated in the VHWMR and RCRA:

1. The owner/operator and an independent professional engineer, registered in the Commonwealth of Virginia, will both certify that the HWM facility (or HWMU subject to closure) has been closed in accordance with the specifications in the approved closure plan. The certification statements will be in accordance with the VHWMR, under 9 VAC 20-60-1030, Signatories to Permit Applications and Reports. The certifications will be by an authorized person describe in 9 VAC 20-60-1030.A or by a duly authorized representative of that person as delineated in 9 VAC 20-60-1030.B.
2. The certification of closure by the owner/operator and the professional engineer will be in accordance with the requirements of the VHWMR, under 9 VAC 20-60-1030.D and will be signed, dated, include the title of the person certifying the closure, and include the certification text that is specified within the regulations as follows:

   I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

3. The certification of closure will be submitted by registered mail to DEQ within 60 days of completion of closure (within 240 days after initiation of closure) within the Closure Report.

The certification statement must be by an authorized person or by a duly authorized representative of that person in accordance with the regulations under 9 VAC 20-60-1030.

Prior to signing the closure certification statement, the engineer will review all procedures, systems, analytical data, laboratory reports, QA/QC Plan, QA/QC procedures, QA/QC data, calculations, statistical analyses, and risk-based assessment evaluations, criteria, and conclusions. The engineer's review will also include a determination that appropriate closure plan procedures,

systems, including QA/QC procedures, have been followed and observed in the closure activities at the site and by the contracted laboratory, and that the appropriate equations have been correctly applied and calculated as specified in the closure plan and appropriate guidance documents of the EPA and DEQ. In addition, prior to certification of closure, the engineer's review will verify demonstration that the data verifies that the decontamination standards of the closure plan have been achieved, and that the facility has been closed in accordance with the closure performance standards of the approved closure plan.

20.0 CLOSURE REPORT

In support of the closure activities, a closure report will be submitted with the certifications. This closure report will contain all pertinent descriptions and documentation demonstrating that the closure has been performed in accordance with this plan. The report shall contain, at a minimum, the following information:

1. Certifications of Closure Statements of the owner/operator and the Professional Engineer (P. E.)
2. A summary of closure procedures and activities completed during decontamination and closure of each HWMU. The summary should include sufficient summary and detailed information from the approved closure plan. The closure report should refer the reader to the approved closure plan, when needed.
3. Documentation of HWMUs waste inventories have been removed and disposed to a regulated treatment storage or disposal (TSD) facility. Copies of manifest records shipment to a regulated TSD needs to be provided in an appendix.
4. Documentation of management and characterization of all wastes generated during closure activities in accordance with closure plan and the regulations. Copies of manifest records of the disposal of all closure generated wastes to a regulated TSD, solid waste disposal facility, or facility regulated under the clean water act, as appropriate.
5. Documentation of the sampling locations in the text and figures that correspond with the sample identities and information provided in the text, tables, and laboratory reports.
6. Documentation of the vertical and horizontal extent of excavation in both the narrative text and in figures, if applicable. The depth to clean soil samples, etc., will be demonstrated.
7. Documentation of all sampling analytical tests data, QA/QC plan, QA/QC procedures, and the QA/QC data.
8 Summary tables of all sampling data results to support the closure findings and conclusions.
9. A discussion and summary of QA/QC procedures, data results, implications, findings, and conclusions.

10. All statistical analyses and calculations supporting the closure conclusions.
11. All risk-based assessment calculations, summary tables, and evaluations, findings, and conclusions. Supporting risk-based information and calculations should be provided in the Appendices.
12. Appendices that include all: sampling and chain-of-custody documentation, laboratory data sheets and certifications for all compliance, background, and QA/QC samples.
13. For a facility subject to closure under the industrial/occupational scenario, or a facility which achieves closure in-place, a signed Notice of Use Limitation should also be included in the closure report. A copy of a Notice of Use Limitation statement is included in the *Guidelines for Developing Health-Based Cleanup Goals Using Risk Assessment at Hazardous Waste Site Facility for Restricted Industrial Use*, DEQ, June 1995.

APPENDIX A

FIGURES

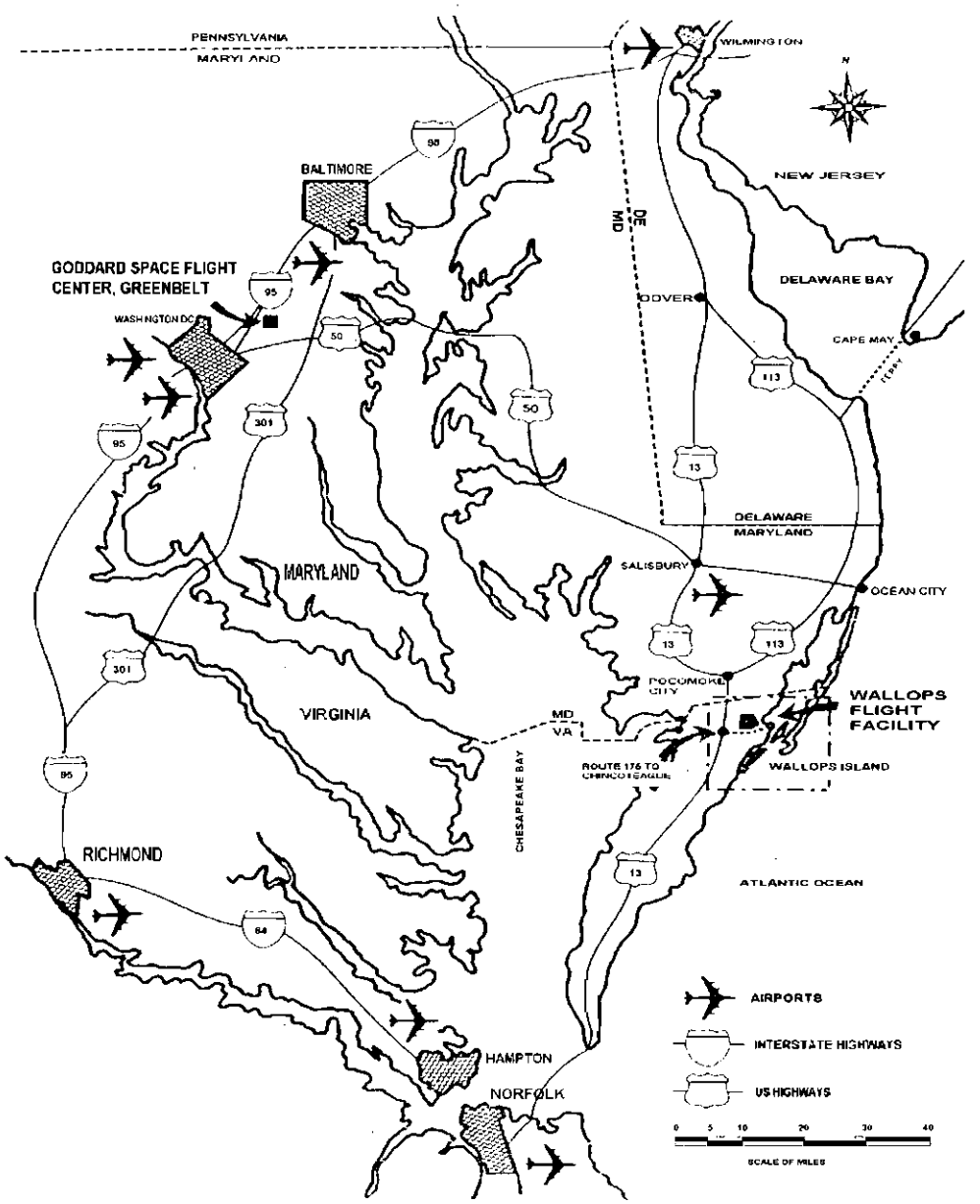
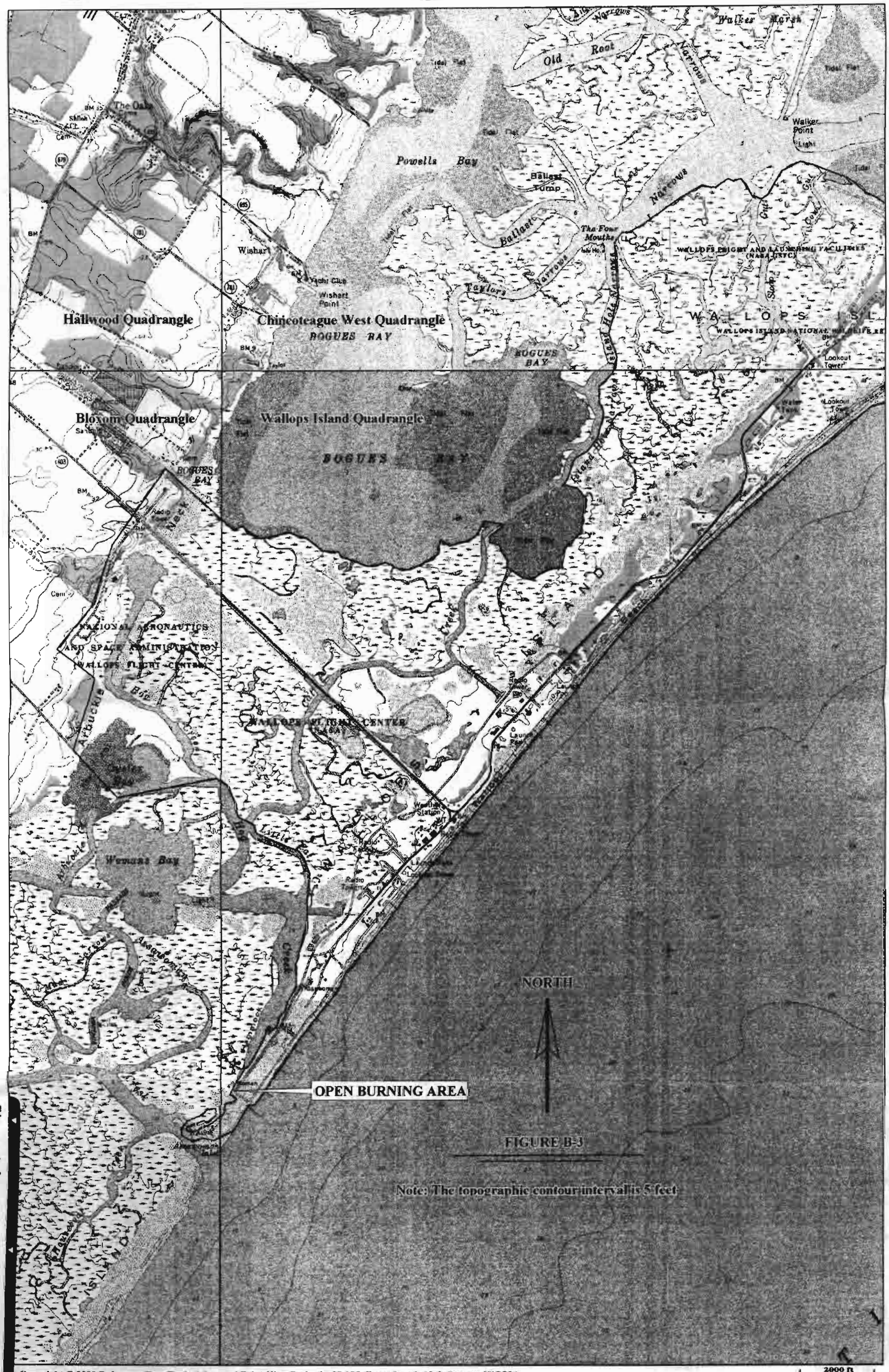


Figure A-1 Site Location Map



—Figure A-2 Large Scale Topographic Map—

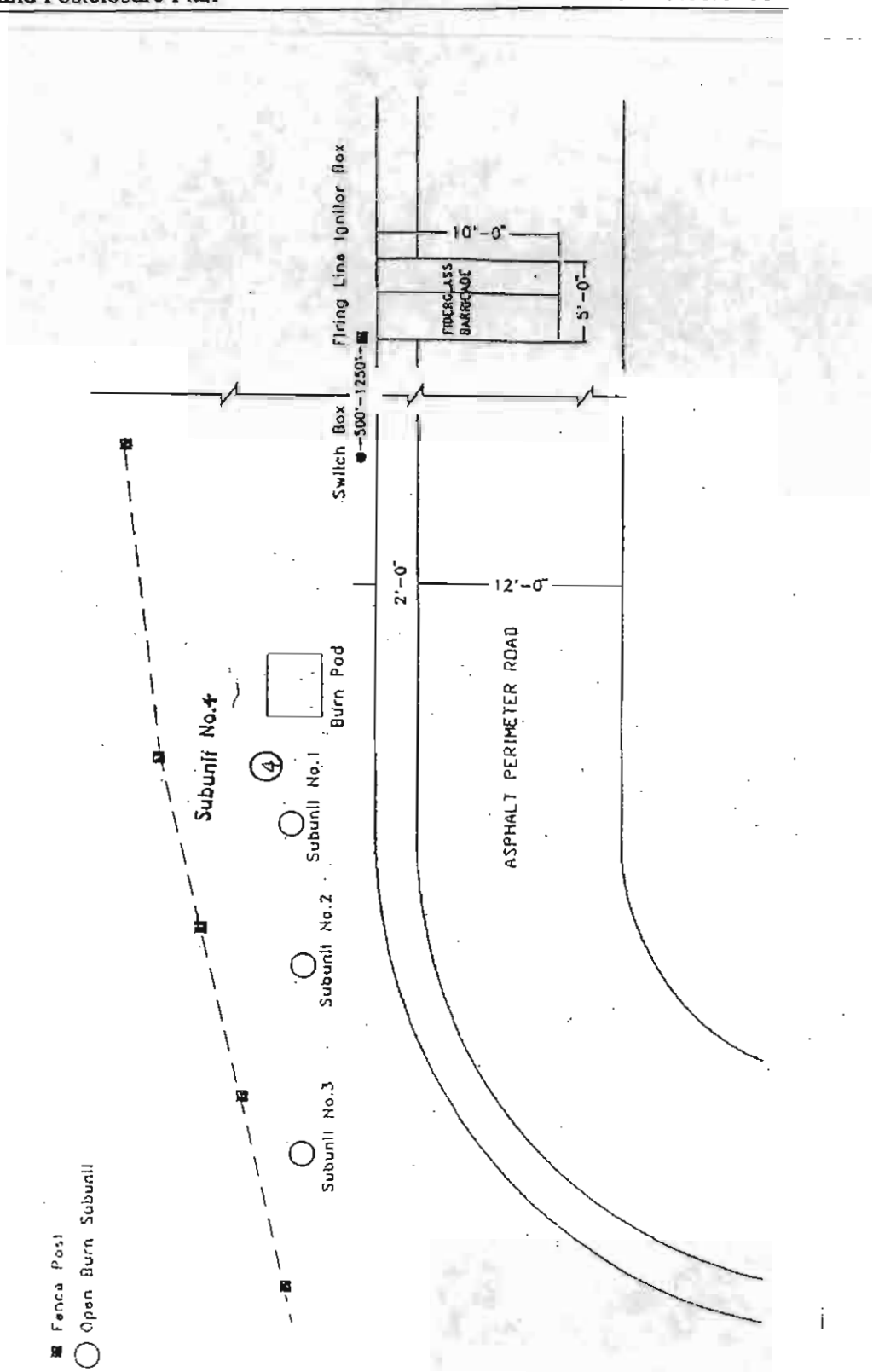


Figure A-4 Open Burning Area Subunits 1, 2, 3, 4 and Burn Pad

Exhibit II GG-1 Appendix A

Also OB Permit Application Attachment 16 Appendix A

Figure A-5 OB Area Subunits 1, 2, 3, and Burn Pad

Note: Drums show are purge drums from groundwater monitoring.

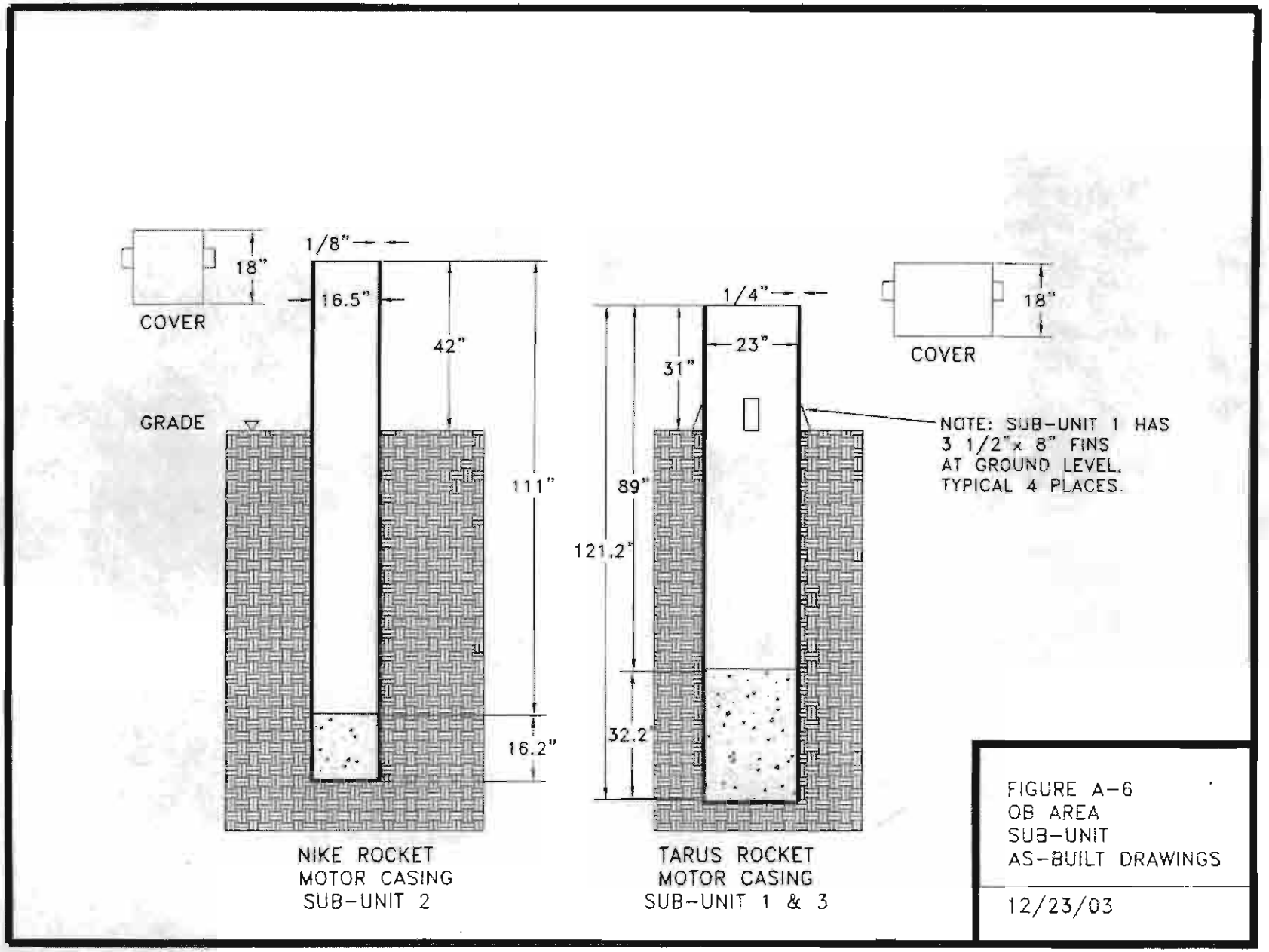


Figure A-6 Open Burn Area Subunits

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The document indicated below is located in the paper file cabinet.

2 Map(s) - Oversized
___ Colored Spreadsheet(s)
___ Blueprint(s)
___ Diagram(s)
___ Pictures (s)
___ CD(s)

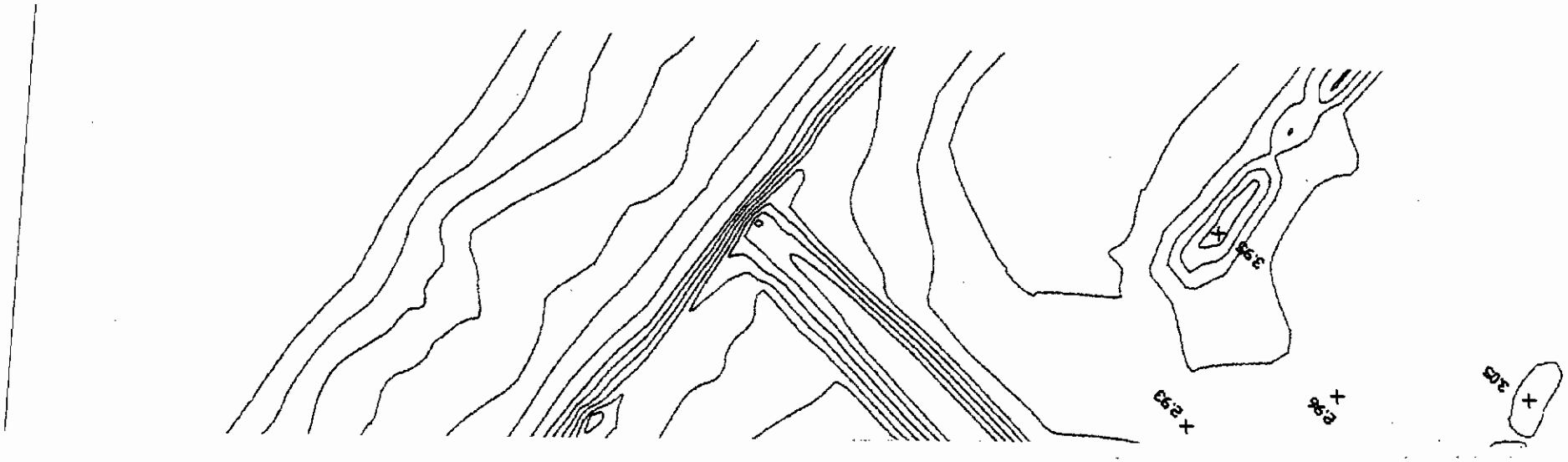
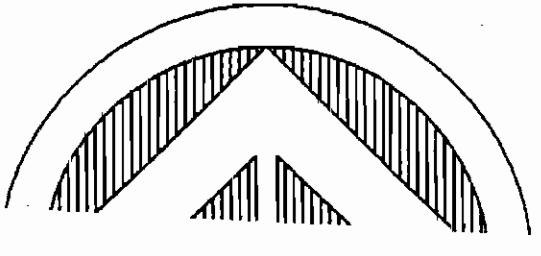


FIGURE A – 3

SHEET NO. 1

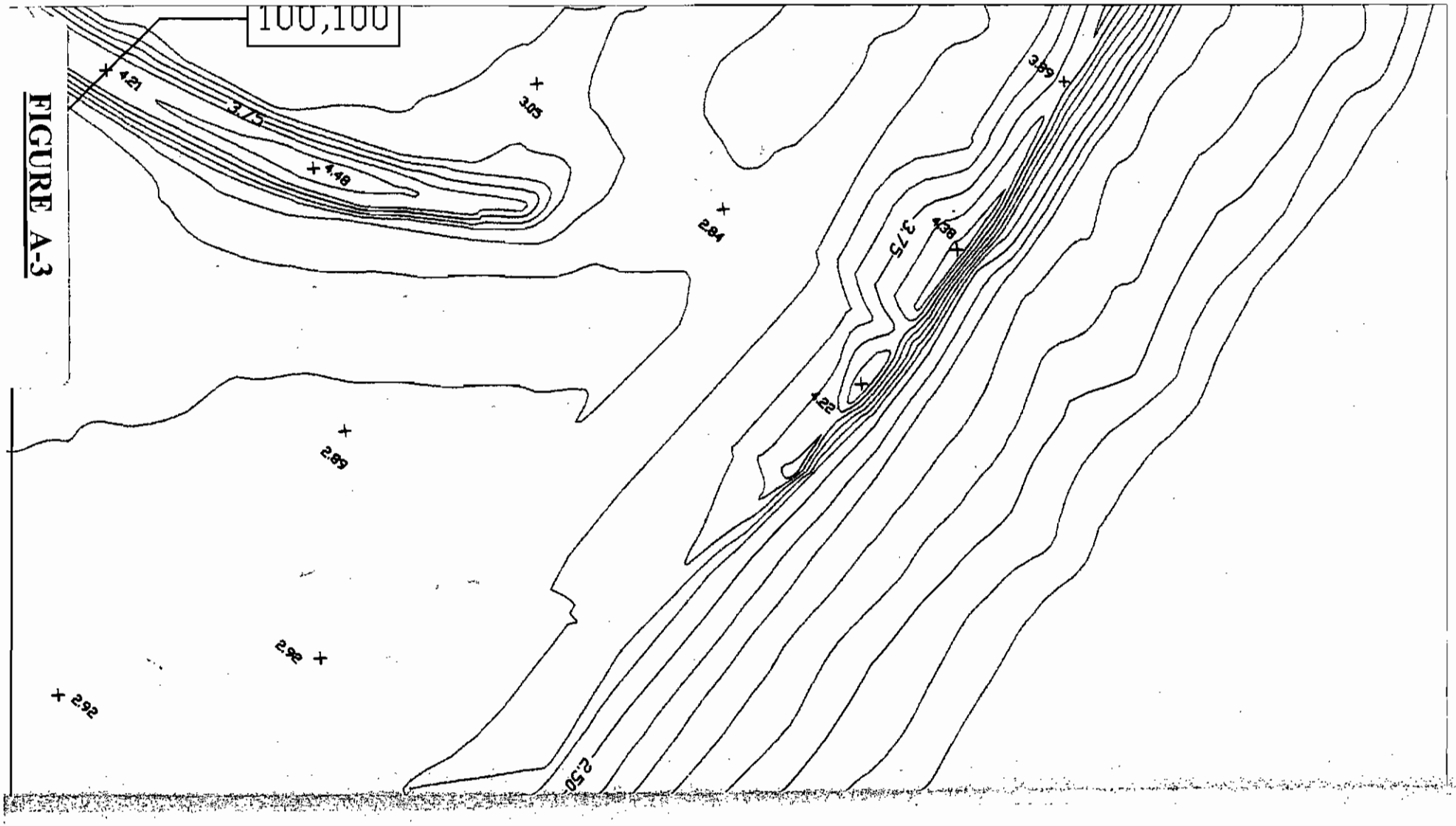
FIGURE A-3



TOPOGRAPHIC SUF
LOCATED AT WA

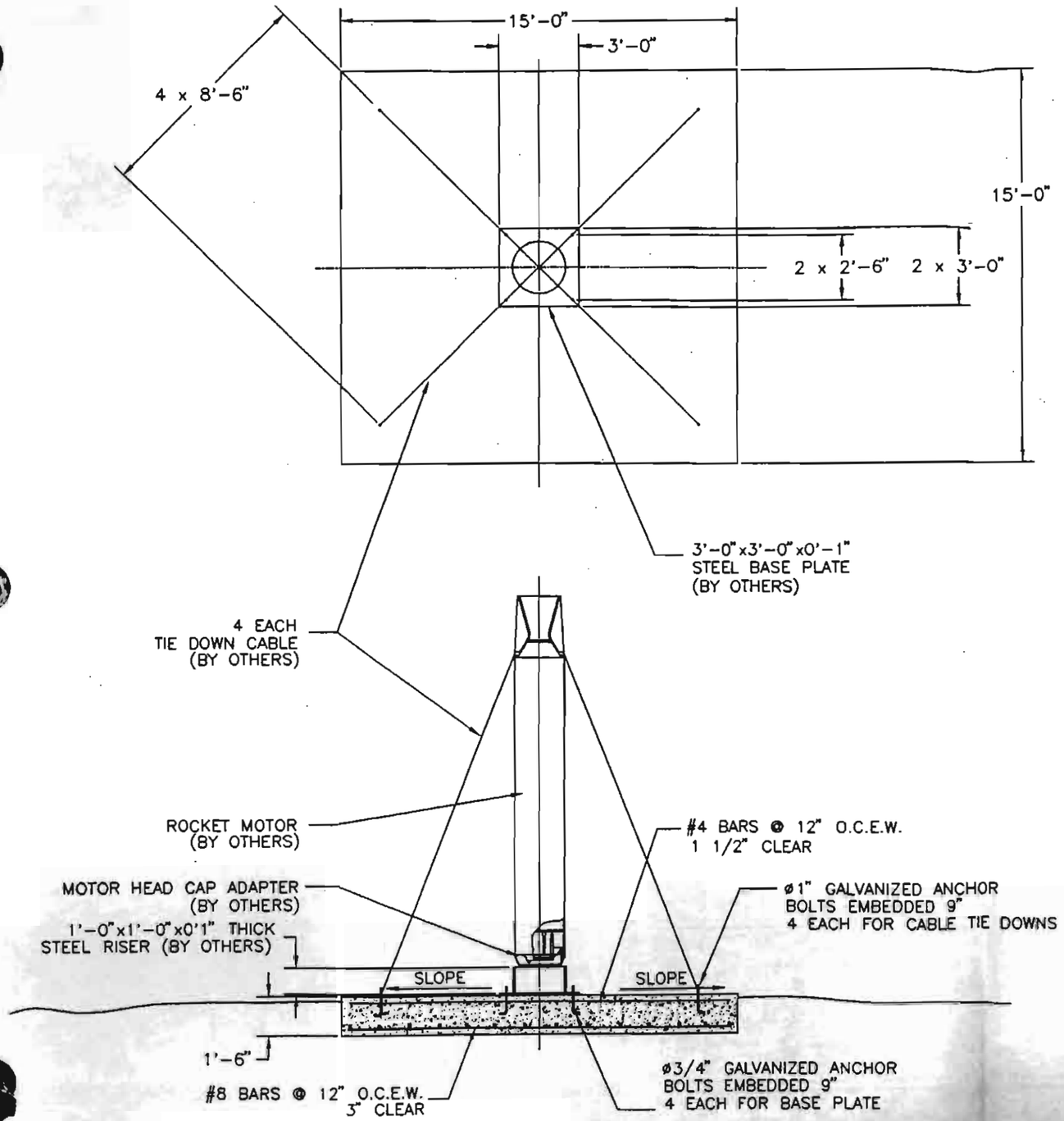
FIGURE A – 3

SHEET NO. 2



NOTES: (UNLESS OTHERWISE SPECIFIED)
1. REMOVE BURRS AND BREAK SHARP EDGES .005 - .010 MAX.
2. INTERPRET DWG. PER ANSI Y 14.5 1988

3-6-97	A	ADDED LOADING INFO, SIZED REBAR	TJ.B



STRUCTURAL DESIGN DATA

FOUNDATION DESIGN LOADS

ROCKET MOTOR WEIGHT	3937 LBS.
ACTUAL THRUST	112,000 LBS.
FACTOR OF SAFETY (FOUNDATION)	2

DESIGN LOADS APPLIED AT ORIGIN OF ADAPTOR ANCHOR BOLT CIRCLE
ANCHOR BOLTS, ADAPTOR, AND TIE-DOWN CABLES BY OTHERS

STRUCTURAL CONCRETE NOTES

1. ALL CAST-IN-PLACE CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI.
2. ALL CONCRETE SHALL HAVE AN APPROVED AIR-ENTRAINING ADMIXTURE.
3. ALL REINFORCING BARS SHALL BE NEW BILLET STEEL CONFORMING TO THE STANDARDS OF ASTM A615, GRADE 60.
4. ALL CONCTETE REINFORCEMENT SHALL BE DETAILED, FABRICATED, LABELED, SUPPORTED, AND SPACED IN FORMS AND SECURED IN PLACE IN ACCORDANCE WITH THE PROCEDURES AND REQUIREMENTS OUTLINED IN THE LATEST EDITION OF THE "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE", ACI 318 AND THE "MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES", ACI 315.
5. MAXIMUM SLUMP SHALL BE 4". MINIMUM CEMENT CONTENT SHALL BE 6 SACKS.
6. MINIMUM CONCRETE COVER SHALL BE 3" FOR CONCRETE CAST AGAINST THE EARTH AND 1 1/2" FOR CONCRETE EXPOSED TO WEATHER.
7. MAXIMUM SIZE FOR COARSE AGGREGATE SHALL BE 3/4".
8. PROVIDE 1/16" PER 12" DRAINAGE SLOPE FROM CENTER OF PAD TO OUSIDE EDGES.

Figure A-7 Open Burn Area
Burn Pad

Attachment II.GG. Exhibit II.GG-1, Closure Plan
Appendix A – Figures

Figure A-8, Open Burn Area Subunit 4 – Side View
Installation in 2012
Note: Subunit 3 Scheduled for Removal in 2012

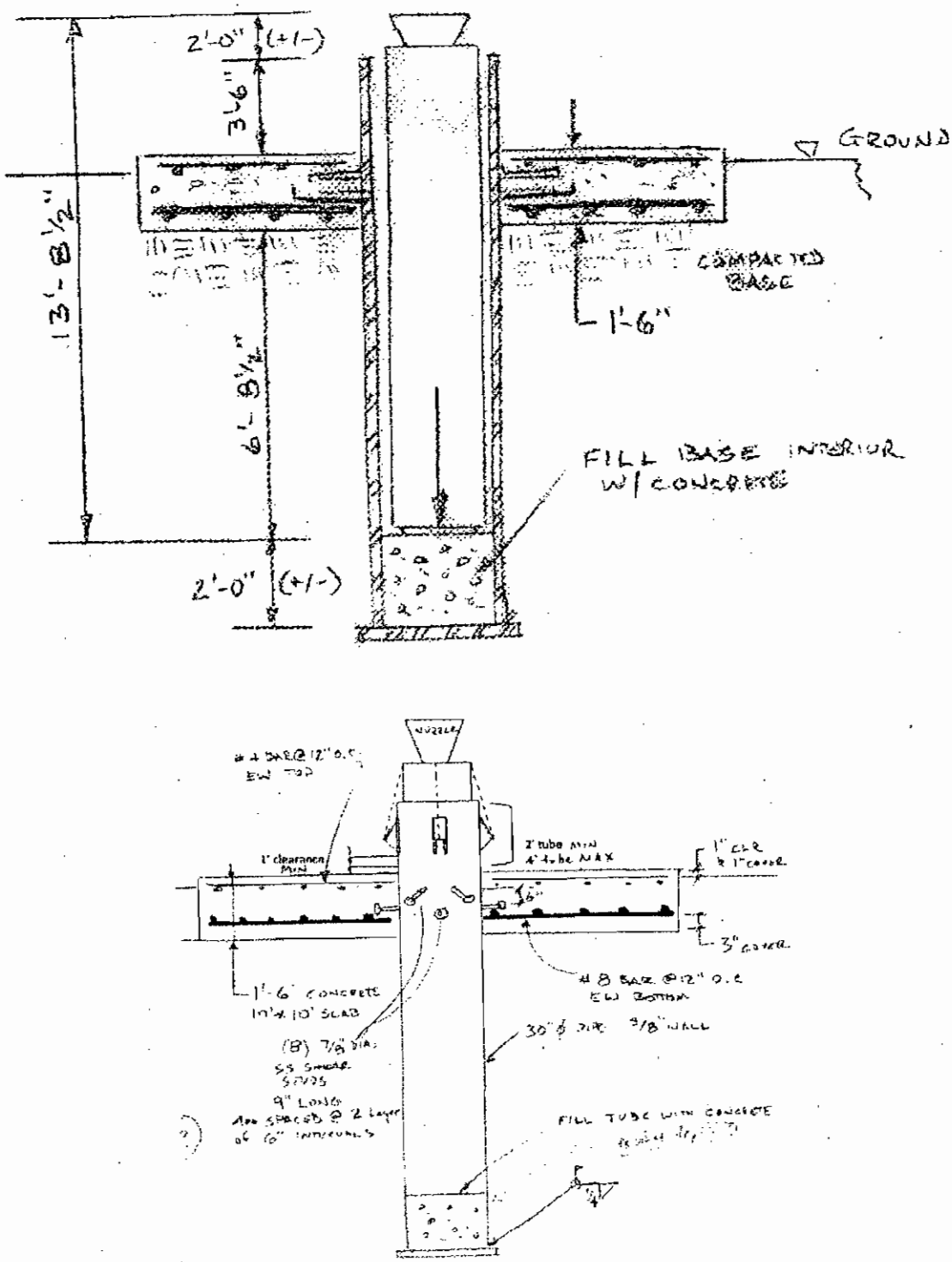


Figure A-8
Open Burning Area Subunit 4
October 2011

Also Permit Application Attachment 16 Appendix A

APPENDIX B

MATERIAL SAFETY DATA SHEETS

Table C-3: Rocket Propellant and Igniter Constituents

Name	Chemical Formula	Hazardous Waste ID Number
Nitrocellulose	$C_{12}H_{16}(ONO_2)_4O_6$	D003
Nitroglycerin	$C_3H_5N_3O_9$	D003
Nitroguanidine	$CH_4N_4O_2$	D003
Ammonium Perchlorate	NH_4ClO_4	D003
(PPG) Polypropylene glycol	$HO(C_3H_6O)_nH$	Unlisted
(TEA) Triethanol amine	$(HOCH_2CH_2)_3N$	Unlisted
Poly 1,4-butylene glycol	$HOCH_2CH_2CH_2CH_2OH$	Unlisted
(TDI) Toluene di isocyanate	$CH_3C_6H_3(NCO)_2$	Unlisted
Carbon Black	C	Unlisted
(FeAA) Iron acetylacetate	$C_{15}H_{21}O_6Fe$	Unlisted
Sulfur	S	Unlisted
(DOZ) Dioctyl azelate	$(CH_2)_7[COOCH_2CH(C_2H_5)C_4H_9]_2$	Unlisted
(NDPA) n-phenyl-beta-napthylamine	$C_{10}H_7NHC_6H_5$	Unlisted
(PS) Polysulfide	$[-CH_2S_2S_2-]_n$	Unlisted
(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	$C_9H_{18}N_3OP$	Unlisted
(Parabar 441) 2,6-di-tert-butyl-p-cresol	$[C(CH_3)_3]_2CH_3C_6H_2OH$	Unlisted
(TA) Triacetin	$C_3H_5(OCOCH_3)_3$	Unlisted
(2-NDPA) 2-nitrodiphenyl amine	$C_6H_5NHC_6H_4NO_2$	Unlisted
(DPA) di-n-propyl adipate	$(C_6H_5)_2NH$	Unlisted
Pb (lead) salicylate	$Pb(OOCC_6H_4OH)_2H_2O$	Unlisted
Candelilla wax (main constituent)	$C_{13}H_{64}$	Unlisted
Monobasic copper salicylate	$Cu(OOCC_6H_4ON)_2H_2O$	Unlisted
(PU) Polyurethane	$R_1NHCOOR_2$	Unlisted
Aluminum Al	$C_8H_8O_8N_8$	D003
(HMX) "Her majesty's explosive", cyclotetra-methylenetetranitramine		D003
Resorcinol	$C_6H_4(OH)_2$	Unlisted
(PVC) Polyvinylchloride	$(-H_2CCHCl-)_x$	Unlisted
(DOA) Dioctyladipate	$[CH_2CH_2COOH_2CH(C_2H_5)C_4H_9]_2$	Unlisted
(DEP) Diethyl phthalate	$C_6H_4(CO_2C_2H_5)_2$	Unlisted
(DMP) Dimethylaminomethyl- substituted phenols	$C_6H_4OHCH_2N(CH_3)_2$	Unlisted
Graphite	C	Unlisted
Magnesium oxide	MgO	Unlisted
Nylon	$(C_6H_{11}NO)_N$	Unlisted
Zirconium carbide	ZrC	Unlisted

Table C-3: Rocket Propellant and Igniter Constituents (continued)

Name	Chemical Formula	Hazardous Waste ID Number
(HX-752) Propylene imine product of isophalic acid	$CH_2HCNHCH_2$	Unlisted
(Flexzone/DTBH) Phenylene diamine/ hydroquinone	$C_6H_4(NH_2)_2$	Unlisted
Phosphorus	P	Unlisted
(PBCT) Polybutadiene carboxy terminated	$(C_4H_6)_{100}\,C_2H_2O_4$	Unlisted
Pb (lead) 2-ethyl hexoate	$PbC_5H_{11}COOC_2H_4$	Unlisted
Ferric (iron) oxide	Fe_2O_3	Unlisted
Copper chromate	$CuCrO_4\ 2CuO\ 2H_2O$	Unlisted
Potassium perchlorate	$KClO_4$	D003
(DOS) Dioctylsebacate	$(C_4H_8COOC_8H_{17})_2$	Unlisted
Octylene oxide	Mixed $CH_3(CH_2)_5CHCH_2O$ & $CH_3(CH_2)_4CHCH(CH_3)O$	Unlisted
(ERL 2795) Epoxy resin	$-OCH_2CHOCH_2$	Unlisted
Chromium 2-ethyl hexoate	$CrC_5H_{11}COOC_2H_4$	Unlisted
Lecithin	$C_8H_{17}O_5NRR'$	Unlisted
Substituted Ferrocene	$(C_5H_5)_2\,Fe$	Unlisted
(LBR) Lead beta-resorcylate	$C_{14}H_{10}O_8Pb$	Unlisted
(PBAA) Polybutadiene acrylic acid	$C_{70}H_{104}O_4$*	Unlisted
Circo Oil	$C_{15}H_{32}$	Unlisted
(PMAPO) bis 1-(2 methyl) aziridinyl phosphine oxide	$C_{12}H_{17}N_2OP$	Unlisted
(PBHT) Polybutadiene hydroxy terminated	$C_{73}H_{110}O_6$*	Unlisted
(DDI) Desmodour diiocyanate	$C_{38}H_{72}N_2O_2$	Unlisted
Hycar 1300 Synthetic elastomers	$C_{70}H_{100}N_{3.5}O_{1.5}$*	Unlisted
Polyester resin	$(C_7H_{12}O_2)_x$	Unlisted
Cobalt Octoate	$C_4H_9CH(C_2H_5)COOH$	Unlisted
Cumene Hydrogen Peroxide	$C_6H_5C(CH_3)_2OOH$	Unlisted
Copper Oxide	Cu_2O	Unlisted
Zinc Stearate	$Zn(C_{18}H_{35}O_2)_2$	Unlisted

* - Formula approximations for polymers

Table C-4: Chemical Composition of Rocket Motors to be Thermally Treated

Rocket Motor	Propellant Composition	Action
2.75" FFAR	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	(DPA) di-n-propyl adipate	Plasticizer
	Pb (lead) salicylate	Burn rate modifier
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Candelilla wax	Processing aid
	Monobasic copper salicylate	Burn rate modifier
Aries	(AP) Ammonium perchlorate	Oxidizer
	(PU) Polyurethane	A class of binder materials
	(Al) Aluminum	Metal fuel
Antares X259 IIA	(AP) Ammonium perchlorate	Oxidizer
	(HMX) "Her majesty's explosive", cyclotetra-methylenetetranitramine	Oxidizer
	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(Al) Aluminum	Metal fuel
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Resorcinol	Plasticizer
Apache	(AP) Ammonium perchlorate	Oxidizer
TPG-3016D:	(PU) Polyurethane	A class of binder material
	(Al) Aluminum	Metal fuel
Arcas	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
	(PVC) Polyvinylchloride	Binder
	(DOA) Dioctyladipate	Plasticizer
Black Brant III	(AP) Ammonium perchlorate	Oxidizer
CARDE A24RX5:	(PU) Polyurethane	Binder
	(Al) Aluminum	Metal fuel
Black Brant VC	(AP) Ammonium perchlorate	Oxidizer
ANP-2872 JM mod 1:	(PPG) Polypropylene glycol	Binder
	(TEA) Triethanol amine	Stabilizer
	Poly 1,4-butylene glycol	Binder
	(TDI) Toluene diisocyanate	Curative
	(Al) Aluminum	Metal fuel
	Carbon black	Burn rate modifier
	(FeAA) Iron acetylacetate	Cure catalyst

Rocket Motor	Propellant Composition	Action
ANP-2872 JM mod 1 (con't):	(S) Sulfur	Catalyst
	(DOZ) Dioctyl azelate	Plasticizer
	(NDPA) n-phenyl-beta-napthylamine	Stabilizer
Cajun	T22:	
	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
Castor	TP-H-8038A:	
	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
Honest John	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
HYDAC	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
	Circo light oil	Plasticizer
	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	(PMAPO) bis 1-(2-methyl) aziridinyl phenyl phosphine oxide	Curative
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid
Javelin III	(AP) Ammonium perchlorate	Oxidizer
	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	(Al) Aluminum	Metal fuel
	Circo light oil	Plasticizer
	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	(PMAPO) bis 1-(2-methyl) aziridinyl phenyl phosphine oxide	Curative
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid
Lance	GCR-221:	
	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
M37A1 Spin Rocket	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(DEP) Diethyl phthalate	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer

Rocket Motor	Propellant Composition	Action
M37A1 Spin Rocket (con't)	(LBR) Lead beta-resorcylate	Burn rate modifier
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
	Candelilla wax	Processing aid
M57A1	(AP) Ammonium perchlorate	Oxidizer
	(HMX) "Her majesty's explosive," cyclotetra-methylenetetranitramine	
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(NC) Nitrocellulose	Binder / oxidizer
	(Al) Aluminum	Metal fuel
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Resorcinol	Plasticizer
Malemute	(PBHT) Polybutadiene hydroxy terminated	Binder
	(DDI) Desmodour diisocyanate	Curative
	(HX-752) Propylene imine product of isophthalic acid	Bonding agent
	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
Mk 70 Terrier	See: Terrier below	
Nihka	(PBHT) Polybutadiene hydroxy terminated	Binder
	(AP) Ammonium perchlorate	Oxidizer
	(Al) Aluminum	Metal fuel
Nike	(NC) Nitrocellulose	Binder/oxidizer
	(NG) Nitroglycerin	Plasticizer/oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	*(DMP) Dimethylaminomethyl- substituted phenols	Curing agent
	*Pb (lead) stearate	Stabilizer
	*Graphite	Stabilizer
Orion	(AP) Ammonium perchlorate	Oxidizer
	(PU) Polyurethane	Class of binder materials
	(Ngu) Nitroguanidine	Oxidizer
Sargeant	(AP) Ammonium perchlorate	Oxidizer
	(S) Sulfur	Catalyst
	(LP-33) Polysulfide	Binder
	*(MgO) Magnesium oxide	Burn rate modifier
	(GMF)	Curative
	Nylon	Binder

Rocket Motor	Propellant Composition	Action
Sidewinder	(AP) Ammonium perchlorate	Oxidizer
	(RDX) "Royal daughter's explosive", cyclotrimethyl- enetrinitramine	Oxidizer
	(PBHT) Polybutadiene hydroxy terminated	Binder
	(DOA) Dioctyladipate	Plasticizer
	(DDI) Desmodour diisocyanate	Curative
	*(ZrC) Zirconium carbide	
	(HX-752) Propylene imine product of isophthalic acid	Bonding agent
	(Flexzone/DTBH) Phenylene diamine/hydroquinone	Bonding agent
Signal Flare	Phosphorus	Metal fuel
25" Spherical Motor	TP-L-3050:(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
Star 6B	TP-H-3237A:	
	(Al) Aluminum	Metal fuel
	(AP) Ammonium perchlorate	Oxidizer
	(PBCT) Polybutadiene carboxy terminated	Binder
Super Arcas	(AP) Ammonium perchlorate	Oxidizer
	(PVC) Polyvinylchloride	Binder
Super Loki	(AP) Ammonium perchlorate	Oxidizer
	(PS) Polysulfide	Binder
	(Al) Aluminum	Metal fuel
Talos	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Pb (lead) 2-ethyl hexoate	Burn rate modifier
Taurus	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
Terrier	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer / oxidizer
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Pb (lead) 2-ethyl hexoate	Burn rate modifier
Tomahawk	(PBCT) Polybutadiene carboxy terminated	Binder
	(AP) Ammonium perchlorate	Oxidizer
	(Al) Aluminum	Metal fuel
	Ferric (iron) oxide	Burn rate modifier
)te I	(AP) Ammonium perchlorate	Oxidizer
PI-PAP-8:	(PS) Polysulfide	Binder

Rocket Motor	Propellant Composition	Action
VAM-20	Potassium Perchlorate	Oxidizer
	Polyester Resin	Binder
	Styrene	Binder
	Carbon Black	Catalyst
	Cobolt Octoate	catalyst
	Cumene Hydrogen Peroxide	Burn rate modifier
Viper	(AP) Ammonium perchlorate	Oxidizer
	*Hycar 1300, TM for various types of synthetic elastomers	
	(Al) Aluminum	Metal fuel
	Copper chromite	Burn rate modifier
	*(KClO4) Potassium perchlorate	Oxidizer
	(DOS) Dicotylsebacate	Plasticizer
	(Parabar 441) 2,6-di-tert-butyl-p-cresol	Processing aid
	Octylene oxide	
	Epon 812	Processing aid
	(ERL 2795) Epoxy resin	Binder
Zap	(AP) Ammonium perchlorate	Oxidizer
	(PBCT) Polybutadiene carboxy terminated	Binder
	(Al) Aluminum	Metal fuel
	Chromium 2-ethyl hexoate	Burn rate modifier
	(ERL 0510) Epoxy resin	Binder
	Lecithin	
	Ferric (iron) oxide	Burn rate modifier
	Substituted ferrocene	Burn rate modifier
	Dibutyl carbitol formal	Plasticizer
Zuni	(NC) Nitrocellulose	Binder / oxidizer
	(NG) Nitroglycerin	Plasticizer/oxidizer
	(Al) Aluminum	Metal fuel
	(TA) Triacetin	Plasticizer
	(2-NDPA) 2-nitrodiphenylamine	Stabilizer
	Pb (lead) salicylate	Burn rate modifier
	Carbon black	Burn rate modifier
	(LBR) Lead beta-resorcylate	Burn rate modifier
	Candelilla wax	Processing aid
	(DPA) Di-n-propyl adipate	Plasticizer
	Monobasic copper salicylate	Burn rate modifier

* The full name and actions of these were derived from Hawley's Condensed Chemical Dictionary.

Information on chemical constituents was developed by John Hopkins University, Applied Physics Laboratory in Laurel, Maryland.

Table C-5: Chemical Composition of Igniters to be Thermally Treated

Ignitor	Propellant Composition	Action
Antares	(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	Curative
	Aluminum	Metal fuel
	Ammonium Perchlorate	Oxidizer
	Boron Potassium nitrate	Oxidizer
Caster	(PBAA) Polybutadiene acrylic acid copolymer	Binder
	Ammonium Perchlorate	Oxidizer
	Iron oxide	Burn rate modifier
	(DOS) Dicotylsebacate	Plasticizer
Altair	Same as Antares	
Orion	Polysulfide	Binder
	Quinone Dioxime	Curative
	Diphenly-Guanidine	Curative
	Sulfur	Catalyst
	Magnesium Oxide	Burn rate modifier
	Di(Butoxyethoxyet) Formal	Curative
	Iron Oxide	Burn rate modifier
	Ammonium Perchlorate	Oxidizer
	Boron Potassium nitrate	Oxidizer
Tomahawk	Same as Orion	
Malemute	T	
Black Brant III	Magnesium powder	Oxidizer
	Potassium Nitrate	Oxidizer
	Acaroid Resin	Binder
	Zinc Stearate	Stabilizer
Lance	T	
UTE	T	
Super Loki	Aluminum	Metal Fuel
	Cupric Oxide	Catalyst
Arcas	Boron Potassium Nitrate (Pellets)	Oxidizer
Javeline III	Aluminum	Metal Fuel
	Cupric Oxide	Catalyst
Aerojet Jr.	Potassium Perchlorate	Oxidizer
	Aluminum	Metal Fuel
	Vegetable Oil	Binder
15" Spherical	Ammonium Perchlorate	Oxidizer
	Aluminum	Metal Fuel
	Iron Oxide	Burn rate modifier
	(PBAA) Polybutidiene Acylic Acid	Binder
	Epoxy	Binder

– Thermal Igniter

BLACK BRANT MOTOR

Black Brant Motor

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List)	Use
26KS20000-BBV Motor with Nozzle	Sounding Rocket

Section I

Manufacturer's Name	Emergency Telephone Number
Bristol Aerospace Ltd.	204-344-5545
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-5545
	Date Prepared March 20, 1995
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Asbestos (See Note 1)	N/A	2.00ml	N/A	<1.20
Phenyl B-Naphthylamine (PBNA) (See Note 2)	N/A	N/A	N/A	<0.20
Black Brant Propellant Class 1.3C UN0186	N/A	N/A	N/A	85 to 90

Note 1: Asbestos is encapsulated within the motor and is not released during storage or operation. Interior of fired motors will contain surface asbestos which may exceed the percent specified and could be released by uncontrolled cutting, grinding, wire brushing, etc.

Note 2: PBNA is a constituent of the solid propellant. It is not released from the motor during storage and is completely consumed during operation.

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A
Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water	Appearance and Odour
Insoluble - Propellant contains Ammonium Perchlorate which is soluble in water.	Cylindrical - no odour.

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
N/A Propellant has auto ignition temperature of 275°C (528°F)		N/A	N/A

Extinguishing Media
None; self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires, move personnel from area.

Unusual Fire and Explosion Hazards
If initiated, material burns rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability			Conditions to Avoid
	Unstable		Avoid any possible sources of ignition. Observe temperature limits of product.
	Stable	X	

Incompatibility (Materials to Avoid)
Strong acids and bases.

Hazardous Decomposition or Byproducts
HCL, Al_2O_3, CO, CO_2, H_2

Hazardous Polymerization			Conditions to Avoid
	May Occur		
	Will Not Occur	X	

Section VI - Health Hazard Data

Route(s) of Entry:	Inhalation? No	Skin? No	Ingestion? No

Health Hazards (Acute and Chronic)
N/A

Carcinogenicity: U	NTP? N/A	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure	Medical Conditions Generally Aggravated by Exposure
If material burns, injuries to personnel may be serious and will involve burns, lacerations, shock and possible inhalation of fumes.	None known.

Emergency and First Aid Procedures
If material burns, trained personnel should treat victims.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
- Eliminate all ignition sources. - Structural fire fighters protective clothing does not provide adequate protection, if material burns. - Inspection required before use.	- Dispose of material in accordance with local legislation.
Precautions to be Taken in Handling and Storing	**Other Precautions**
Keep material away from impact, friction and high temperatures. Use precautions against electrostatic build up.	

Section VIII - Control Measures

Respiratory Protection (Specify Type)
If dust or fumes exist, use NIOSH approved respirators for dust or organic fumes.

Ventilation	Local Exhaust	Special
- Under normal conditions ventilation is not required. - If material burns structural fire fighter's self-contained breathing apparatus will provide reasonably adequate protection against toxic gases produced.	Not Required	Not Required
	Mechanical (General) Not Required	Other Not Required

Protection Gloves	Eye Protection
Latex or vinyl.	Safety Glasses

Other Protective Clothing or Equipment	Work/Hygiene Practices
Structural fire fighter's protective clothing will not provide adequate protection, against flames from an ignited motor.	- Minimize exposure to interior propellant. - Wash hands after exposure to material.

BLACK BRANT IGNITER

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List)	USE
1. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04862-3	1. Black Brant VC Rocket Motor High Altitude Igniter
2. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04850-1	2. Black Brant Igniter Kit 600-04005-1, Black Brant High Altitude Igniter
3. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-00339-1	3. Black Brant Igniter Assy 600-00335-1, Black Brant High Altitude Igniter

Section I

Manufacturer's Name	Emergency Telephone Number
Bristol Aerospace Limited	204-344-3201
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-3211
	Date Prepared August 20, 2001
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
1) Boron Potassium Nitrate Pellets (BPN) 380 gms total weight 1.3L explosive UN 0359			Manufacturer suggests TLV of 10 mg/m^3.	
2) Asbestos Insulator		2f/cc asbestos	Insulator encapsulated in ablative sealant material	

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A

Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A
Solubility in Water Assembly is watertight. If seal broken BPN is water soluble.		Appearance and Odour Fully assembled and sealed - no odour.	

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used) Igniter has auto ignition temperature of 221°C (430°F)	Flammable Limits N/A	LEL N/A	UEL N/A

Extinguishing Media
None self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires involving this material. If quantities are small and safety is not compromised an attempt to limit fire spread can be made.

Unusual Fire and Explosion Hazards
If initiated, material will burn rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability	Unstable		Conditions to Avoid Fire, flame and other ignition sources.
	Stable	X	

Incompatibility (Materials to Avoid)
BPN pellets are incompatible with strong oxidizers, or active fuels.

Hazardous Decomposition or Byproducts
Boric Oxide, Potassium Oxide, Nitrogen in the form of hot particles and gases.

Hazardous Polymerization	May Occur		Conditions to Avoid N/A
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry: N/A	Inhalation? N/A	Skin? N/A	Ingestion? N/A

Health Hazards (Acute and Chronic)
Sealed unit does not pose a health hazard. If opened dust from BPN pellets may irritate eyes, respiratory system.

Carcinogenicity: No	NTP? No	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure BPN Dust - irritation of eyes, nose, coughing, sneezing, nausea.	Medical Conditions Generally Aggravated by Exposure None known.

Emergency and First Aid Procedures
1) For irritation - remove to fresh air. Flush affected area with soap and water.

2) For burns - treat for burn, shock, lacerations and possible inhalation of combustion products.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
Eliminate all ignition sources, carefully clean-up spilled material. Place in conductive container.	Burn under approved controlled conditions.
Precautions to be Taken in Handling and Storing	**Other Precautions**
Store in approved magazine for 1.3 explosive in shipping container at ambient temperature and humidity.	N/R

Section VIII - Control Measures

Respiratory Protection (Specify Type)
In the event of a spill use NIOSH approved dust type respirator for dust exposure.

Ventilation	Local Exhaust	Special
N/R - sealed unit		N/R
	Mechanical (General)	Other N/R

Protection Gloves	Eye Protection
N/R	Safety glasses.

Other Protective Clothing or Equipment	Work/Hygiene Practices
Flame resistant clothing	If dust present (spill) wash clothing, hands, face.

12A Dart

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor

Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

Identity (As Used on Label and List)
PWN-12A Robinsphere Dart (P/N 466-10)

Special hazard warnings are not provided. If any hazardous ingredients or data information is available, the sheet must be completed as far as it can.

Section I

Manufacture's Name OSC Space Data Division	Emergency Telephone Number (602) 228-5772
Address (Number, Street, City, State, and ZIP Code) Meteorological Data Systems 1303 West 21st Street Tempe, Arizona 85282	Telephone Number for Information (602) 814-6800
	Date Prepared April 27, 1992
	Signature of Preparer (optional)

Section II - Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Boron Potassium Nitrate, $BKNO_3$, 2A Powder	U	5 mg/m^3	N/A	N/A
Cis-2-Butene (590-18-1)	N/A	N/A	N/A	N/A
Igniter Delay (S-326), Pyrotechnic Delay Train	N/A	N/A	N/A	N/A

Note: These assemblies are hermetically sealed within the wooden shipping containers.

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity ($H_2O = 1$)	N/A
Vapor Pressure (mm Hg)	N/A	Melting point	N/A
Vapor Density ($Air = 1$)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water
N/A

Appearance and Odor
N/A

Section IV - Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
N/A	N/A	N/A	N/A

Extinguishing Media: Water spray, Fog or Foam. CO_2, Dry Chemical

Special Fire Fighting Procedures: Remove all personnel from danger area. Reduce vapors with fog or fine water spray. Decomposition byproducts are toxic. Avoid the fumes. Fight fires only from a safe distance. Should units become engulfed in flames, use self-contained breathing apparatus and light fragment shield protection. DOD 6055.26M, Chapter 10. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

Unusual Fire and Explosion Hazards: Once initiated, the Ignition Delay will explosively eject the 5 pound nose cone. Flammable gas may form mixtures with air an auto-ignite.

Published by THE BUREAU OF NATIONAL AFFAIRS, INC., Washington, D.C. 20037

Section V - Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable	X	Elevated temperatures and pressures. High impact.

Incompatibility (Materials to Avoid) NONE
Use normal storage in ordnance magazine.

Hazardous Decomposition of Byproducts
Oxides of Nitrogen, Carbon, Lead Vapors, CO/CO_2

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
	N/A	N/A	N/A

Health Hazards (Acute and Chronic)
N/A

Carcinogenicity	NTP?	IARC Monographs?	OSHA Regulated?
	N/A	N/A	N/A

Signs and Symptoms of Exposure
N/A
Medical Conditions
Generally Aggravated by Exposure
N/A

Emergency and First Aid Procedures
N/A

Section VII - Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled
Evacuate all personnel to a safe distance. Contact ordnance disposal personnel.

Waste Disposal Method
To be determined by the local ordnance disposal personnel.

Precautions to Be Taken in Handling and Storing
These assemblies must be handled by personnel trained in ordnance device handling.

Other Precautions
Keep fire and flame away, handle each unit separately, do not collect in mass

Section VII - Control Measures

Respiratory Protection (Specify Type)
N/A

Ventilation		
Local Exhaust	N/A	Special N/A
Mechanical (General)	N/A	Other N/A

Protective Gloves N/A	Eye Protection Safety glasses are recommended.

Other Protective Clothing or Equipment
Use electrostatic control program.

Work/Hygienic Practices
Use hygiene practice, after handling these devices, wash hands prior to eating , drinking or smoking

*USGPO 1986-491-529/45775

IMPROVED ORION ROCKET MOTOR

JHCS Custom Query Form

DOD Compontent: A

Tri-Service Coordination: N

NSN: 1337-00-484-855

Nomenclature: ROCKET MOTOR, M112

DODIC: V229

Inhabited Building Distance:

DOD Hazard Class/Division/Subdivision: 1 3

Compatibility Group: C

Label (First Label): 3

Label (Second Label):

UN Number: 0186

Label (Third Label):

Proper Shipping Name: ROCKET MOTORS

Technical Name:

DOT Explosive Registration Number: 8811544

High Explosive Wt-lbs: 0.00000

HighExplosiveWt-kgs: 0.000000

Net Propellant Wt-lbs: 650.0000

Net Propellant WT-kgs: 294.83511

Net Explosive Wt-lbs: 650.0000

Net Explosive Wt-kgs: 294.83511

Net Explosive QD Wt-lbs: 650.0000

Net Explosive QD Wt-kgs: 294.83511

Maximum Credible Event Wt-lbs:

Maximum Credible Event Wt-kgs:

PN/Dwg1:

PN/Dwg2:

PN/Dwg3:

Remarks:

Date Changed: 9310

Last Action: C

Elements Chgd: OPQ

Record 101 of 490

MATERIAL SAFETY DATA SHEET MSDS D0059 Page 1 of 4

Latest Revision: May 29, 1990 Superseding: August 6, 1985

Thiokol Corporation
P.O. Box 707
Brigham City, UT 84302-0707

Emergency Phone No. (801) 863-8545
Product Information (801) 863-3325

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms:
TP-H1194 Malemute Propellant

II. PHYSICAL DATA

A. Appearance and Odor: Gray, rubbery, solid propellant with an aromatic odor.

B. Volatiles: None.

III. TYPICAL COMPOSITION

Hazardous Ingredients	Percent	TWA (PEL)	STEL (PEL)	TLV
Hydroxyl terminated polybutadiene polymer	*	NE	NE	NE
Dimeryl diisocyanate	*	NE	NE	0.005 ppm
Difunctional aziridine (HX-752)	*	NE	NE	NE
Aluminum powder** CAS No. 7429-90-5	*	5 mg/m^3	NE	5 mg/m^3
	EPA section 313 toxic chemical (1989)			
Ammonium perchlorate**	*	NE	NE	NE

* Percentages are confidential.
** Exposure potential is limited by physical form of material.
NE: Not established.

IV. HEALTH HAZARD DATA

A. Threshold Limit Value (TLV): Not known for cured material. As an uncured mixture, this material has a TLV of 0.005 ppm, due to the presence of dimeryl diisocyanate.

B. Effects of Overexposure

Inhalation: The diisocyanate contained in this mixture in the uncured state may cause serious lung damage and death if inhaled in large volume. HX-752 may also irritate the upper respiratory tract. There is evidence that HX-752 may be carcinogenic. Once cured, this material poses no known inhalation risk until it is burned.

Eyes: Diisocyanate in the uncured material will cause serious injury to the eyes if directly exposed.

Skin: Causes skin irritation in uncured state.

Ingestion: Highly toxic in uncured form. See Inhalation. Cured hazard is not known.

Existing conditions which may be aggravated: Uncured isocyanates may trigger severe reactions in people with asthma or other respiratory ailments.

V. EMERGENCY FIRST AID PROCEDURES

A. Inhalation: Contact physician. Give oxygen or artificial respiration if needed. For thermal burns contact physician.

B. Eyes: Flush immediately with water for at least 15 minutes. Contact physician.

C. Skin: Wash with soap and water. Contact physician.

D. Ingestion: Contact physician.

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: Not applicable.

B. Explosion Limits: Not applicable.

C. Extinguishing Media: Do not attempt to fight burning propellant. Water, CO_2 or foam may be used to restrict the spread of fire.

D. Special Fire Fighting Procedures: Propellant and igniter materials contain oxidizer and fuel. Do not fight fires involving this material. If ignited, thrust created while burning may give this propellant uncontrollable ballistic properties. Fire fighting should be limited to preventing the spread of fire.

E. Explosion Hazards: Static discharge, impact, friction and pinch points between hard surfaces can initiate propellant fires. Overpressures associated with rapidly burning propellant can be explosive-like, creating fireballs and shock waves.

VII. REACTIVITY DATA

A. Stability: Unstable.
Conditions to Avoid: Temperatures above 250°F, shock, impact, friction and static charge buildup.

B. Incompatibility (materials to avoid): Water-soaked propellant may evolve Hydrogen gas.

C. Hazardous Decomposition Products: CO, CO_2, HCl and NO_x.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

Protective Measures

A. Ventilation: General recommended for cured material. With uncured material, provide sufficient mechanical (general and/or exhaust) ventilation to keep vapors below the TLV.

B. Respiratory Protection: None required for cured propellant. For uncured propellant, a NIOSH/MSHA approved air purifying respirator is advised in the absence of proper environmental control. Engineering and/or administrative controls may be implemented to reduce exposure.

C. Protective Gloves: Wear nonporous gloves such as natural rubber or neoprene for handling.

D. Eye Protection: Chemical monogoggles in compliance with OSHA regulations are advised.

E. Other Protective Equipment: Flame resistant clothing is advised.

F. Other Precautions: Propellant should be controlled and handled only by personnel properly trained to handle pyrotechnic materials.

IX. HANDLING AND STORAGE PRECAUTIONS

Handling and Storage Precautions: Protect propellant from ignition sources, static charge buildup, mechanical shock, friction and temperatures above 250°F. Motor should only be fired when the environmental history is known, and aging and temperature limits set by design and aging studies have not been exceeded.

X. ENVIRONMENTAL PROTECTION

A. Precautions if Container is Damaged or Materials Spilled: Propellant must be protected from sources of ignition (see Section VI). If ignited, unpredictable ballistic properties should be anticipated, releasing pressure and spreading flaming, burning material over a wide area, and producing toxic decomposition fumes. Contact appropriate authorities.

B. Waste Disposal Method: This material is highly reactive and flammable. Dispose of in accordance with federal, state and local regulations.

For industrial use only. To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

MALEMUTE IGNITER

MATERIAL SAFETY DATA SHEET MSDS D0087

Latest Revision: January 31, 1986

MORTON THIOKOL, INC.
PO BOX 524
Brigham City, UT 84302 Emergency Phone No. (801) 863-8545
Product Information (801) 863-3325

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms:
C-4 1st Stage Igniter
Malemute Igniter

II. PHYSICAL DATA

A. Appearance: Metal cased igniter.

B. Volatiles: None.

III. TYPICAL COMPOSITION

A. Hazardous Ingredients	Percent	PEL	TLV
TP-H1137 Propellant:			
Hydroxyl terminated polybutadiene resin	*	NE	NE
Iron oxide**	*	NE	NE
Isophorone diisocyanate**	*	NE	0.01ppm(skin)
Difunctional Aziridine (HX752)	*	NE	NE
Powdered aluminum**	*	NE	10mg/m^3
Ammonium perchlorate**	*	NE	NE
Igniter granules (UIX 156-02):			
Boron**	*	NE	NE
Potassium Nitrate**	*	NE	NE
Insulation:			
Asbestos-filled Rubber**	*	2 fibers/cc (Asbestos 2 fibers/cc)	2 fibers/cc

*Company Proprietary
**Exposure potential is limited by physical form of material. Once cured, the isocyanate and aziridine are completely reacted.
NE Not Established

IV. HEALTH HAZARD DATA

A. Threshold Limit Value: None established. The TLVs listed above are for individual components in the uncured state. Exposure to the finished product is not known to be hazardous. Decomposition products are considered toxic.

B. Effects of Overexposure:

Inhalation: For burned out igniter, chronic respiratory conditions may result from asbestos fiber exposure. Decomposition products are known to cause breathing difficulty and respiratory damage.

Eyes: Not known. Decomposition products are irritating.

Skin: Not known

Skin Absorption. Not known

Ingestion: Not known.

V. EMERGENCY AND FIRST AID PROCEDURES

A. Inhalation (of decomposition products): Contact physician. Give oxygen or artificial respiration if needed.
B. Eyes: Contact physician.
C. Skin: Wash with soap and water. Contact physician.
D. Skin Absorption: Not applicable.
E. Ingestion: Contact physician.

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: Not applicable.

B. Explosion Limits: Not applicable.

C. Extinguishing Media: Do not attempt to extinguish.

D. Special Fire Fighting Procedures: This igniter contains DOT Class A explosives, oxidizers, and fuel. Fire fighting should be limited to evacuating an area proportional to the amount of propellant which may burn and preventing the spread of fire beyond the isolated area.

E. Explosion Hazards: Static discharge, impact, friction and pinch points between hard surfaces may initiate a conflagration or detonation. Overpressures associated with rapidly burning propellant can be explosive-like, creating fireballs and shock waves.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Temperatures above 250°F, shock, impact, friction, and static charge buildup.

B. Incompatibility (Materials to Avoid): Water soaked propellant may evolve explosive hydrogen gas.

C. Hazardous Decomposition Products: CO, CO_2, HCl, NO_x, unidentified organics.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

Ventilation: None required.

Respiratory Protection: For a fired motor, provide sufficient mechanical (general and/or local exhaust) ventilation to maintain asbestos exposure below TLV. If potential exists for exceeding the TLV of asbestos, a NIOSH/MSHA approved air purifying respirator is advised.

Protective Gloves: Impervious gloves are recommended.

Eye Protection: Safety glasses with side shields.

Other Protective Equipment: Clothing combinations which may create static discharges must be avoided. Flame resistant clothing is advised. If propellant is removed it should be contained in conductive containers.

IX. HANDLING AND STORAGE PRECAUTIONS

Buildings and transporting equipment must be protected from lightning and other forms of static discharge. Protect igniter from ignition sources, static charge buildup, mechanical shock or friction and temperatures above 250°F. Igniter should only be fired when the environmental history is known and aging and temperature limits set by design and aging studies have not been exceeded.

Other Precautions: Explosives contained in this igniter are federally controlled. Igniter should be controlled and handled only by personnel properly trained and authorized to handle explosive materials. This igniter must be stored according to the specifications referenced in the contract through which it was manufactured.

Note: This document pertains to the C-4 igniter as shipped from Morton Thiokol Wasatch Operations.

X. ENVIRONMENTAL PROTECTION

A. Precautions if Container is Damaged or Spilled: Igniter must be protected from sources of ignition (See Section VI). Contact appropriate authorities.

B. Waste Disposal Method: This igniter contains explosives. Fired motor residues may include asbestos-containing dust and char. Dispose of in accordance with federal, state, and local regulations.

For industrial use only. To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

MARK 12 TERRIER ROCKET MOTOR

MK 12 TERRIER

MATERIAL SAFETY DATA SHEET (MSDS)

Serial No. 3280
(Assigned by Code 04)

Identity (As Used on Label)	Trade Name(s)/Synonyms
Cast Double Base Propellant	MARK 12 TERRIER

Section I

Manufacturer	Emergency Telephone Number
Naval Ordnance Station Indian Head, MD 20640-5000	(301)-743-4438
	Telephone Number for Information (301)-743-4484
Date Prepared 7/22/91	

Section II – Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED	% (optional)
Casting Powder				60 - 70
Casting Solvent				30 - 40

Section III – Physical/Chemical Characteristics

Impact Sensitivity (mm)		Specific Gravity (H2O)=1	
Friction Sensitivity (psig)		Heat of Explosion	
ESD Sensitivity (joules)		Evaporation Rate (Butyl Acetate=1)	

Solubility in Water: Non-Soluble

Appearance and Odor: Red or Black Grain, Sweet Odor

Section IV – Fire and Explosion Hazard Data

Flash Point (Method Used)		Autoignition Temperature	

Extinguishing Media: Water

Special Fire Fighting Procedures: Use extreme caution in fire-fighting situations. Self-contained breathing apparatus must be used.

Unusual Fire and Explosion Hazards: This material is a Class 1, Division 3 Explosive. This material gives off toxic fumes when burning.

DW-NAVORDSTA 5100/11 (10/89) *Note: Blank Spaces are not permitted. If any item is sto applicable, or no information is available, the space must be marked to indicate that.*

BK Rocket Motor, 1.3C, UN0186, PGII EX 8803651 NALC V298 NSN: 9937-LL-990-0145
NASA Modified Rocket Motor Mk12

NAVORDSTA
MATERIAL SAFETY DATA SHEET

CHEMICAL NAME N/A
SYNONYMS: N/A
FORMULA: N/A
TRADE NAME AND SYNONYMS: ABI ABI 1362 ABI 1481 CASTING POWDERS
DATE OF PREPARATION/CHANGE: 12/22/87

REGULAR TELEPHONE NO. (301) 743-4484
EMERGENCY TELEPHONE NO. (301) 743-4484
CHEMICAL FAMILY Double Base Propellant
MOLECULAR WEIGHT N/A

I. PHYSICAL DATA

	References		References
BOILING POINT: @ 760 mm Hg. N/A		FREEZING POINT: N/A	
SPECIFIC GRAVITY (H2O = 1) 1.6-1.69 typical		VAPOR PRESSURE @ °C Negligible	
VAPOR DENSITY (AIR = 1) N/A		SOLUBILITY IN WATER, % BY WT @ °C Negligible	
PERCENT VOLATILES BY VOLUME Negligible		EVAPORATION RATE (BUTYL ACETATE = 1) N/A	
APPEARANCE AND ODOR Small Granular Solids			

II. HAZARDOUS INGREDIENTS

Material	%	PEL or TLV (UNITS)	References
* Nitrocellulose	65.36 - 84.40	- Not established	
* Nitroglycerine	10.80 - 19.00	- 0.2 ppm	
* 2-Nitrodiphenylamine	0.60 - 2.20	- Not established	
* Lead Salicylate	2.00 - 3.30	- 50 ug/m3	
* Lead Beta Resorcylate	0.00 - 3.30	- 50 ug/m3	
Lead 2-Ethyl Hexoate	0.00 - 2.50	- 50 ug/m3	
Aluminum Powder	0.00 - 9.46	- 10 mg/m3	
* Carbon Black	0.00 - 0.37	- 3.5 mg/m3	
Graphite (Glaze)	0.04	- 3.5 mg/m3	

III. FIRE AND EXPLOSION HAZARD DATA

		References
FLASH POINT (TEST METHOD) N/A	AUTOIGNITION TEMPERATURE 145°C	
FLAMMABLE LIMITS IN AIR, % BY VOLUME	LOWER N/A UPPER N/A	

EXTINGUISHING MEDIA: Self oxidizing, Deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in a very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

NAVORDSTA 8000/2 (6/86) TEST

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

Prepared by: J. Castelli
Date Prepared: 2-17-88

Approved by:
Date:

IV. HEALTH HAZARD DATA

		References
THRESHOLD LIMIT VALUE or PERMISSIBLE EXPOSURE LIMIT	Not established	See Section II
EFFECTS OF OVEREXPOSURE		
EMERGENCY AND FIRST AID PROCEDURES	EYES: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. If flushing water does not relieve irritation, seek medical attention. SKIN: Wash with soap and running water. INHALATION: Remove to fresh air. If symptoms listed above develop, seek medical attention	

V. REACTIVITY DATA

STABILITY				References
UNSTABLE	STABLE X	CONDITIONS TO AVOID	Avoid open flame, sparks and heat.	Sax
INCOMPATIBILITY (MATERIALS TO AVOID)	Acid and bases (Organic and inorganic)			N/A
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of Nitrogen and Carbon			SAX
HAZARDOUS POLYMERIZATION MAY OCCUR	WILL NOT OCCUR	CONDITIONS TO AVOID	NONE	N/A

VI. SPILL OR LEAK PROCEDURES

		References
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction, impact and electrostatic discharge.	
WASTE DISPOSAL METHOD	Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.	

VII. SPECIAL PROTECTION INFORMATION

				References
RESPIRATORY PROTECTION (SPECIFY TYPE)	Selection of type respirator shall be lead exposure specified in accordance w/OPNAVINST 5100.23B, Cha.21, Par. 21004 (d)(2)			
VENTILATION	LOCAL EXHAUST	SPECIAL		
	MECHANICAL (GENERAL)		OTHER Adequate Ventilation	
PROTECTIVE GLOVES	Cotton or leather	EYE PROTECTION	Safety glasses	
OTHER PROTECTIVE EQUIPMENT	Flame retardant coveralls and conductive shoes			

VIII. SPECIAL PRECAUTIONS

		References
PRECAUTIONARY LABELING	Nitrocellulose (flammable solid) Nitroglycerine (skin) Lead Salicylate, Lead Beta Resorcylate, Lead 2-Ethyl Hexoate Aluminum powder	
OTHER HANDLING AND STORAGE CONDITIONS	Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21°C (70°F) at 50% Humidity.	

IX. LABEL

DATE:

TRADE NAME:
Chemical Name or Common Name

DOUBLE BASE PROPELLANT

ABL 785, ABL 917, ABL 1362, ABL 1491, ABL 2434

DANGER!

EXTREMELY FLAMMABLE. SEVERE
FIRE AND EXPLOSIVE HAZARD.

KEEP AWAY FROM HEAT, SPARKS AND FLAME. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. AVOID BREATHING DUST AND VAPORS. DO NOT STORE IN DIRECT SUNLIGHT.

WHEN HANDLING WEAR SAFETY GLASSES, GLOVES AND PROTECTIVE CLOTHING. USE WITH ADEQUATE VENTILATION AND EMPLOY RESPIRATORY PROTECTION WHEN EXPOSED TO DUST AND VAPORS. WASH THOROUGHLY AFTER HANDLING.

EFFECTS OF OVEREXPOSURE:
CONTACT CAN CAUSE IRRITATION TO THE EYES AND SKIN. INHALATION OF DUST OR VAPORS CAN CAUSE IRRITATION TO MUCOUS MEMBRANES, DRYNESS OF MOUTH AND THROAT, HEADACHE, NAUSEA AND DIZZINESS.

FIRST AID PROCEDURES:

EYES:
IMMEDIATELY FLUSH WITH WATER. IF FLUSHING WITH WATER DOES NOT RELIEVE IRRITATION SEEK MEDICAL ATTENTION.

SKIN:
WASH WITH SOAP AND WARM WATER. REMOVE CONTAMINATED CLOTHING. IF IRRITATION DEVELOPS SEEK MEDICAL ATTENTION.

INHALATION:
REMOVE PERSON FROM CONTAMINATED AIR. IF SYMPTOMS LISTED ABOVE DEVELOP SEEK MEDICAL ATTENTION.

INGESTION:
SEEK MEDICAL ATTENTION.

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

MARK 70 TERRIER ROCKET MOTOR

MATERIAL SAFETY DATA SHEET NO: 3074***

THIOKOL CORPORATION
Tactical Operations
Huntsville Division
Huntsville, AL 35815-1506
Telephone: ~~205~~ 256/882-8000
Date Revised: July 27, 1989

5201

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms: MK 70 Propellant
B. Propellant Formulation: TPH 8238

II. PHYSICAL DATA

A. Appearance: Rubbery/solid/grey propellant.

III. HAZARDOUS INGREDIENTS

MATERIAL (Note 1)	CAS # (Note 2)	RTECS (Note 3)	PEL (Note 4)	TLV (Note 5)
Aluminum Powder	7429905	BD0330000	None	5 mg/m3
Ammonium Perchlorate	779089	SC7520000	None	None
Isophorone Diisocynate	4098719	NQ9370000	.005ppm (skin)	.005ppm (skin)
Dioctyl Adipate (Note 6)	103231	AU9700000	None	None
Hydroxyl Terminated Polybutadiene	6910295	None	None	None

NOTES:
1. The physical form of solid propellant limits exposure to the individual ingredients
2. Chemical Abstract Service Number
3. Registry of Toxic Effects of Chemical Substances
4. Permissible Exposure Limit - published by OSHA
5. Threshold Limit Value - published by ACGIH.
6. Suspected Animal Carcinogen - IARC

IV. HEALTH HAZARD DATA

A. Threshold Limit Value: See Section III.
B. Effects of Overexposure:
   1. Inhalation: Decomposition products could cause breathing difficulty and respiratory damage.
   2. Eyes: Decomposition products are extremely irritating.
   3. Skin: No known hazard.
   4. Skin Absorption: No known hazard.

C. Primary Route of Entry: Inhalation

V. EMERGENCY AND FIRST AID PROCEDURES

A. Inhalation: If decomposition products are inhaled, remove victim to fresh air. Obtain immediate medical attention.
B. Eyes: If irritated, flush with large quantities of water for at least 15 minutes, obtain immediate medical attention.
C. Skin: If burned, obtain immediate medical attention.
D. Ingestion: Obtain immediate medical attention.

I. FIRE AND EXPLOSION HAZARD

A. Flash Point: Not Applicable
B. Explosive Limits: Not Applicable
C. Extinguishing Media: DO NOT ATTEMPT TO FIGHT FIRE INVOLVING AFTER PROPELLANT HAS BURNED OUT, water, CO2, or foam may be used to restrict the spread of fire.
D. Special Fire Fighting Procedures: DO NOT ATTEMPT TO FIGHT FIRE INVOLVING PROPELLANT. Propellant contains both oxidizer and fuel and cannot readily be extinguished. Fire fighting should be limited to preventing the spread of other fires.
D. Explosion Hazards: Static discharge, impact, friction, or pinch points between hard surfaces can initiate propellant fires and should be avoided.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Temperatures above 200 degrees F. Avoid shock, impact, friction, and static charge buildup.
B. Incompatibility (Materials to Avoid): Strong acids, alkalies.
C. Hazardous Decomposition Products: CO_2, CO, HCl, Al_2O_3, H_2, N_2
D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

A. Protective Measures: For handling a loaded rocket motor, wear cotton or other static-free clothing.
B. Handling and Storage Precautions: Protect propellant from static charge buildup, mechanical shock, impact, friction or temperatures over 200 degrees F. (See Section VII)
C. Other Precautions: This propellant is a DOT Class B Explosive and a Military Class 1.3 explosion hazard.
Access to propellant should be limited to personnel trained in the handling of pyrotechnic and explosive devices.

IX. ENVIRONMENTAL PROTECTION

A. Precautions if Component is Damaged: Damaged motor propellant must be protected from sources of ignition. (See Section VI.) Damaged propellant may be more susceptible to ignition.
B. Proper DOT Classification: EXPLOSIVE B
C. Waste Disposal Method: Dispose of in accordance with federal, state and local regulations.

FOR INDUSTRIAL USE ONLY. To the best of our knowledge, the information contained herein is correct. All chemicals may present unknown health hazards and must be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of the suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESSED OR IMPLIED, TO INCLUDE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS.

Prepared by: Wayne Throneberry — Date: 7/28/89
Wayne Throneberry,
Engineer

Approved by: E. J. Krupko — Date: 8/1/89
E. J. Krupko
Manager, Safety

MK 23 MOD 3 JATO

JHCS LINKS	JHCS MAIN MENU	JHCS DATA ELEMENTS	ESMAM	SENSITIVITY GROUPS
	JHCS CUSTOM QUERY	COMPATIBILITY GROUPS	USATCES	LOG OUT

Record 1 of 1	JHCS Data Item Detail

NSN:	1340-01-231-3984	DODIC:	J145

Nomenclature:	JET THRUST UNIT MK 23 MOD 3 SHIPPING CONDITION
Proper Shipping Name:	ROCKET MOTORS
Technical Name:	
DOT Registration (EX #):	8708594
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PG II

Inhabited Building Distance:		Shipping Label 1:	EXPLOSIVE 1.3C
DOD Hazard Class/Division/Subdivision:	1.3	Shipping Label 2:	
Compatibility Group:	C	Shipping Label 3:	
UN Number:	0186	Part/Dwg1	1255AS200
DOD Component:	NAVY	Part/Dwg2	
IRI-Service Coordination:	YES	Part/Dwg3	

WEIGHT	POUNDS	KILOGRAMS	TYPE OF WEIGHT
High Explosive Weight (HEW)	0.330750	0.150026	Class 1.1 Material
Net Propellant Weight (NPW)	110.00000	49.895176	Class 1.3 Material
Net Explosive Weight (NEW)	110.33100	50.045200	Transportation Qty
Net Explosive QD Weight (NEWQD)	110.33100	50.045315	Storage Quantity

Record 1 of 1

New Query

PROPELLANT

MSDS Propellant, Space Data Corp, 386-10

SPACE DATA -- SDC 386-10 - ROCKET MOTOR FUEL
MATERIAL SAFETY DATA SHEET
NSN: 134000F016457
Manufacturer's CAGE: 27555
Part No. Indicator: A
Part Number/Trade Name: SDC 386-10

General Information

Item Name: ROCKET MOTOR FUEL
Company's Name: SPACE DATA CORPORATION
Company's Street: 3380 SOUTH PRICE ROAD
Company's City: CHANDLER
Company's State: AZ
Company's Zip Code: 85248
Company's Emerg Ph #: (602) 899-6000
Company's Info Ph #: (602) 899-6000
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Date MSDS Prepared: 29MAR90
Safety Data Review Date: 12JUN91
MSDS Preparer's Name: BOB FISHER
Preparer's Company: SPACE DATA CORPORATION
Preparer's St Or P. O. Box: 3380 SOUTH PRICE ROAD
Preparer's City: CHANDLER
Preparer's State: AZ
Preparer's Zip Code: 85248
MSDS Serial Number: BKGPH
Net Propellant Weight-Ammo: 590 LBS

Ingredients/Identity Information

Proprietary: NO
Ingredient: POLY BUTADIENACRYLIC ACID COPOLYMER
Ingredient Sequence Number: 01
Percent: 12.40%
NIOSH (RTECS) Number: 1006308PA

Proprietary: NO
Ingredient: EPOXY
Ingredient Sequence Number: 02
Percent: 0.20%
NIOSH (RTECS) Number: 1000515EP

Proprietary: NO
Ingredient: FERRIC OCTOATE, IRON (3+) OCTANOATE
Ingredient Sequence Number: 03
Percent: 0.10%
NIOSH (RTECS) Number: 1006309FO
CAS Number: 3130-28-7

Proprietary: NO
Ingredient: MAPO, REGULAR
Ingredient Sequence Number: 04
Percent: 0.35%
NIOSH (RTECS) Number: 1006310MR

Proprietary: NO
Ingredient: AMMONIUM PERCHLORATE
Ingredient Sequence Number: 05
Percent: 68%
NIOSH (RTECS) Number: SC7520000
CAS Number: 7790-98-9

Proprietary: NO
Ingredient: ZL-496 (POLYURETHANE LAQUER)
Ingredient Sequence Number: 06
Percent: 3.09%
NIOSH (RTECS) Number: 1006311PL

Proprietary: NO
Ingredient: ALUMINUM (SARA III)
Ingredient Sequence Number: 07
Percent: 16%
NIOSH (RTECS) Number: BD0330000
CAS Number: 7429-90-5
OSHA PEL: 15MG/M3 DUST/5 FUME
ACGIH TLV: 10MG/M3 DUST; 9192

Physical/Chemical Characteristics

Fire and Explosion Hazard Data

Extinguishing Media: WATER
Special Fire Fighting Proc: TREAT FIRE AS CLASS I, DIVISION 3 FIRE HAZARD. CLASS B ROCKET MOTORS, HANDLE AS CLASS 1.3, MASS FIRE HAZARD.
Unusual Fire And Expl Hazrds: AUTOIGNITION TEMP: 275F.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): SPARK & FLAME
Hazardous Decomp Products: H2O/HYDROGEN CHLORIDE/CO/CO2/MAGNESIUM OXIDE/ALUMINUM OXIDE/SULFUR DIOXIDE/HYDROGEN SULFIDE/NITROGEN OXIDE/SULFUR OXIDE
Hazardous Poly Occur: NO

Health Hazard Data

Route Of Entry - Inhalation: NO
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: NO
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: PROPELLANT IS NOT LIKELY TO BE RELEASED FROM MOTOR. KEEP SPARK & FLAME PRODUCING ITEMS AWAY FROM PROPELLANT.
Waste Disposal Method: DISPOSE OF IN ACCORDANCE W/LOCAL, STATE, & FEDERAL REGULATIONS.
Precautions-Handling/Storing: HANDLE & STORE AS CLASS I DIVISION 3 ITEM. MOTOR SHOULD BE ELECTRICALLY GROUNDED WHEN NOT IN ITS SHIPPING CONTAINER.
Other Precautions: PROPELLANT IS NOT LIKELY TO BE RELEASED FROM MOTOR. KEEP SPARK & FLAME PRODUCING ITEMS AWAY FROM PROPELLANT.

Control Measures

Transportation Data

Disposal Data

Label Data

Label Required: YES
Label Status: G
Common Name: SDC 386-10
Special Hazard Precautions: N/K N/K
Label Name: SPACE DATA CORPORATION
Label Street: 3380 SOUTH PRICE ROAD
Label City: CHANDLER
Label State: AZ
Label Zip Code: 85248
Label Emergency Number: (602) 899-6000

UNIVERSAL PROPULSION INC -- 11740301, ROCKET MOTOR MK 119 ASSEMBLY

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MSDS Safety Information

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FSC: 1377
NIIN: 00-244-1578
MSDS Date: 06/25/1992
MSDS Num: BPTXG
Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
MFN: 01
Responsible Party
Cage: 51998
Name: UNIVERSAL PROPULSION CO INC
Address: 25401 NORTH CENTRAL AVE
City: PHOENIX AZ 85027-7837
Info Phone Number: 602-869-8067
Emergency Phone Number: 602-869-8067;602-234-6663
Preparer's Name: N. WHITE
Published: Y

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Contractor Summary

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Cage: 51998
Name: UNIVERSAL PROPULSION CO
Address: 25401 N CENTRAL AVENUE
City: PHOENIX AZ 85027-7899
Phone: 602-516-3340

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Item Description Information

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Item Manager: NCB
Item Name: ROCKET MOTOR
Unit of Issue: EA
Container Qty: E

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Ingredients

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Name: COMPOSITE PROPELLANT-MIXTURE OF INGREDIENTS 2-10
% Wt: 2.53LBS

Name: CARBOXYL TERMINATED POLYBUTADIENE
% Wt: <10

Cas: 10099-74-8
RTECS #: OG2100000
Name: LEAD (II) NITRATE (1:2) (SARA III)
% Wt: 53.58
ACGIH TLV: 0.15 MG/M3 (PB)
EPA Rpt Qty: 100 LBS
DOT Rpt Qty: 100 LBS

Cas: 7778-74-7
RTECS #: SC9700000
Name: PERCHLORIC ACID, POTASSIUM SALT (1:1); (POTASSIUM PERCHLORATE)
% Wt: 15-20

Cas: 7429-90-5
RTECS #: BD0330000
Name: ALUMINUM (SARA III)
% Wt: 15-20
OSHA PEL: 15MG/M3 DUST;5 FUME
ACGIH TLV: 10MG/M3 DUST;5 FUME

Name: BORON POTASSIUM NITRATE; (IGNITION MATERIAL)
% Wt: 2 GM

Name: IGNITION PELLET
% Wt: 11

Name: PERCUSSION PRIMER ((1) PVU-1/A)
% Wt: 0.05 GM

Cas: 7439-92-1
RTECS #: OF7525000
Name: LEAD (SARA III). %: 36% BY WT OF EXPLOSIVES
% Wt: SEE ING
OSHA PEL: 0.05 MG/M3
ACGIH TLV: 0.15 MG/M3; DUST
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB

Cas: 7439-92-1
RTECS #: OF7525000
Name: LEAD; (LEAD COMPOUNDS). %: 57% BY WT OF EXPLOSIVES.
% Wt: SEE ING
OSHA PEL: 0.05 MG/M3
ACGIH TLV: 0.15 MG/M3, DUST
EPA Rpt Qty: 1 LB
DOT Rpt Qty: 1 LB

Health Hazards Data

LD50 LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry Inds - Inhalation: YES
Skin: NO
Ingestion: NO
Carcinogenicity Inds - NTP: NO
IARC: YES
OSHA: NO
Effects of Exposure: NOTE: LEAD 7439-92-1 APPEARS ON THE NAVY LISTING OF OCCUPATIONAL REPRODUCTIVE HAZARDS. SEEK CONSULTATION FROM APPROPRIATE HEALTH PROFESSIONALS CONCERNING LATEST HAZARD LIST INFORMATION AND SAFE HANDLI NG AND EXPOSURE RECOMMENDATIONS (FP N).
Explanation Of Carcinogenicity: LEAD & LEAD COMPOUNDS: GROUP 2B (IARC).
Signs And Symptions Of Overexposure: SEE HEALTH HAZARDS.
Medical Cond Aggravated By Exposure: AVOID INHALATION OF PRODUCTS OF COMBUSTION.
First Aid: INGESTION: CALL MD IMMEDIATELY. INHALATION: REMOVE FROM EXPOSURE. SUPPORT BREATHING (GIVE ARTIFICIAL RESPIRATION/OXYGEN) (FP N). SKIN: FLUSH WITH COPIOUS AMOUNTS OF WATER (FP N). EYES: FLUSH WITH WATE R FOR AT LEAST 15 MINUTES (FP N).

Handling and Disposal

Spill Release Procedures: AN UNDAMAGED UNIT MAY BE PICKED UP AND RETURNED TO ORIGINAL CONTAINER.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Methods: IF UNIT IS DAMAGED OR NEEDS TO BE DISPOSED OF FOR ANY REASON,IT SHOULD BE DISPOSED OF BY PERSONNEL QUALIFIED TO DISP OF EXPLO AT AN APPRVD DISP SITE UNDER APPRVD CNDTNS. DISPOSE OF IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS (FP N).
Handling And Storage Precautions: HANDLE & STORE AS CLASS 1.3 COMPATIBILITY GROUP C EXPLOSIVE I/A/W DOD 4145.26M, FEDERAL, STATE & LOCAL LAWS. DO NOT EXPOSE TO HEAT OR OPEN FLAME.
Other Precautions: DO NOT EXPOSE TO ELECTRICAL DISCHARGE OF ANY SORT. DO NOT DROP OR ROUGH HANDLE.

Fire and Explosion Hazard Information

Extinguishing Media: USE MEDIA SUITABLE FOR SURROUNDING FIRE CONDITIONS (FP N). NONE ARE EFFECTIVE FOR LARGE FIRES.
Fire Fighting Procedures: WEAR NIOSH/MSHA APPROVED SCBA & FULL PROT EQUIP (FP N). DO NOT FIGHT FIRE. EVACUATE AREA UNTIL ROCKET MOTOR(S) BURN(S) OUT. ROCKET MOTOR(S) WILL BE PROPULSIVE.
Unusual Fire/Explosion Hazard: CLASSED AS DOT ROCKET MOTOR CLASS B EXPLOSIVE. NEW=2.56 LBS.

Control Measures

Respiratory Protection: NONE. WEAR NIOSH/MSHA APPROVED RESPIRATOR APPRORIATE FOR EXPOSURE OF CONCERN (FP N).
Ventilation: GENERAL VENTILATION SUFFICIENT TO KEEP AIRBORNE CONCENTRATIONS BELOW EXPOSURE LIMITS (FP N).
Protective Gloves: IMPERVIOUS GLOVES (FP N).
Eye Protection: CHEMICAL WORKERS GOGGLES (FP N).
Other Protective Equipment: FLAME RESISTANT CLOTHING RECOMMENDED.
Work Hygienic Practices: NORMAL PRACTICES.
Supplemental Safety and Health: SPECIFIC GRAVITY: (H*2O=1) (PROPELLANT).

Physical/Chemical Properties

Spec Gravity: 2.77(SUPP DATA)
Appearance and Odor: METAL PART. NO ODOR.

Reactivity Data

Stability Indicator: YES
Hazardous Decomposition Products: LEAD OXIDES.
azardous Polymerization Indicator: NO
onditions To Avoid Polymerization: NOT RELEVANT.

Toxicological Information

Ecological Information

MSDS Transport Information

Regulatory Information

Other Information

Transportation Information

Responsible Party Cage: 51998
Trans ID NO: 60269
Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
MSDS Prepared Date: 06/25/1992
Review Date: 01/27/1993
MFN: 1
Multiple KIT Number: 0
Review IND: Y
Unit Of Issue: EA
ntainer QTY: E

Detail DOT Information

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DOT PSN SC
DOT Proper Shipping Name: ROCKET MOTORS
Hazard Class: 1.3C
UN ID Num: UN0186
DOT Packaging Group: II
Label: EXPLOSIVE 1.3C
Special Provision: 109
Packaging Exception: NONE
Non Bulk Pack: 62
Bulk Pack: NONE
Max Qty Pass: FORBIDDEN
Max Qty Cargo: 220 KG
Vessel Stow Req: B

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Detail IMO Information

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IMO PSN Code: NDJ
IMO Proper Shipping Name: ROCKET MOTORS
IMDG Page Number: 1295
UN Number: 0186
UN Hazard Class: 1.3 C
IMO Packaging Group: -
Subsidiary Risk Label: -
EMS Number: 1-03
MED First Aid Guide NUM: *

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Detail IATA Information

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IATA PSN Code: VUX
IATA UN ID Num: 0186
IATA Proper Shipping Name: ROCKET MOTORS +
IATA UN Class: 1.3C
IATA Label: EXPLOSIVE
Packing Note Passenger: FORB
Max Quant Pass: FORB
Max Quant Cargo: 220 KG
Packaging Note Cargo: 130

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Detail AFI Information

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AFI PSN Code: VUX
AFI Proper Shipping Name: ROCKET MOTORS
AFI Hazard Class: 1.3C
AFI UN ID NUM: UN0186
AFI Packing Group: II
Special Provisions: P4, 109
Back Pack Reference: A5.73

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HAZCOM Label

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Product ID: 11740301, ROCKET MOTOR MK 119 ASSEMBLY
Cage: 51998
Company Name: UNIVERSAL PROPULSION CO
Street: 25401 N CENTRAL AVENUE
City: PHOENIX AZ
Zipcode: 85027-7899
Health Emergency Phone: 602-869-8067;602-234-6663
Label Required IND: Y
Date of Label Review: 08/24/1992
Status Code: C
Label Date: 08/24/1992

Origination Code: G
Chronic Hazard IND: Y
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: CAUTION
Respiratory Protection IND: YES
Health Hazard: None
Contact Hazard: None
Fire Hazard: Slight
Reactivity Hazard: Slight
Hazard And Precautions: HANDLE & STORE AS CLASS 1.3 COMPATABILITY GROUP C. EXPLOSIVE IN ACCORDANCE WITH DOD 4145.26M. DO NOT EXPOSE TO ELECTRICAL DISCHARGE OF ANY SORT. DO NOT DROP OF ROUGH HANDLE. ACUTE: NONE UNDER NORMAL HANDLING. CHRONIC: NONE. CONTAINS LEAD WHICH IS A SUSPECT HUMAN CARCINOGEN.

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Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever expressly or implied warrants, states, or intends said information to have any application, use or viability by or to any person or persons outside the Department of Defense nor any person or persons contracting with any instrumentality of the United States of America and disclaims all liability for such use. Any person utilizing this instruction who is not a military or civilian employee of the United States of America should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation regardless of similarity to a corresponding Department of Defense or other government situation.

NIHEA IGNITOR

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard

U = Undetermined
N/A = Not Available

IDENTITY (As Used on Label and List)	USE
1. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04862-3	1. Black Brant VC Rocket Motor High Altitude Igniter
2. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-04850-1	2. Black Brant Igniter Kit 600-04005-1, Black Brant High Altitude Igniter
3. 26KS20000 Igniter 1.3G UN 0315 Bristol P/N: 600-00339-1	3. Black Brant Igniter Assy 600-00335-1, Black Brant High Altitude Igniter

Section I

Manufacturer's Name Bristol Aerospace Limited	Emergency Telephone Number 204-344-3201
Address (Number, Street, City, State, Zip Code) Rockwood Plant Propellant Plant Road Stony Mountain, Manitoba, Canada	Telephone Number for Information 204-344-3211
	Date Prepared August 20, 2001
	Signature of Preparer (Optional)

Section II - Hazardous Ingredients/Identify Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
1) Boron Potassium Nitrate Pellets (BPN) 380 gms total weight 1.3L explosive UN 0359			Manufacturer suggests TLV of 10 mg/m^3.	
2) Asbestos Insulator		2f/cc asbestos	Insulator encapsulated in ablative sealant material.	

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_2O) = 1)	N/A

Vapour Pressure (Hg)	N/A	Melting Point	N/A
Vapour Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water
Assembly is watertight. If seal broken BPN is water soluble.

Appearance and Odour
Fully assembled and sealed - no odour.

Section IV - Fire and Explosive Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
Igniter has auto ignition temperature of 221°C (430°F)	N/A	N/A	N/A

Extinguishing Media
None self sustaining combustion.

Special Fire Fighting Procedure
Do not fight fires involving this material. If quantities are small and safety is not compromised an attempt to limit fire spread can be made.

Unusual Fire and Explosion Hazards
If initiated, material will burn rapidly (deflagrate) producing high temperature flame, hot high velocity gases and particulate matter. Severe damage can be caused to eyes, exposed skin and mucous membranes. Products of reaction are toxic, do not inhale or ingest.

Section V - Reactivity Data

Stability	Unstable		Conditions to Avoid Fire, flame and other ignition sources.
	Stable	X	

Incompatibility (Materials to Avoid)
BPN pellets are incompatible with strong oxidizers, or active fuels.

Hazardous Decomposition or Byproducts
Boric Oxide, Potassium Oxide, Nitrogen in the form of hot particles and gases.

Hazardous Polymerization	May Occur		Conditions to Avoid N/A
	Will Not Occur	X	N/A

Section VI - Health Hazard Data

Route(s) of Entry: N/A	Inhalation? N/A	Skin? N/A	Ingestion? N/A

Health Hazards (Acute and Chronic)
Sealed unit does not pose a health hazard. If opened dust from BPN pellets may irritate eyes, respiratory system.

Carcinogenicity: No	NTP? No	IARC Monographs? No	OSHA Regulated? No

Signs and Symptoms of Exposure
BPN Dust - irritation of eyes, nose, coughing, sneezing, nausea.

Medical Conditions Generally Aggravated by Exposure
None known.

Emergency and First Aid Procedures
1) For irritation - remove to fresh air. Flush affected area with soap and water.

2) For burns - treat for burn, shock, lacerations and possible inhalation of combustion products.

Section VII - Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled	Waste Disposal Method
Eliminate all ignition sources, carefully clean-up spilled material. Place in conductive container.	Burn under approved controlled conditions.
Precautions to be Taken in Handling and Storing	**Other Precautions**
Store in approved magazine for 1.3 explosive in shipping container at ambient temperature and humidity.	N/R

Section VIII - Control Measures

Respiratory Protection (Specify Type)
In the event of a spill use NIOSH approved dust type respirator for dust exposure.

Ventilation	Local Exhaust	Special
N/R - sealed unit		N/R
	Mechanical (General)	Other N/R
Protection Gloves		**Eye Protection**
N/R		Safety glasses.
Other Protective Clothing or Equipment	**Work/Hygiene Practices**	
Flame resistant clothing	If dust present (spill) wash clothing, hands, face.	

Thiokol Corporation
Elkton Division
P.O. Box 241
Elkton, Maryland 21922-0241
Emergency Phone (410) 392-1000

MSDS 157B
TE-P-372-7

MATERIAL SAFETY DATA SHEET

MSDS No. 157 Rev. B
Date Issued: 09/12/89
Date Revised: 07/23/93

Revised By: L. K. Hartwell
L. K. Hartwell

Approved By: K. W. Phillips
K. W. Phillips

I. PRODUCT IDENTIFICATION

A. Trade Name and Synonyms: Orion Igniter (TE-P-372-7)

B. DOT Shipping Description and Classification: Igniter, rocket motor, Class B explosive, EX #8908180, UN0315, 1.3G.

II. PHYSICAL DATA

A. Appearance and Odor: Pyrotechnic material housed in a silica phenolic case with an aluminum closure. No odor.

B. Volatiles: None.

III. COMPOSITION

Hazardous Ingredients	Percent	OSHA PEL	ACGIH TLV
A. Propellant TP-E-8035 (0.4 lb)			
1. Thiokol Polysulfide Polymer (LP-33 base)	23.0	NE	NE
2. Magnesium Oxide	1.0	15mg/m^3(fume)	10mg/m^3(fume)
3. Iron Oxide	2.0	10mg/m^3(fume)	5mg/m^3(fume)
4. Ammonium Perchlorate	74.0	15mg/m^3(total) 5mg/m^3(resp.)	10mg/m^3(total) 5mg/m^3(resp.)
B. Boron Potassium Nitrate (3 gms) B,KNO_3, 2A Pellets	100.0	NE	NE

A. Threshold Limit Value: See section III. [illegible] only pertain to materials when in raw form. Materials are contained within the propellant by a binder system.

B. Effects of Overexposure:
   1. Respiratory: If igniter is activated, decomposition products can cause difficulty in breathing and respiratory damage.
   2. Eyes: No known hazard unless activated. Decomposition products are irritating to the eyes.
   3. Skin: Fired igniter residue may contain hydrochloric acid and other corrosive compounds which can cause skin irritation.
   4. Skin Absorption: No known hazard.
   5. Ingestion: No known hazard.
   6. Other: N/A

V. EMERGENCY AND FIRST-AID PROCEDURES

A. Inhalation: If decomposition products are inhaled, remove victim to fresh air. Call a physician and/or emergency facility immediately.

B. Eyes: If irritated, flush with water and contact physician.

C. Skin: Thermal burns or reaction from exposure to decomposition products, flush with water for 15 minutes and call a physician.

D. Other: N/A

VI. FIRE AND EXPLOSION HAZARD DATA

A. Flash Point: N/A

B. Explosive Limits: DOT Class B explosive.

C. Extinguishing Media: Do not attempt to extinguish an initiated igniter. Static discharge, impact, and friction can cause igniter to ignite internally and emit toxic fumes, shrapnel, and fire. CO_2, H_2O, or foam may be used to restrict fire from spreading after igniter has burned.

VI. FIRE AND EXPLOSION HAZARD DATA (continued)

D. Special Fire Fighting Procedures: Igniter contains pyrotechnic materials. Do not fight fires involving these materials. Evacuate area immediately if ignition occurs. Fire fighting should be limited to preventing the spread of other fires.

E. Explosion Hazards: Static discharge, impact, and friction can initiate igniter and should be avoided. Igniter and operators should be grounded when handling this device.

VII. REACTIVITY DATA

A. Stability: Unstable. Conditions to avoid: Ignition materials become unstable when exposed to temperatures above 200°F.

B. Avoid shock, impact, and static charge buildup.

C. Hazardous Decomposition Products: CO, CO_2, COS, $FeCl_2$, H_2, H_2S, MgO, SO_2, S_2, and N_2 are theoretical exhaust products.

D. Hazardous Polymerization: Will not occur.

VIII. SPECIAL PRECAUTIONS

A. Protective Measures:
1. Ventilation: Initiated igniter will emit toxic fumes while burning. Firing area should be well ventilated before operators are exposed.
2. Respiratory Protection: If personnel are exposed to exhaust gases use a NIOSH/OSHA approved respirator with organic vapor/acid gas cartridges or positive pressure airline.
3. Protective Clothing: Acid-resistant gloves should be worn when handling decomposition products. Flame-resistant lab coats or coveralls, safety glasses, and safety shoes are recommended when handling explosives.

B. Handling and Storage Precautions: Protect igniter from ignition sources and elevated temperatures (above 200°F).

C. Other Precautions: Live igniters are DOT Class B Explosive. Access to this igniter should be limited to authorized personnel trained in the handling of pyrotechnic devices.

IX. ENVIRONMENTAL PROTECTION

A. Precautions if Component is Damaged: Damaged igniter must be protected from sources of ignition. If ignition occurs, toxic fumes, shrapnel, and fire may be emitted. Contact appropriate authorities.

B. Waste Disposal Method: Dispose of in accordance with federal, state and local regulations.

C. Fired igniter cases should be inspected and determined propellant-free before disposal.

WARNING: Manufactured with 1,1,1-trichloroethane, a substance which harms public health and environment by destroying ozone in the upper atmosphere.

"To the best of our knowledge the information contained herein is correct. All chemicals may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely.

NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESSED OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS."

JHCS Database

DODIC:	V160
NSN:	1337-00-032-2462
Nomenclature:	ROCKET MOTOR, M5 M1M-14A
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8806858
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PGII

Inhabited Building Distance:		**Label (First Label):**	3
DOD Hazard Class/Division/Subdivision:	1.3	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0186	**Part/Dwg Number 1:**	8025075
DOD Component/ TRI-Service Coordination:	IY	**Part/Dwg Number 2:**	
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	755.00000	342.46234
Net Explosive Weight: (Transportation Qty)	755.00000	342.46234
Net Explosive QD Weight: (Storage Quantity)	755.00000	342.46234
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

JHCS Database

DODIC:	J203
NSN:	1340-00-981-1250
Nomenclature:	ROCKET MOTOR, M37A1 FOR 762MM ROCKET
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8811664
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.1C UN 0280 PGII

Inhabited Building Distance:		**Label (First Label):**	1
DOD Hazard Class/Division/Subdivision:	1.1	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0280	**Part/Dwg Number 1:**	
DOD Component/ TRI-Service Coordination:	AN	**Part/Dwg Number 2:**	
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	1.930000	0.875434
Net Explosive Weight: (Transportation Qty)	1.930000	0.875434
Net Explosive QD Weight: (Storage Quantity)	1.930000	0.875434
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

JHCS Database

DODIC:	V187
NSN:	1337-00-889-2074
Nomenclature:	ROCKET MOTOR, M100 MGM 29
Proper Shipping Name:	ROCKET MOTORS
DOT Registration (EX #):	8806880
Technical Name:	
Proper Shipping Description:	ROCKET MOTORS 1.3C UN 0186 PGII

Inhabited Building Distance:		**Label (First Label):**	3
DOD Hazard Class/Division/Subdivision:	1.3	**Label (Second Label):**	
Compatibility Group:	C	**Label (Third Label):**	
UN Number:	0186	**Part/Dwg Number 1:**	1039072
DOD Component/ TRI-Service Coordination:	IY	**Part/Dwg Number 2:**	10102215
		Part/Dwg Number 3:	

TYPE OF WEIGHT	Pounds	Kilograms
High Explosive Weight: (Class 1.1 Material)	0.000000	0.000000
Net Propellant Weight: (Class 1.3 Material)	5900.0000	2676.1958
Net Explosive Weight: (Transportation Qty)	5900.0000	2676.1958
Net Explosive QD Weight: (Storage Quantity)	5900.0000	2676.1958
Maximum Credible Event Weight: (Storage Quantity)		

Special Remarks

Record 1 of 1

New Query

MATERIAL SAFETY DATA SHEET (MSDS)

Serial No. 3280
(Assigned by Code 04)

Identity (As Used on Label)	Trade Name(s)/Synonyms
Cast Double Base Propellant	MARK 11 TALOS
Section I	
Manufacturer Naval Ordnance Station Indian Head, MD 20640-5000	Emergency Telephone Number (301)-743-4438 Telephone Number for information (301)-743-4484
Date Prepared 7/22/91	

Section II – Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED	% (optional)
Casting Powder				60 – 70
Casting Solvent				30 – 40

Section III – Physical/Chemical Characteristics

Impact Sensitivity (mm)		Specific Gravity (H2O)=1	
Friction Sensitivity (psig)		Heat of Explosion	
ESD Sensitivity (joules)		Evaporation Rate (Butyl Acetate=1)	

Solubility in Water: Non-Soluble

Appearance and Odor: Red or Black Grain, Sweet Odor

Section IV – Fire and Explosion Hazard Data

Flash Point (Method Used)		Autoignition Temperature	

Extinguishing Media: Water

Special Fire Fighting Procedures: Use extreme caution in fire-fighting situations. Self-contained breathing apparatus must be used.

Unusual Fire and Explosion Hazards: This material is a Class 1, Division 3 Explosive. This material gives off toxic fumes when burning.

DW-NAVORDSTA 5100/11 (10/89)

Note: Blank Spaces are not permitted. If any item is n/o applicable, or no information is available, the space must be marked to indicate that.

NAVORDSTA
MATERIAL SAFETY DATA SHEET

CHEMICAL NAME N/A
SYNONYMS: N/A
FORMULA: N/A
TRADE NAME AND SYNONYMS: ABI [redacted] ABI 1362, ABI 1481 CASTING POWDERS
DATE OF PREPARATION/CHANGE: 12/22/87

REGULAR TELEPHONE NO. (301) 743-4484
EMERGENCY TELEPHONE NO. (301) 743-4430
CHEMICAL FAMILY Double Base Propellant
MOLECULAR WEIGHT N/A

I. PHYSICAL DATA

	References		References
BOILING POINT: @ 760 mm Hg. N/A		FREEZING POINT: N/A	
SPECIFIC GRAVITY (H2O = 1) 1.6-1.69 typical		VAPOR PRESSURE @ °C Negligible	
VAPOR DENSITY (AIR = 1) N/A		SOLUBILITY IN WATER, % BY WT @ °C Negligible	
PERCENT VOLATILES BY VOLUME Negligible		EVAPORATION RATE (BUTYL ACETATE = 1) N/A	
APPEARANCE AND ODOR Small Granular Solids			

II. HAZARDOUS INGREDIENTS

Material	%	PEL or TLV (UNITS)	References
* Nitrocellulose	65.36 - 84.40	- Not established	
* Nitroglycerine	10.80 - 19.00	- 0.2 ppm	
* 2-Nitrodiphenylamine	0.80 - 2.20	- Not established	
* Lead Salicylate	2.00 - 3.30	- 50 ug/m^3	
* Lead Beta Resorcylate	0.00 - 3.30	- 50 ug/m^3	
* Lead 2-Ethyl Hexoate	0.00 - 2.60	- 50 ug/m^3	
Aluminum Powder	0.00 - 9.46	- 10 mg/m^3	
* Carbon Black	0.00 - 0.37	- 3.5 mg/m^3	
Graphite (Glaze)	0.00	- 3.5 mg/m^3	

III. FIRE AND EXPLOSION HAZARD DATA

		References
FLASH POINT (TEST METHOD) N/A	AUTOIGNITION TEMPERATURE 145°C	
FLAMMABLE LIMITS IN AIR, % BY VOLUME LOWER N/A	UPPER N/A	

EXTINGUISHING MEDIA: Self oxidizing, Deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in a very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

NAVORDSTA 8000/2 (6/86) TEST

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

Prepared by: [signature]
Date Prepared: 3-7-88

Approved by: [signature]
Date: [illegible]

IV. HEALTH HAZARD DATA

		References
THRESHOLD LIMIT VALUE or PERMISSIBLE EXPOSURE LIMIT	Not established	See Section II
EFFECTS OF OVEREXPOSURE		
EMERGENCY AND FIRST AID PROCEDURES	EYES: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. If flushing water does not relieve irritation, seek medical attention. SKIN: Wash with soap and running water. INHALATION: Remove to fresh air. If symptoms listed above develop, seek medical attention.	

V. REACTIVITY DATA

STABILITY				References
UNSTABLE	STABLE X	CONDITIONS TO AVOID	Avoid open flame, sparks and heat.	Sax
INCOMPATIBILITY (MATERIALS TO AVOID)	Acid and bases (Organic and inorganic)			N/A
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of Nitrogen and Carbon			SAX
HAZARDOUS POLYMERIZATION MAY OCCUR	WILL NOT OCCUR	CONDITIONS TO AVOID	NONE	N/A

VI. SPILL OR LEAK PROCEDURES

		References
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction, impact and electrostatic discharge.	
WASTE DISPOSAL METHOD	Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.	

VII. SPECIAL PROTECTION INFORMATION

				References
RESPIRATORY PROTECTION (SPECIFY TYPE)	Selection of type respirator shall be lead exposure specified in accordance W/OPNAVINST 5100.23B, Cha.21, Par. 21004 (d)(2)			
VENTILATION	LOCAL EXHAUST	SPECIAL		
	MECHANICAL (GENERAL)	OTHER	Adequate Ventilation	
PROTECTIVE GLOVES	Cotton or leather	EYE PROTECTION	Safety glasses	
OTHER PROTECTIVE EQUIPMENT	Flame retardant coveralls and conductive shoes			

VIII. SPECIAL PRECAUTIONS

		References
PRECAUTIONARY LABELING	Nitrocellulose (flammable solid) Nitroglycerine (skin) Lead Salicylate, Lead Beta Resorcylate, Lead 2-Ethyl Hexoate Aluminum powder	
OTHER HANDLING AND STORAGE CONDITIONS	Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21°C (70°F) at 50% Humidity.	

NAVORDSTA
MATERIAL SAFETY DATA SHEET

IX. LABEL

DATE:
PAGE: 3 of 3

TRADE NAME:
Chemical Name or Common Name

DOUBLE BASE PROPELLANT

ABL 705, ABL 917, ABL 1362, ABL 1481, ABL 2434

DANGER!

EXTREMELY FLAMMABLE. SEVERE
FIRE AND EXPLOSIVE HAZARD.

KEEP AWAY FROM HEAT, SPARKS AND FLAME. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. AVOID BREATHING DUST AND VAPORS. DO NOT STORE IN DIRECT SUNLIGHT.

WHEN HANDLING WEAR SAFETY GLASSES, GLOVES AND PROTECTIVE CLOTHING. USE WITH ADEQUATE VENTILATION AND EMPLOY RESPIRATORY PROTECTION WHEN EXPOSED TO DUST AND VAPORS. WASH THOROUGHLY AFTER HANDLING.

EFFECTS OF OVEREXPOSURE:
CONTACT CAN CAUSE IRRITATION TO THE EYES AND SKIN. INHALATION OF DUST OR VAPORS CAN CAUSE IRRITATION TO MUCOUS MEMBRANES, DRYNESS OF MOUTH AND THROAT, HEADACHE, NAUSEA AND DIZZINESS.

FIRST AID PROCEDURES:

EYES:
IMMEDIATELY FLUSH WITH WATER. IF FLUSHING WITH WATER DOES NOT RELIEVE IRRITATION SEEK MEDICAL ATTENTION.

SKIN:
WASH WITH SOAP AND WARM WATER. REMOVE CONTAMINATED CLOTHING. IF IRRITATION DEVELOPS SEEK MEDICAL ATTENTION.

INHALATION:
REMOVE PERSON FROM CONTAMINATED AIR. IF SYMPTOMS LISTED ABOVE DEVELOP SEEK MEDICAL ATTENTION.

INGESTION:
SEEK MEDICAL ATTENTION.

NAVAL ORDNANCE STATION
INDIAN HEAD, MD 20640-5000
Telephone (301) 743-4484

JUL-25-1995 09:58 FROM TO 9045242241 P.02

TAURUS

MATERIAL SAFETY DATA SHEET

(431)

HERCULES

REGULAR TELEPHONE NO. (703)539-7254

EMERGENCY TELEPHONE NO.

CHEMICAL NAME N/A

SYNONYMS: N/A

FORMULA: N/A

CHEMICAL FAMILY Double-Base Propellant

MOLECULAR WEIGHT ---

TRADE NAME AND SYNONYMS: Propellant NOSIR-AP-2 Standard

I. PHYSICAL DATA

BOILING POINT, 760mm. Hg N/A	FREEZING POINT N/A
SPECIFIC GRAVITY (H2O = 1) 1.5170	VAPOR PRESSURE @ °C Negligible
VAPOR DENSITY (AIR = 1) N/A	SOLUBILITY IN WATER, % BY WT @ °C Negligible
PERCENT VOLATILES BY VOLUME N/A	EVAPORATION RATE (BUTYL ACETATE = 1) Less than 1

APPEARANCE AND ODOR Flat sheet, brownish in color

II. HAZARDOUS INGREDIENTS

MATERIAL	%	TLV (UNITS)
Nitrocellulose (flammable solid)	51.0	Not established
Nitroglycerin (skin)	38.6	0.05 PPM*
2-Nitrodiphenylamine	2.0	Not established
Di-n-Propyl Adipate	1.6	Not established
Triacetin	2.7	Not established
Lead - Copper - Resorcylate - Salicylate	4.0	Not established
Candelilla Wax	0.1	Not established

Note: *OSHA PEL = 0.20 PPM (ceiling)

III. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (TEST METHOD) N/A	AUTOIGNITION TEMPERATURE 396.5oF
FLAMMABLE LIMITS IN AIR, % BY VOLUME	LOWER N/A UPPER N/A

EXTINGUISHING MEDIA: Self-oxidizing; deluge with water. May not be able to extinguish before all material has been consumed unless large quantities of water are used in very short time period.

SPECIAL FIRE FIGHTING PROCEDURES: Evacuate the area.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Easily ignited, highly combustible; protect from fire, sparks and extreme heat.

HERCULES INCORPORATED
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

39
575

IV. HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE	Not established. See Section II
EFFECTS OF OVEREXPOSURE	Throbbing headache and upset stomach
EMERGENCY AND FIRST AID PROCEDURES	Eyes: In case of contact, flush thoroughly with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. Call a physcian. Skin: Wash with soap and running water. Inhalation: Remove to fresh air. Treat any irritation symptomatically. Call a physcian.

V. REACTIVITY DATA

STABILITY		
UNSTABLE	STABLE	CONDITIONS TO AVOID: Avoid open flame, sparks and heat
	X	
INCOMPATIBILITY (MATERIALS TO AVOID)	Acids and bases (organic and inorganic)	
HAZARDOUS DECOMPOSITION PRODUCTS	Oxides of nitrogen and carbon	
HAZARDOUS POLYMERIZATION		
MAY OCCUR	WILL NOT OCCUR	CONDITIONS TO AVOID: None
	X	

VI. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Clean up spills immediately using a soft bristle brush and a conductive rubber or plastic shovel. Use caution, material is sensitive to friction impact and electrostatic discharge.
WASTE DISPOSAL METHOD	Burn on open burning ground in accordance with state and local regulations. May also be burned in an incinerator approved for explosives.

VII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE)	Not required.			
VENTILATION	LOCAL EXHAUST --		SPECIAL --	
	MECHANICAL (GENERAL) --		OTHER	Adequate ventilation
PROTECTIVE GLOVES	Cotton or Leather		EYE PROTECTION	Safety glasses
OTHER PROTECTIVE EQUIPMENT	Flame retardant coveralls and conductive shoes			

VIII. SPECIAL PRECAUTIONS

PRECAUTIONARY LABELING	Nitrocellulose (flammable solid) Nitroglycerin (skin) Lead-Copper-Resorcylate-Salicylate
OTHER HANDLING AND STORAGE CONDITIONS	Avoid prolonged temperatures above 50°C (125°F) Recommended storage: 21°C (70°F) at 50% humidity

MATERIAL SAFETY DATA SHEET

MSDS:
DATE:
PAGE: 3 of 3

TRADE NAME: PROPELLANT NOSIN-AA-2 STANDARD

IX SPECIAL PRECAUTIONS
PRECAUTIONARY LABELING:

Labeled and packaged in accordance with the Hazardous Materials Regulations of the Department of Transportation for Class B Explosives.

WARNING! FLAMMABLE Solid
Keep away from heat, sparks, and open flame.
Keep containers closed.
Use with adequate ventilation

FIRST AID:

EYES: In case of contact, immediately flush with plenty of low pressure water for at least 15 minutes. Remove any contact lenses to assure thorough flushing. Call a physician.

SKIN: Wash with soap and running water.

INHALATION: Remove to fresh air. Treat any irritation symptomatically. Call a physician.

OTHER HANDLING AND STORAGE CONDITIONS:
Storage also must conform to local, state and Federal Regulations including OSHA - 29CFR 1910.109 and BATF, 27CFR55, Subpart K.

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Viper IIIA Rocket Motor

SECTION I Trade Name: VIPER III
Common Name: ROCKET MOTOR

Manufacturer's Name: UNIVERSAL PROPULSION CO., INC.
Address: 25401 NORTH CENTRAL AVENUE
PHOENIX, AZ 85027-9801

Emergency Telephone No.: 24 HOUR 602-234-6663 Date Received:
Information Telephone No.: 602-869-8067 Date Prepared: 07/08/91
Preparer: W. Roberts

Chemical Name: NA

Supplier's Generic Name: NA

Synonyms: NA

Hazard Class: EXPLOSIVE

Other Identifying Data: UN 0186, PROPER SHIPPING NAME= ROCKET MOTORS

Explosive Class = 1.3C, COMPETENT AUTHORITY CA-9212010, EX-8805252.

N.E.W. = 57.5 lbs

NFPA-704 =

HMIS =

This product contains a toxic chemical or chemicals subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372. Those chemicals are: Dibutyl Phthalate, CAS #84-74-2, 2.8% by weight.

SECTION II - HAZARDOUS INGREDIENTS/IDENTIFY INFORMATION

Chemical Name	OSHA-PEL (ppm)	ACGIH-TLV (ppm)	CAS Number	Percent
Polysulfide Rubber			NDA	<18
DiButylphthalate	5MG/M3	5MG/M3	NDA	<3
Magnesium Oxide 15mg/m3dust	5MG/M3	10MG/M3	NDA	<1
Sulfur			NDA	<.1
Diphenylguanidine (DPG)			NDA	<.2
Aluminum	5MG/M3	5MG/M3	NDA	<2
Ammonium Perchlorate			NDA	77

NOTE: If PEL or TLV is followed by the letter M, value is Mg/Cubic Meter

TTS KH

51205-1 & -2

Part Number:	NFPA Rating	
51205-1 51205-2	2	(Keyword - Re: Health Hazard - Toxicity) Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURERS NAME:	Universal Propulsion Company	REGULAR TELEPHONE NO.: EMERGENCY TELEPHONE NO.:	707-422-1880 800-424-9300
ADDRESS:	P.O. Box KK, Fairfield, CA 95433-0658		
TRADE NAME:	Flexible Confined Detonating Cord (FCDC)		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT Note: The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
X-Cord®, 2.5 grains/ft; Lead Sheath HNS II (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Lead (Tubing)	20062-22-0 7439-92-1	>1 >1	PEL-TWA = Not listed, Mfg. recommends 1.5 mg/m³ PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
Booster Cup, Loaded HNS I (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$ Aluminum (Booster Cup)	20062-22-0 7429-90-5	>1 >1	PEL-TWA = Not listed, Mfg. recommends 1.5 mg/m³ PEL-TWA = 5.0 mg/m³ (Respirable)
Note: Net Explosive Weight (N.E.W.)/ unit = 3.683 grams		100%	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	Low	EVAPORATION RATE (Butyl Acetate = 1)	NA
APPEARANCE AND ODOR: Lead sheathed detonating cord confined within a red and white nylon braid. Unit has a metallic tip attached to each end. No odor.			

12/31/2002 07:09 5056789489 NSROC PAGE 01

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	FLAMMABLE LIMITS	Lower: NA	Upper: NA
SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.		
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device may expel shrapnel. May rupture in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.		

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

HNS:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of HNS from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream HNS can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of HNS does occur.

Skin Absorption: Slight to moderate dermal absorption.

Eye contact: Redness and irritation, possible keratitis and cataract inducement

Ingestion: Once the ingested HNS passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Aluminum (Dust or Fume):

Inhalation: The respiratory effects caused by aluminum include: coughing; increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen; sense of tightness in the chest due to spasmodic contraction of the bronchi; difficult or labored breathing (dyspnea); and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis). Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD), which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hyoertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS.

Lead: ***Warning:*** **This product contains lead, which is listed as a *California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.***

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenoepermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

EMERGENCY FIRST AID PROCEDURES

Eyes: Flush with water for 20 minutes. Call physician.

Skin: Wash immediately with cold water, then thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Mechanical shock, static electricity, heat, flame or sparks
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Alkalis, acids, corrosives, and strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Lead, lead oxides, antimony, antimony oxides, aluminum, aluminum oxides, hydrogen, nitrogen, nitrogen oxides, carbon monoxide, carbon dioxide, and other carbonaceous combustion by-products.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

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SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA Waste Codes D003 and D008.

Fired Units/Debris: Dispose as a characteristically Toxic Hazardous Waste, EPA Waste Code D008.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.

VENTILATION	**LOCAL EXHAUST:** Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels or TLV/PEL/TWA.	**SPECIAL:** NA
	MECHANICAL (General): NA	**OTHER:** NA
PROTECTIVE GLOVES: Normal: Leather Split: PBI or leather gloves as outer shells with nitrile gloves as inserts.		**EYE PROTECTION:** Safety glasses as a minimum. Blast shields where necessary.

OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg) to prevent electrostatic discharge ignition.

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or side packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store units in a properly sited and maintained magazine. Reference BATF, OSHA, DoD 4145.

PREPARED BY: Universal Propulsion Company — Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0659

ISSUE DATE: 11-01-95

REVISION DATE: 11-01-95, 10-18-96, 9-19-97, 9-21-98

References:

Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doulls: Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehude Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1996.

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Part Number:	NFPA Rating:	(Keyword - Re: Health Hazard - Toxicity)
51202-1	2	Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Combustible
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURERS NAME:	Universal Propulsion Company	REGULAR TELEPHONE NO.:	707-422-1880
		EMERGENCY TELEPHONE NO.:	800-424-9300
ADDRESS:	P.O. Box KK, Fairfield, CA 94533-0658		
TRADE NAME:	Manifold Assembly		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT Note: The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
X-Cord®, 10.0 grains/ft.; Aluminum Sheath RDX Lead Tubing	 121-82-4 7439-92-1	 >1 >1	 PEL-TWA = 1.5 mg/m³ PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
Booster Cup, Loaded RDX Aluminum (Booster Cup)	 121-82-4 7429-90-5	 >1 >1	 PEL-TWA = 1.5 mg/m³ PEL-TWA = 5.0 mg/m³ (Respirable)
Note: The Net Explosive Weight(NEW)/unit =up to 0.30 grams		100%	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	NA	EVAPORATION RATE (Butyl Acetate = 1)	NA
APPEARANCE AND ODOR: Metallic block with an input and output port. No odor			

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	FLAMMABLE LIMITS	Lower: NA	Upper: NA

SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device may expel shrapnel. May rupture or explode in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Aluminum (Dust or Fume)

Inhalation: The respiratory effects caused by aluminum include: coughing; increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen; sense of tightness in the chest due to spasmodic contraction of the bronchi; difficult or labored breathing (dyspnea); and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis). Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD), which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

RDX:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of RDX from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream, RDX can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of RDX does occur.

Skin Absorption: Slight to moderate dermal absorption.

Eye contact: Redness and irritation, possible cataract inducement

Ingestion: Once ingested, RDX passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Lead: ***Warning: This product contains lead, which is listed as a California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.***

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact Irritation. Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

EMERGENCY FIRST AID PROCEDURES:

Eyes: Flush with water for 20 minutes

Skin: Flush exposed area with cold water for 10 min., then wash thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Mechanical shock, static electricity, heat, flame or sparks
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Alkalis, acids, corrosives, and strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Aluminum, aluminum oxides, carbon monoxide, carbon dioxide, other carbonaceous by-products, nitrogen, nitrogen oxides, and hydrogen.

HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations.

Unfired devices / units: Dispose as a characteristically Reactive Hazardous Waste, EPA waste code D003.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

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SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.		
VENTILATION	LOCAL EXHAUST: Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels or TLV/PEL/TWA.	SPECIAL: NA
	MECHANICAL (General): NA	OTHER: NA
PROTECTIVE GLOVES:	Normal: Leather Split: PBI or leather gloves as outer shells with nitrile gloves as inserts.	EYE PROTECTION: Safety glasses as a minimum. Blast shields where necessary.
OTHER PROTECTIVE EQUIPMENT:	Flame retardant coat (PBI or FR-7 cotton), grounding straps (Wrist and Leg) to prevent electrostatic discharge ignition.	

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or slide packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store units in a properly sited and maintained magazine. Reference BATF, OSHA, DoD 4145

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533

ISSUE DATE: 7-17-95

REVISION DATE: 9-24-98

References:

Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doull's Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1996.

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Part Number:	NFPA Rating:	(Keyword - Re: Health Hazard - Toxicity)
51203-4	2	Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURER'S NAME:	Universal Propulsion Company	**REGULAR TELEPHONE NO.:**	707-422-1880
		EMERGENCY TELEPHONE NO.:	800-424-9300
ADDRESS:	P.O. Box KK Fairfield, CA 94533-0659		
TRADE NAME:	Safe & Arm Device		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

Note: MATERIAL OR COMPONENT The following materials or components are contained within the sealed unit.	CAS #	% by Weight	HAZARD DATA
Electric Detonator			
Zirconium	7440-67-7	>1	PEL-TWA = 5.0 mg/m³
Potassium Perchlorate	7778-74-7	>1	PEL-TWA = 5.0 mg/m³ (Respirable)
Lead Azide	13424-46-9	>1	PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
RDX	121-82-4	>1	PEL-TWA = 1.5 mg/m³
NOTE: Net Explosive Weight (NEW)/unit = .080 grams		100 %	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	**MELTING POINT**	NA
VAPOR PRESSURE (mm Hg.)	NA	**SPECIFIC GRAVITY (H_2O = 1)**	NA
VAPOR DENSITY (AIR =1)	NA	**PERCENT VOLATILE BY VOLUME (%)**	NA
SOLUBILITY IN WATER (wt.%)	Insoluble	**EVAPORATION RATE (Butyl Acetate = 1)**	NA
APPEARANCE AND ODOR: Metallic device containing a detonator. No odor.			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	FLAMMABLE LIMITS	Lower: NA	Upper: NA
SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area. Use a self contained full-face breathing apparatus in the positive pressure mode to contain incipient or resulting fire.		
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device may expel shrapnel. May rupture or explode in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.		

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Lead Azide
(As Inorganic Lead)

Warning: This product contains lead, which is listed as a California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

RDX:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of RDX from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream, RDX can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of RDX does occur.

Skin Absorption: Slight to moderate dermal absorption

Eye contact: Redness and irritation, possible cataract inducement

Ingestion: Once ingested, RDX passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Zirconium:

Inhalation: Irritation to nose, throat, and upper respiratory tract. Possible decrease in the forced expiratory volume (FEV 1) and vascular congestion and lung hemorrhages.

Skin Contact: Mild to moderate irritation.

Skin Absorption: NA

Eye contact: Mild to moderate irritation.

Ingestion: Severe irritation of the mouth, throat, and esophagus; gastroenteritis

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION CONT.

EFFECTS OF OVEREXPOSURE: Not a hazard if unit is intact. If the unit becomes damaged and the explosive powders are released or the unit is functioned, exposure to hazardous ingredients or by-products is possible. No health hazard data is available on the mixture of materials as mixed in the powder, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Potassium Perchlorate:

Inhalation:	Irritation of the respiratory tract and possible pneumoconiosis. Possible methemoglobinemia.
Skin Contact:	Irritation, local oxidizing of skin.
Skin Absorption:	NA
Eye contact:	Irritation, conjunctivitis, and possible corneal damage.
Ingestion:	Gastroenteritis, possible methanoglobenimia

EMERGENCY FIRST AID PROCEDURES

Eyes:	Flush with water for 20 minutes. Call physician.
Skin:	Wash immediately with cold water, then thoroughly with soap and water
Inhalation:	Move to fresh air, call physician
Ingestion:	Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		CONDITIONS TO AVOID: Heat, sparks, flame, friction and mechanical shock
	Stable	X	

INCOMPATIBILITY (Materials to Avoid): Strong acids, bases, oxidizers, and strong reducing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon dioxide, carbon monoxide, other carbonaceous by-products, nitrogen, nitrogen oxides, potassium, potassium oxides, potassium chloride and chlorates, hydrogen, hydrogen chloride, zirconium, zirconium oxides, zirconium chloride and chlorates, lead, lead oxides, lead chloride and chlorates and chlorine.

HAZARDOUS POLYMERIZATION	May Occur		CONDITIONS TO AVOID: NA
	Will Not Occur	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking or exposed, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA waste codes D003 and D008.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

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SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH approved respirator if action levels or the TWA/TLV/PEL are exceeded.

VENTILATION	LOCAL EXHAUST: Should be used during test firing of units if airborne contaminants produced are at or above their respective action levels or TLV/PEL/TWA.	SPECIAL: NA
	MECHANICAL (General): NA	OTHER: NA
PROTECTIVE GLOVES:	Normal: Leather Spill: PBI or leather gloves as outer shells with nitrile gloves as inserts.	EYE PROTECTION: Safety glasses as a minimum. Blast shields where necessary.
OTHER PROTECTIVE EQUIPMENT:	Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg) to prevent electrostatic discharge ignition.	

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or side packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store assemblies in a properly sited and maintained magazine. Reference BATF, OSHA, DoD 4145

PREPARED BY: Universal Propulsion Company Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0659

ISSUE DATE: 6/8/01

REVISION DATE: 6/8/01

References:
Merck Index, 11th Edition, 1989
Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doull's Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
Toxicity and Metabolism of Explosives, Author Jehuda Yinon, CRC Press, 1990.
Toxicology Desk Reference, Third Edition, Robert Ryan and Claude Terry Editors, 1998.

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Part Number:	NFPA Rating:	(Keyword - Re: Health Hazard - Toxicity)
51204-1	2	Moderate Health Hazard
	3	(Keyword - Re: Combustibility - Flammability) Highly Flammable
	3	(Keyword - Re: Reactivity) Highly Reactive

MATERIAL SAFETY DATA SHEET

SECTION I PRODUCT IDENTIFICATION

MANUFACTURERS NAME: Universal Propulsion Company		REGULAR TELEPHONE NO.	707-422-1880
		EMERGENCY TELEPHONE NO.	800-424-9300
ADDRESS:	P.O. Box KK Fairfield, CA	94533-0659	
TRADE NAME:	Thrust Termination System		
D.O.T. PSN:	Charges, Shaped, Flexible, Linear, 1.4D, UN-0237, PG II ** This unit is shipped as part of a kit under exemption # DOT-E-5895 **		

SECTION II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT	CAS #	% by Weight	HAZARD DATA
JETCORD*,200 gr/ft; Copper Sheath			
HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$	20062-22-0	>1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³
Copper Tubing	7440-50-8	>1	PEL-TWA = 0.1 mg/m³ (fume)
Transfer Booster			
Booster Cup, Loaded			
HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$	20062-22-0	>1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³
Aluminum (Booster Cup)	7429-90-5	>1	PEL-TWA = 5.0 mg/m³
X-Cord*, 45.0 grains/ft (Lead Sheath)			
HNS (Hexanitrostilbene) $C_{14}H_6N_6O_{12}$	20062-22-0	>1	PEL-TWA = Not listed, mfg. recommends 1.5 mg/m³
Lead Tubing	7439-92-1	>1	PEL-TWA = 0.05 mg/m³ (Inorganic Lead)
NOTE: Net Explosive Weight (NEW)/unit = .080 grams		100 %	

SECTION III PHYSICAL DATA

BOILING POINT (°F)	NA	MELTING POINT	NA
VAPOR PRESSURE (mm Hg.)	NA	SPECIFIC GRAVITY (H_2O = 1)	NA
VAPOR DENSITY (AIR =1)	NA	PERCENT VOLATILE BY VOLUME (%)	NA
SOLUBILITY IN WATER (wt.%)	NA	EVAPORATION RATE (Butyl Acetate = 1)	NA
APPEARANCE AND ODOR: Rectangular shaped composite retainer, black in color, containing copper sheathed linear shaped charge. No odor.			

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SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used): NA	FLAMMABLE LIMITS	Lower: NA	Upper: NA
SPECIAL FIRE FIGHTING PROCEDURES:	Do not attempt to extinguish. Evacuate area to safe distance. Use a self contained, full-face, breathing apparatus in the positive pressure mode to contain incipient or resulting fire.		
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Uncontained initiation of this device will expel shrapnel. Will rupture in fire. Products contained in unit are explosives and are extremely flammable and readily ignited.		

SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: No exposure is normally possible unless the unit is damaged and leaking contents or the unit is initiated. Then exposure to hazardous ingredients is possible. No health hazard data is available on the mixture of materials as mixed in this device, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Copper (as dust or fume):

Inhalation: Irritation to upper respiratory tract. Possible metal fume fever 24-48 hrs after exposure. Characterized by chills, fever, aching muscles, dryness in the throat and mouth, and headache. Possible pulmonary edema and lung damage. Possible hepatomegaly and development of jaundice due to liver damage. Possible headache, vertigo, and drowsiness due to interaction with the CNS. Possible degenerative changes to the basal ganglia of the brain. Possible ventricular extrasystoles, tachycardia, and occasional unifocal bigeminy with acute exposures. Possible kidney damage due to necrosis of the tubular cells as indicated by hematuria, glycosuria, cylindruria, and proteinuria. Possible hemolytic anemia and methemoglobinemia.

Skin Contact: Irritation. Possible itching, pruritic dermatitis, erythema, dermatitis, and allergic contact dermatitis.

Skin Absorption: NA

Eye contact: Irritation. Possible conjunctivitis and keratitis. Possible corneal discoloration and necrosis.

Ingestion: Possible gastric and intestinal mucosa erosion. Possible hepatomegaly and development of jaundice due to liver damage. Possible headache, vertigo, and drowsiness due to interaction with the CNS. Possible degenerative changes to the basal ganglia of the brain. Possible ventricular extrasystoles, tachycardia, and occasional unifocal bigeminy with acute exposures. Possible kidney damage due to necrosis of the tubular cells as indicated by hematuria, glycosuria, cylindruria, and proteinuria. Possible hemolytic anemia and methemoglobinemia.

HNS:

Inhalation: Irritation to the respiratory tract mucous membrane. Absorption of HNS from the lower respiratory tract into the bloodstream is efficient and complete. Once in the bloodstream HNS can cause a number of symptoms to occur depending on dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness

Skin Contact: Dermatitis as skin redness, hardening, and scaliness of the skin. Dermal absorption of HNS does occur.

Skin Absorption: Slight to moderate dermal absorption

Eye contact: Redness and irritation, possible cataract inducement

Ingestion: Once the ingested HNS passes into the bloodstream a number of symptoms can occur depending on the dose and the person being exposed. The main symptoms of very large doses (Acute) are: Aplastic anemia, toxic jaundice due to liver damage, cyanosis due to methemoglobinemia and vasoconstriction, nausea, vomiting, feeling of fullness, dull ache in the epigastrium, anilism with retrosternal pressure, and chronic dyspepsia, sleepiness, kidney disease.

Lead: ***Warning: This product contains lead, which is listed as a California Proposition 65 Carcinogen, Reproductive Toxin, and Developmental Toxin.***

Inhalation: Irritant to mucous membranes of the respiratory system. Cardiovascular system damage to include hypertension, heart disease. Possible Damage to all of the following: liver , kidney , Central and peripheral nervous system, hemopoietic system. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Skin Contact: Irritation, erythema

Skin Absorption: Possible, Slight to moderate

Eye Contact: Irritation, Possible conjunctivitis and keratitis

Ingestion: Cardiovascular system damage to include hypertension, heart disease. Symptoms may include: anorexia, insomnia, nausea, vomiting, colic, constipation, metallic taste in mouth, muscle and joint pains, visual disturbances, hearing deficit or tinnitus, blue or blue-black dot like pigmentation on the gums (lead line), shortness of breath, cough, orthopnea, and chest pains. Possible decreased sex drive, sterility, teratospermia, hypospermia, asthenospermia, and impotence in men. Possible increased incidence in miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves, decreased fertility, and abnormal menstrual cycles in women. In addition fetal toxicity can occur due to the ability of lead to cross the placental barrier.

Note: Health Hazard Information Continued on Page 3

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SECTION V HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE: No exposure is normally possible unless the unit is damaged and leaking contents or the unit is initiated. Then exposure to hazardous ingredients is possible. No health hazard data is available on the mixture of materials as mixed in this device, therefore, the individual material health hazard data is presented in the MSDS:

Routes of Exposure:

Aluminum: (Dust or Powder)

Inhalation: The respiratory effects caused by aluminum include: coughing; increased production of phlegm and pulmonary irritation which have been seen in welders; pulmonary fibrosis from chronic inhalation of aluminum dust; dyspnea; Shaver's Disease, which is characterized by respiratory distress and fibrosis, frequently followed by spontaneous pneumothorax; asthma; chronic obstructive lung disease; and nodular interstitial fibrosis. The symptoms associated with extrinsic or allergic asthma (from exposure to aluminum soldering flux) include: sudden onset after exposure to an allergen; sense of tightness in the chest due to spasmodic contraction of the bronchi; difficult or labored breathing (dyspnea) and wheezing. Symptoms may subside in one hour or less, continue for several hours, or persist as status asthmaticus for many days. End of attack is marked by pronounced coughing with expectoration of thick, tenacious sputum, immediately followed by a sensation of relief and "clearing" of the air passages. Physical signs consist of prolongation of expiration and the presence of sonorous and sibilant rales throughout the chest; normal but labored respiration; markedly distended chest; bluish-purplish discoloration of skin and mucous membranes (cyanosis). Between attacks breathing may be quiet, but forced expiration will produce sonorous or sibilant rales. Frequency and severity of attacks may be greatly influenced by secondary factors (e.g., changes in temperature and humidity); by exposure to noxious fumes; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or by emotional stress. Since these secondary factors may perpetuate attacks, attention should be directed to their control. The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD), which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

Skin Contact: Possible irritation and contact dermatitis.

Skin Absorption: NA

Eye Contact: Irritation due to aluminum dust.

Ingestion: The main musculoskeletal effect caused by aluminum is aluminum-related bone disease (ARBD); which is characterized by bone pain, fractures, muscle weakness, and crippling deformities. The neurological effect caused by aluminum is Dialysis Encephalopathy Syndrome (DES). Symptoms of DES include speech impairment, seizures, motor disturbance, dementia, visual and auditory hallucinations; and an EEG pattern of diffuse slowing, bursts of slow (Delta) waves, and high voltage spike activity. DES is often fatal within 6-9 months after onset of symptoms. Another neurological disease linked to aluminum toxicity is Alzheimer's. The cardiovascular effect caused by aluminum is cardiac hypertrophy, which has been seen in renal failure patients on chronic hemodialysis.

EMERGENCY FIRST AID PROCEDURES:

Eyes: Flush with water for 20 minutes

Skin: Flush exposed area with cold water for 10 minutes, then wash thoroughly with soap and water

Inhalation: Move to fresh air, call physician

Ingestion: Call Physician

SECTION VI REACTIVITY DATA

STABILITY	Unstable		**CONDITIONS TO AVOID:** Heat, static electricity, shock, and friction, open flames.
	Stable	X	
INCOMPATIBILITY (Materials to Avoid):	Strong acids, bases, oxidizing agents, halogens, reducing agents, and organics		
HAZARDOUS DECOMPOSITION PRODUCTS:	Copper, copper oxides, aluminum, aluminum oxides, lead, lead oxides, hydrogen, nitrogen, nitrogen oxides, carbon monoxide, carbon dioxide, and other carbonaceous compounds.		
HAZARDOUS POLYMERIZATION	May Occur		**CONDITIONS TO AVOID:** NA
	Will Not Occur	X	

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SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Call local hazardous materials team. Cover any spilled or exposed material with vegetable oil or diesel fuel and remove for approved disposal.

NEUTRALIZING CHEMICALS: N/A, unless article has been damaged and explosive powder is leaking, then vegetable oil or diesel fuel can be applied to the powder to form a flammable paste. The material in this form is still hazardous for flammability and should be handled accordingly.

WASTE DISPOSAL METHOD: In accordance with all Local, State, and Federal Laws and Regulations. Our customers should follow proper safety steps in accordance with Federal, State, and Local Laws and Regulations

Unfired units / devices: Dispose as a characteristically Reactive and Toxic Hazardous Waste, EPA waste codes D003 and D008.

Fired units / devices and related debris: Dispose as a characteristically Toxic Hazardous Waste, EPA waste code D008.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type): NIOSH/MSHA approved respirator if action levels or TWA/PEL/TLV levels are met or exceeded.

VENTILATION	LOCAL EXHAUST: Should be used during test firing of units in need to maintain airborne contaminents at or below their respective action levels or TLV/PEL/TWA levels.	SPECIAL: NA
	MECHANICAL (General): NA	OTHER: NA
PROTECTIVE GLOVES: Normal: Leather or PBI or both, Spill: PBI or leather gloves as outer shells with nitrile gloves as inner shells.		**EYE PROTECTION:** Safety glasses as a minimum, Blast shields if necessary.

OTHER PROTECTIVE EQUIPMENT: Flame retardant coat (PBI or FR-7 cotton), grounding straps(Wrist and Leg), conductive shoes to ensure that static charges are being drained off of your body.

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

CAUTION: Never drop, skid, cause impact to, expose to high heat, or side packages containing class 1 materials.

THIS MSDS IS NOT INTENDED TO BE AN ORDNANCE HANDLING DOCUMENT

OTHER PRECAUTIONS: Store assemblies in a properly sited and maintained magazine in accordance with BATF, OSHA, DoD.

PREPARED BY: Universal Propulsion Company — Contact: Safety Manager

ADDRESS: P.O. Box KK, Fairfield, CA 94533-0659

ISSUE DATE: 8/31/98

REVISION DATE: 8/31/98, 12/19/98

References:

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Hazardous Chemicals Desk Reference, N. Irving Sax & Richard J. Lewis, Sr., 1987.
Handbook of Toxic and Hazardous Chemicals and Carcinogens, Third Edition, Marshall Sittig, 1991
Casarett and Doulls; Toxicology, The Basic Science of Poisons, Fourth Edition, 1991.
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APPENDIX C

CLOSURE TIMELINE

CLOSURE TIMELINE

Activity	Days After Approval
Decision to close OB area 1. Notify DEQ 45 days prior to commencement date 2. Advertise/award closure contract. 3. Preparation of health and safety plan for site closure.	0-30 days
Mobilization and Construction of Decontamination Area	30-45 Days
Subunits 1, 2, 3, Sub unit Covers, and Burn Pad Cover Closure Process 1. Excavation and removal of cylinders. 2. High pressure steam cleaning (decontamination) of interior and exterior surfaces. 3. Collect and dispose waste residues and concrete. 4. Wipe sampling of surfaces. 5. Collection of containment area decontamination water samples. 6. Soil sampling beneath subunits 1,2,3. 7. Soil, wipe sampling and decontamination sampling analytical results received.	45-60 Days
Burn Pad Assembly Closure Process 1. High pressure steam cleaning (decontamination) of concrete exterior surface. 2. High pressure steam cleaning of the burn pan and cover. 3. Demolition and removal of concrete pad. 4. Collect and dispose waste residues and concrete. 5. Disposal of burn pans 6. Wipe sampling of surfaces. 7. Collection of containment area decontamination water samples. 8. Soil sampling beneath concrete burn pad assembly. 9. Analytical results received.	60-75 Days
Background Soil Sampling 1. Plan preparation and submission to DEQ for approval. 2. Background sampling and analysis 3. Analytical results received. 4. Statistical/risk review of analytical results from Subunits, Burn Pad Assembly and background soil sampling.	75-80 Days 80-90 Days
Contaminated Soils Excavation, Removal And Disposal, If Required	90-120 Days

Groundwater Sampling For Site Closure 1. Groundwater monitoring well sampling and analysis. 2. Analytical results received. 3. Statistical/risk review of analytical results.	120-130 Days
Closure Report Prepared and Submitted with Certifications	130-180 Days

APPENDIX D

RISK-BASED CLOSURE

RISK-BASED CLOSURE

1.0 Introduction

This document discusses the protocol for conducting a risk assessment to implement closure of a hazardous waste management unit (HWMU) in accordance with the VHWMR and RCRA.

2.0 Risk-Based Evaluation

In order to estimate the risk for hazardous constituents of concern (HCOC) associated with the materials remaining in a HWMU, a risk assessment will be conducted according to the Virginia DEQ document titled *Guidance for Development of Health Based Cleanup Goals Using Decision Tree /REAMS Program* (Virginia Risk Guidance) , November 1, 1994, and the approved closure plan. The risk assessment report will contain the following sections:

- site evaluation
- development of a site conceptual model
- identification of contaminants of concern
- identification of media and exposure pathways,
- toxicity assessment,
- estimation of contamiant concentration at the point of exposure, and
- summary of health risk.

The submission instructions contained in Appendix IX of the Virginia Risk Guidance will be reviewed prior to submitting the report to confirm that all necessary risk issues have been addressed. The risk goals associated with the closure performance standards (risk goals) will include:

i. a total cumulative hazard index of 1.0 or less for non-carcinogens;

ii. a risk of 1E-06 or less for individual carcinogens;

iii. a total cumulative risk of 1E-04 or less for all carcinogens; and

iv. the concentrations of HCOC remaining in the HWMU will not result in contamination of other environmental media of concern, including the groundwater beneath the unit.

Compliance with the closure standard shall be verified by comparing the calculated individual and cumulative risk/hazard for all HCOC that failed the background statistical comparison (if such comparison is preformed) to the risk goals.

The risk assessment will be conducted assuming a future residential/industrial use of the property. The methodology and equations for estimating the exposure concentrations are presented in subsequent sections.

The initial step in the risk assessment will be to develop a site conceptual exposure model (SCEM), which depicts all potential exposure routes and media for the site and the receptors which may be exposed. Then HCOC for the risk assessment are identified.

In the next step, the exposure assumptions outlined in the Virginia Risk Guidance will be employed to estimate the risk. Information will also be taken as needed from U.S. EPA documents and databases (e.g., the Risk Assessment Guidance for Superfund (RAGS), and the Integrated Risk Information System (IRIS). The chemical intake equations and exposure parameter assumptions used to estimate risk (obtained from the Virginia Risk Guidance) are shown in Tables 1 through 4. Additional details on the approach and assumptions used for each potential exposure pathway are provided below.

As a part of the Risk Exposure and Analysis Modeling System (REAMS) evaluation, fate and transport modeling is conducted to demonstrate that the residual concentrations of contaminants of concern would not result in contamination of other environmental media of concern including the groundwater underneath the closure unit. For this purpose, representative soil sample(s) will be collected around the unit (subjected to closure) for analysis of the properties listed on page 62 of the REAMS document. In certain situations, groundwater sampling is preferable.

3. Identification of Hazardous Constituents of Concern for Risk Assessment

For the purpose of REAMS evaluation associated with a HWMU, HCOC are those closure constituents present at concentrations statistically exceeding the background levels. If the concentrations of a closure constituent did not statistically exceed the background levels, no further risk-based evaluation for such constituent is required.

4. Exposure Assessment

The exposure assessment will identify transport mechanisms for the contaminants of concern that may potentially impact human receptors. The results of this assessment will be used to document the current and potential exposure posed by the HWMU.

With regard to the soil, a residential exposure will be assumed to document unrestricted closure of the soil. If the risk for potential residential exposure does not exceed the performance standards, unrestricted closure of soil will be accepted. If the site cannot be clean closed for residential use, then the option to pursue restricted closure (commercial/ industrial) will be exercised.

Closure to the commercial/industrial scenario will require the facility to enact institutional controls and deed restrictions that eliminate the possibility of future residential use of the site. The requirements for establishing such a deed restriction are detailed in DEQ's *Guidelines for Developing Health-Based Cleanup Goals Using Risk Assessment at A Hazardous Waste Site Facility for Restricted Industrial Use*, dated June 1995.

Exposure routes will include ingestion, dermal absorption, and inhalation of vapors and dust particles.

With regard to impact to the groundwater beneath the HWMU, REAMS fate and transport modeling[1] will be required to assess impact from residual soil contamination to the groundwater. If the groundwater does not qualify for clean closure, the scope of future groundwater monitoring will be discussed with DEQ. The groundwater exposure routes to be evaluated include ingestion, dermal absorption, and inhalation of volatiles emitted from the contaminated groundwater.

The exposure assumptions presented in the following sections are based on residential exposure. These constitute a reasonable maximum exposure scenario (RME), an exposure which is unlikely to occur but is reasonable.

4.1. Ingestion of Soil

The equation for potential chemical intake by soil ingestion onsite is included in Table 1. This scenario also assumes that weather or other conditions (e.g., frozen ground/ snow /other cover) do not affect exposure and that all soil ingested is from contaminated areas of the site. These assumptions are protective of human health and the environment.

4.2. Dermal Contact with Soil

The equation for calculating the potential absorbed chemical dose by dermal contact with contaminated soil is provided in Table I. This scenario assumes that weather or other conditions (e.g., frozen ground/ snow or other cover) do not affect exposure, that contaminated soil remains on the skin long enough for the HCOC to be absorbed and that all soil adhering to the skin is from contaminated areas of the site.

The skin surface areas (SA) used in the dermal pathway have been identified in Virginia Risk Guidance as 4,860 cm^2 for adults which is the 50th percentile value for the arms, hands, and lower legs (U.S. EPA, 1989b - See Attachment A). A skin-soil adherence factor of 1.45 mg/cm^2 will be used in the dermal intake calculations. The U.S. EPA guidance for dermal exposure assessment *[Dermal Exposure Assessment: Principles and Applications,* EPA/600/8-91/O11 B) states that a range of values from 0.1mg/cm^2 to 1.5 mg/cm^2 per event appear possible for dermal adherence factors (AF). In order to estimate the amount of a particular HCOC, which may potentially be absorbed through the skin, chemical-specific dermal absorption factors are used.

[1] REAMS includes the unsaturated zone fate and transport model SESOIL. The purpose of running the model-is two fold: a) determine whether the contaminants will reach the groundwater in the next 30 years, b) calculate the risk associated with the estimated concentration in the groundwater. For constituents with a promulgated MCL, the estimated concentration will be directly compared against the MCL. However, prior to running the SESOIL model the facility should obtain all the information identified on page 62, of the Virginia Risk Guidance. The closure report must include evaluation of model results (concentrations reaching the groundwater) and a copy of SESOIL output file possible. The exposure pathways for residential exposure include ingestion of soil, dermal contact with soil, inhalation of re-suspended soil particulates, and inhalation of volatile organic compounds.

4.3 Inhalation Of Resuspended Soil

The equation for potential chemical intake by inhalation of resuspended contaminated soil is included in Table 1. An inhalation rate of 0.83 m^3/hr will be used as specified in the Virginia Risk Guidance. This scenario assumes that the concentration of HCOC in indoor dust will be equal to that in outdoor soil and that weather or other conditions, (e.g., frozen ground/snow or other cover) do not affect resuspension or exposure. However, an appropriate model or equations in Table 1 will be used to estimate the potential amount of respirable particulate matter generated by wind erosion. The estimated generation rate for eroded particulate matter will then be used to derive an ambient air particulate concentration. Justification for and documentation of the model(s) used will be submitted to DEQ as part of the risk assessment.

4.4 Inhalation of Volatilized HCOC in Soil

Since the HCOC have appreciable vapor pressures they are expected to volatilize from soil. Inhalation of HCOC as volatilized vapors is considered for this risk assessment. The equations in Table 1 will be considered for estimating the intake for this condition.

5.0 Toxicity Assessment

The two principle indices of toxicity used in risk assessment are the reference dose (RfD) and the cancer slope factor (SF). A RfD is the intake or dose per unit of body weight (mg/kg-day) that is unlikely to result in toxic (non-carcinogenic) effects to human populations, including sensitive subgroups (e.g., the very young or elderly). The RfD allows for the existence of a threshold dose below which no adverse effects occur.

The SF is used to express the cancer risk attributable to a discrete unit of intake; that is, the cancer risk per milligram ingested per kilogram of body weight per day [(mg/kg-day]. The SF is an estimate of the upper-bound probability of an individual: developing cancer as a result of exposure to a particular-carcinogen. Unlike the RfD, the SF assumes that there is no threshold dose below which the probability of developing cancer is zero. Note that SFs are only developed for those chemicals, which have been shown to be carcinogens in man or in at least several animal species. A carcinogenic weight of evidence rating is used to describe the strength of the experimental evidence for carcinogenicity. The U.S. EPA has developed SFs for most chemicals with weight of evidence ratings of "A" (known human carcinogen) or "B" (probable human carcinogen).

RfDs and SFs are derived by the U.S. EPA for the most toxic chemicals generally associated with chemical releases to the environment for which adequate toxicological data are available. If both the carcinogenic and non-carcinogenic effects of a particular compound are significant, both values may be established. However, in most cases only one value is available.

5.1. Inhalation and Oral RfDs and SFs

RfDs and SFs pertinent to the oral and inhalation exposure pathways will be obtained from IRIS database. The IRIS on-line database was established by the EPA to provide risk assessors with peer reviewed toxicological data on chemicals commonly encountered at environmental sites of contamination. If data is not available from IRIS, it will be obtained from the Health Effects Assessment Summary Tables (HEAST), a compilation of toxicity values produced by the. EPA on a quarterly basis. The hierarchy presented in Appendix III of the Virginia Risk Guidance will be followed for using these sources.

5.2. Dermal RfDs and SFs

Chemical specific oral route absorption values (ABS_{oral}) are used to adjust the oral RfD or SF, which is computed from an administered dose, for use in the dermal exposure pathway. This correction is necessary due to the differences in absorption between the skin and the gastrointestmal tract. By correcting the administered dose oral RfD or SF for the fraction expected to be absorbed in the gut, a dermal absorption factor can be used to estimate-the correct dose received through the skin.

6.0 Evaluation of Risk

Using the toxicity criteria and identified exposure pathways discussed above, and the procedures described in the Virginia Risk Guidance, the risk presented by the HCOC will be estimated. The estimated risk will consider the effects from multiple constituents and all routes of exposure. The risk goals will be a total cumulative hazard index of 1.0 for multiple carcinogens and a total cumulative carcinogenic risk of 1E-04 for multiple carcinogens. However, the risk from each individual carcinogen shall not exceed 1E-06 (i.e., one case of cancer per 1,000,000 population).

6.1 Estimation of Exposure Concentration

For the contaminants detected at the site, an exposure point concentration (EPC) for each exposure pathway will be calculated for each contaminant by estimating the 95th upper confidence limit (UCL) on the arithmetic mean of the concentrations. If the calculated 95th UCL is greater than the maximum detected concentration, then the maximum detected concentration will be used as the EPC. The risk for contaminants will be calculated as per the equations and assumptions described in Tables 1 through 4. 1f for a contaminant both carcinogenic and non-carcinogenic risk-based cleanup goal exists, the lower of the two will be used as a pathway specific to estimate the risk.

6.2. Risk Estimation

Health risk assessments are based on the relationship involving intake, contaminant concentration, risk, and toxicity. Chronic daily intake (CDI), a product of intake and contaminant concentration, are estimated using the exposure equations and assumptions

associated with each route of exposure. CDIs are then combined with the RfDs or SFs to determine the resulting risk. For carcinogen(s), cumulative potential risk ($RISK_c$) will be calculated as follows:

$$RISK_c = CDI_{ingestion} * SF_{ingestion} + CDI_{dermal} * SF_{dermal} +$$

$$CDI_{inhalation\text{-}VOCs} * SF_{inhalation\text{-}VOCs} + CDI_{inhalation\ particles} * SF_{inhalation\text{-}particles}$$

For noncarcinogen(s), cumulative hazard index (HI_c) will be calculated as follows:

$$Hi_c = CDI_{indigestion} / RfD_{ingestion} + CDI_{dermal} / RfD_{dermal} +$$

$$CDI_{inhalation\text{-}VOCs} / RfD_{inhalation\text{-}VOCs} + CDI_{inhalation\text{-}particles} / RfD_{inhalation\text{-}particles}$$

where, taking into account all HCOC and relevant exposure pathways, the excess cancer risk is 10^{-6} or the hazard index is 1.0.

Table 1 - Risk Assessment Algorithm for Carcinogenic Exposure

Exposure Route	Chronic Daily Intake (CDI), mg/L-day	
	Residential Exposure	**Occupational/Industrial Exposure**
	$\frac{CW \times IRW_{adj} \times EF}{AT_c}$	$\frac{CW \times IRWa \times EF_o \times ED_o}{BW_a \times AT_c}$
	$\frac{CW \times IRA_{adj} \times EF \times K}{AT_c}$	$\frac{CW \times IRA_a \times EF_o \times ED_o \times K}{BW_a \times AT_c}$
	$\frac{CW \times SAW_{adj} \times PC \times ET \times EF \times ED_c \times CF}{AT_c}$	$\frac{CW \times SAW_a \times PC \times ET \times EF_o \times ED_o \times CF}{BW_a \times AT_c}$
	$\frac{CS \times IRS_{adj} \times CF \times FI \times EF}{AT_c}$	$\frac{CS \times IRS_a \times CF \times FI \times EF_o \times ED_o}{BW_a \times AT_c}$
	$\frac{CS \times CF \times SAS_{adj} \times AF \times ABS \times EF}{AT_c}$	$\frac{CS \times CF \times SAS_a \times AF \times ABS \times EF_o \times ED_o}{BW_a \times AT_c}$
	$\frac{CS \times VF \times IRA_{adj} \times ET \times EF}{AT_c}$	$\frac{CS \times VF \times IRA_a \times ET \times EF_o \times ED_o}{Bw_a \times AT_c}$
	$\frac{CS \times PEF \times IRA_{adj} \times ET \times EF}{AT_c}$	$\frac{CS \times PEF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_c}$

Table 2 - Risk Assessment Algorithm for Noncarcinogenic Exposure

Exposure Route	Chronic Daily Intake (CDI), mg/L-day	
	Residential Exposure	**Occupational/Industrial Exposure**
	$\frac{CW \times IRW_c \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CW \times IRWa \times EF_o \times ED_o}{BW_a \times AT_n}$
	$\frac{CW \times IRA_n \times EF \times ED_c \times K}{BW_c \times AT_n}$	$\frac{CW \times IRA_a \times EF_o \times ED_o \times K}{BW_a \times AT_n}$
	$\frac{CW \times SAW_n \times PC \times ET \times EF \times ED_c \times CF}{BW_c \times AT_n}$	$\frac{CW \times SAW_a \times PC \times ET \times EF_o \times ED_o \times CF}{BW_a \times AT_n}$
	$\frac{CS \times IRS_c \times CF \times FI \times EF \times ED_c}{BW_n \times AT_n}$	$\frac{CS \times IRS_o \times CF \times FI \times EF_o \times ED_o}{BW_a \times AT_n}$
	$\frac{CS \times CF \times SA_c \times AF \times ABS \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times CF \times SA \times AF \times ABS \times EF_o \times ED_o}{BW_a \times AT_n}$
	$\frac{CS \times VF \times IRA_c \times ET \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times VF \times IRA_o \times ET \times EF_o \times ED_o}{Bw_a \times AT_n}$
	$\frac{CS \times PEF \times IRA_c \times ET \times EF \times ED_c}{BW_c \times At_n}$	$\frac{CS \times PEF \times IRA_a \times ET \times EF_o \times ED_o}{BW_o \times AT_n}$

A carcinogenic risk assessment is based on adult exposure.

Table 3 - Age Adjusted Factors

$$IRA_{adj} = \frac{ED_c \, x \, IRA_c}{Bw_c} + \frac{(ED_{tot} - ED_c) x \, IRA_a}{BW_a}$$

$$IRW_{adj} = \frac{ED_c \, x \, IRW_c}{Bw_c} + \frac{(ED_{tot} - ED_c) x \, IRW_a}{BW_a}$$

$$SAW_{adj} = \frac{ED_c \, x \, SAW_c}{Bw_c} + \frac{(ED_{tot} - ED_c) x \, SAW_a}{BW_a}$$

$$IRS_{adj} = \frac{ED_c \, x \, IRS_c}{Bw_c} + \frac{(ED_{tot} - ED_c) x \, IRS_a}{BW_a}$$

$$SAS_{adj} = \frac{ED_c \, x \, SA_c}{Bw_c} + \frac{(ED_{tot} - ED_c) x \, SA_a}{BW_a}$$

Note regarding age adjusted factor:
Because the contact rate with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risk during the first 30 years of life were calculated using the age adjusted factor. These factors approximate the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations or two age groups – small children and adults.

Table 4 - Exposure Variables Included in Tables 1, 2, and 3

Symbol	Term	Unit	Value	Reference
ABS	Absorption factor	-	User specified	
AF	Adherence factor	-	1.45	a, c
AT_c	Averaging time carcinogens	days	25550	
AT_n	Averaging time non-carcinogens	days	ED x 365	
BW_a	Body weight adult	kg	70	c
BW_c	Body weight child	kg	15	c
CF	Conversion factor	-	0.000001	-
CS	Chemical concentration in soil	mg/Kg-day	User specified	
CW	Chemical concentration in water	mg/L	User specified	
ED_c	Exposure duration child	years	6	c
ED_{total} ED	Exposure duration for carcinogen total or Residential	years	30	c
ED_o	Exposure duration occupational	years	25	c
EF	Exposure frequency residential	days	350	c
ET	Exposure Time General/Occupational Groundwater Surface Water - ingestion Surface water – dermal Air-inhalation	hrs/day	 8.0 0.2 2.6 2.6 24.0	c,d
FI	Fraction ingested Residential Occupational	-	 1.0 0.5	b
IRA_a	Inhalation rate child	m^3/day	12	b
IRA_{adj}	Inhalation rate – air adjusted	-	11.66	
IRA_c	Inhalation rate child	m^3/day	12	b
IRA_a	Inhalation rate adult	m^3/day	20	b
IR	Ingestion rate food Fruit/veggies Fish	kg/day	0.28 0.122 0.054	c, d
IRS_a	Ingestion rate soil adult	mg/day	100	b

IRS_c	Ingestion rate soil child	mg/day	200	B
IRS_{adj}	Ingestion - soil adjusted	-	114.29	b
IRW_a	Ingestion rate water adult	L/day	2	b
IRW_{adj}	Ingestion -water adjusted	L-y/kg-d	1.09	
IRW_c	Ingestion rate water child	L/day	1	b
K	Volatilization factor, water to air	-	0.5	
PC	Permeability constant	cm/hr	User specified	b
PEP	Particulate emission factor	kg/m^3	6.789926E08	f
SAW_c	Surface area child groundwater dermal surface water dermal	cm^2	7500	b,c
SAS_a SAS_c	Surface area soil occupational - adult child	cm^2/event	4500 1875	e
SAS_{adj}	Surface area soil ajusted,	cm^2/event	2290	
SAW_a	Surface area for water contact adult	cm^2	820	b
SAW_{adj}	Surface area for water contact	cm^2/event	9200	
VF	Volatilization factor, Soil to air	kg/m^3	User specified	-

References:

a. Risk Assessment Guidance for Superfund, Volume I, EPA/540/1-89/002, December 1989.

b. Region III values.

c. Exposure Factors Handbook, EPA/600/8-89/043, July 1989.

d. Human health evaluation manual supplemental guidance, OSWER Directive 9285.6-03. March 25, 1991.

e. Dermal Exposure Assessment, Principles and Applications, Interim Report. EPA/600/8-91/011b. January 1992.

f. Technical „Background Document for Draft Soil Screening Level Guidance. Office of Solid Waste and Emergency Response. EPA/540/R-94/101. December 1999

ATTACHMENT II.HH

PLANS AND SPECIFICATIONS FOR OPEN BURN UNITS

ATTACHMENT II.HH – PLANS AND SPECIFICATIONS FOR OPEN BURN UNITS

II.HH-1. Physical Characteristics, Materials of Construction, and Dimensions

II.HH.1.1. General

Open burning of rocket motor propellants and igniters is performed at the southwestern corner of Wallops Island. The area is located on the shoulder of a 3.7 meters (12 foot) wide asphalt access road. Three subunits and one open burning pad assembly are used for open burning of the rocket motor propellants and igniters. The subunits and burn pad run roughly parallel to the roadway at a distance of 0.9 meters (3.0 feet) to 1.5 meters (5.0 feet) west of the road (Figure II.HH-1). Figure II.HH-2 is a subunit assembly drawing. Figure II.HH-3 is the burn pad assembly drawing. Figures II.HH-4 and II.HH-5 detail the burn pad berm and cover, respectively. Figure II.HH-6 is the burn pans.

II.HH.1.2 Subunits

The individual subunits are described as follows from north to south:

- The open burning pad assembly is a 4.6 meters (15 feet square) by 46 centimeters (18 inches) thick concrete pad with a 0.41 meter (16 inch) high berm and a steel plate in the center for motor head attachment. Four cable tie downs are used to stabilize the motor. Two 0.3 meter by 0.6 meter (12 inch by 24 inch) carbon steel burn pans are used for burning propellant trimmings or residue on the burn pad. The 4.6 meters (15 feet square) pad cover is attached to the berm with tie down straps and screw anchors. Lift eye bolts are attached to the roof and are used to remove the roof for OB operations.

- Subunit No. 1 and 3 are vertical steel cylinders made from Taurus rocket casings with an outside diameter (OD) of 56 centimeters (23 inches). The subunit is 78 centimeters (31 inches) above and 229 centimeters (90.2 inches) below the ground surface. The total length of Subunit No. 1 is 307 centimeters (121.2 inches). (Subunit 3 is scheduled to be removed and undergo "closure" in 2012.)

- Subunit No. 2 is a vertical steel cylinder made from a Nike rocket casing with an outside diameter (OD) of 42 centimeters (16.5 inches). The subunit is 107 centimeters (42 inches) above and 191 centimeters (75.2 inches) below the ground surface. The total length of Subunit No. 2 is 323 centimeters (127.2 inches). The top

surface of the concrete is reached at 282 centimeters (111 inches), yielding a calculated concrete thickness of 41.1 centimeters (16.2 inches).

- Subunit No. 4 is a vertical steel cylinder with an outside diameter (OD) of 76 centimeters (30 inches). The subunit is 107 centimeters (42 inches) above the ground surface and 311 centimeters (122.4 inches) below the ground surface. The total length of subunit No. 4 is 417.8 centimeters (164.5 inches).

II.HH.1.3. Barricade

The designated OB area is approximately 51 square meters (550 square feet). Sea grasses and bushy vegetation sparsely cover this area over coarse brown sand. A fiberglass barricade is located 152 meters (500 feet) north of the burn pad. The barricade is 3 meters (10 feet) by 1.5 meters (5 feet) at the base and is 3 meters (10 feet) in height. The barricade is battered to the top with a final dimension of 3 meters (10 feet) by 0.6 meters (2 feet). The barricade is used to block the roadway prior to open burning and to act as a protective shield during treatment operations. The firing line is located behind the barricade. The firing line is connected to the igniter at the barricade prior to connection of the battery charge. All personnel and equipment will be behind the barricade during open burning. The barricade is portable and will be removed from the roadway after open burning activities are complete.

FIGURE II.HH-1

OPEN BURNING AREA LOCATION

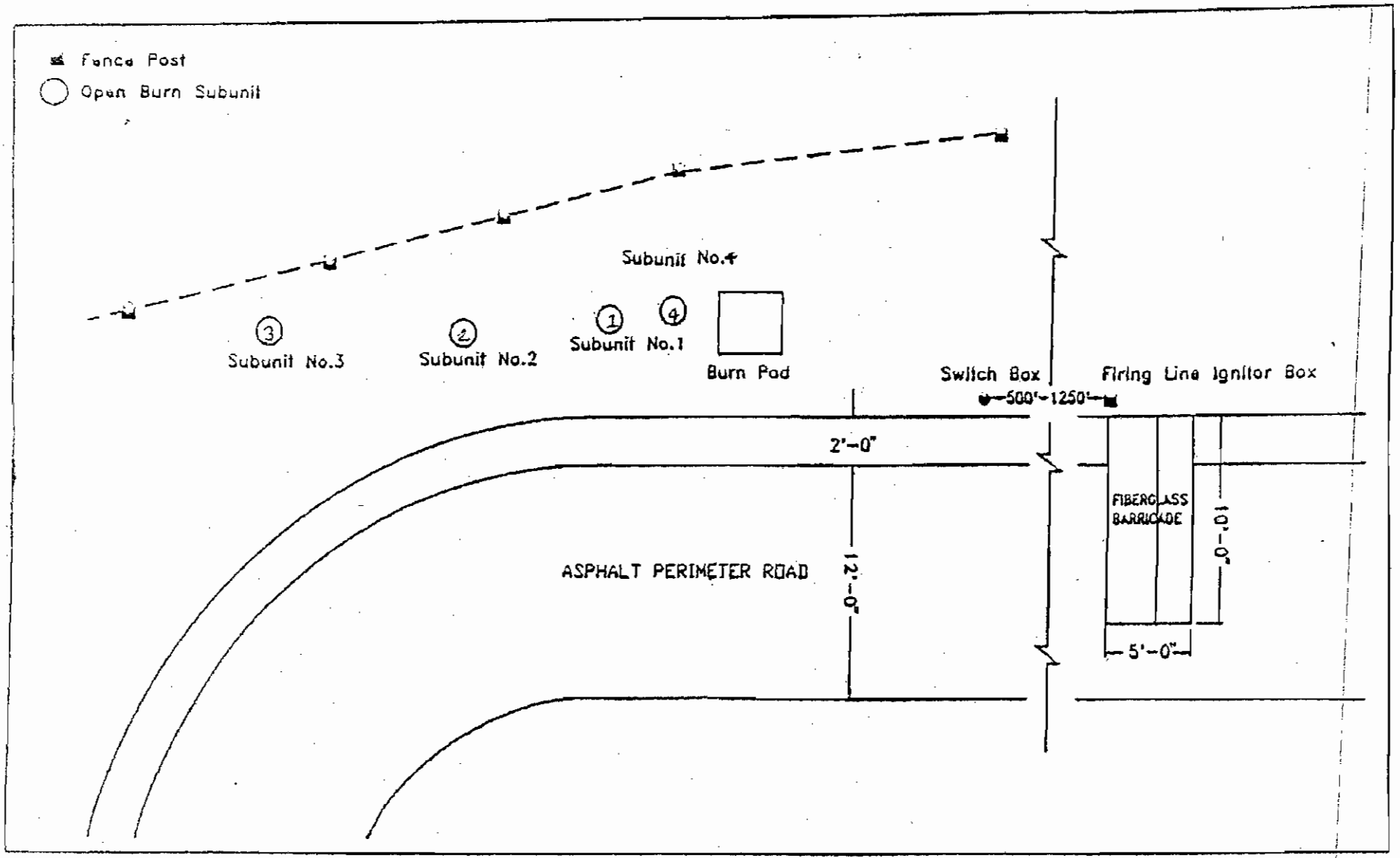


FIGURE II.HH-1
OPEN BURN AREA LOCATION

FIGURE II.HH-2

SUB-UNITS

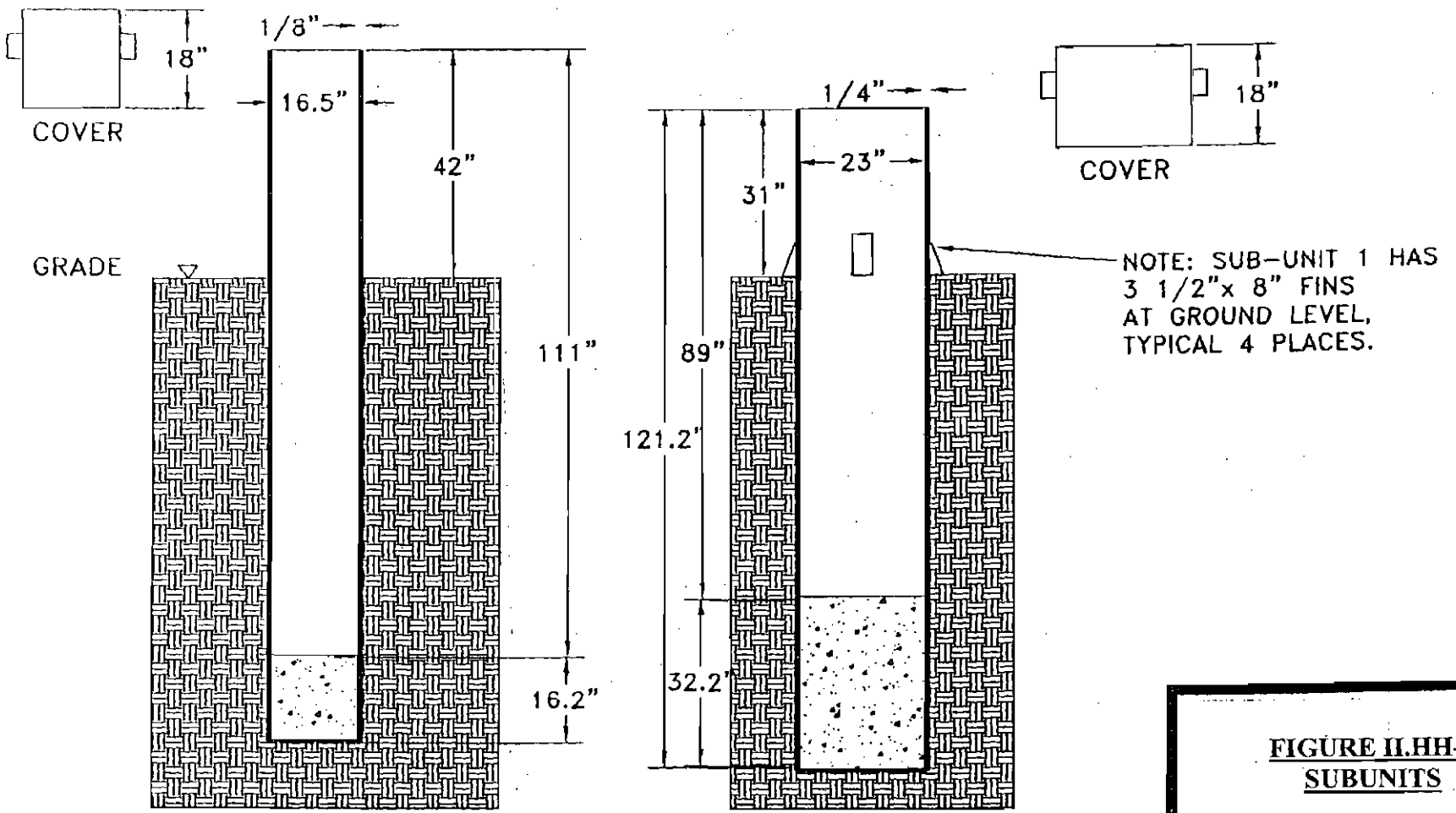


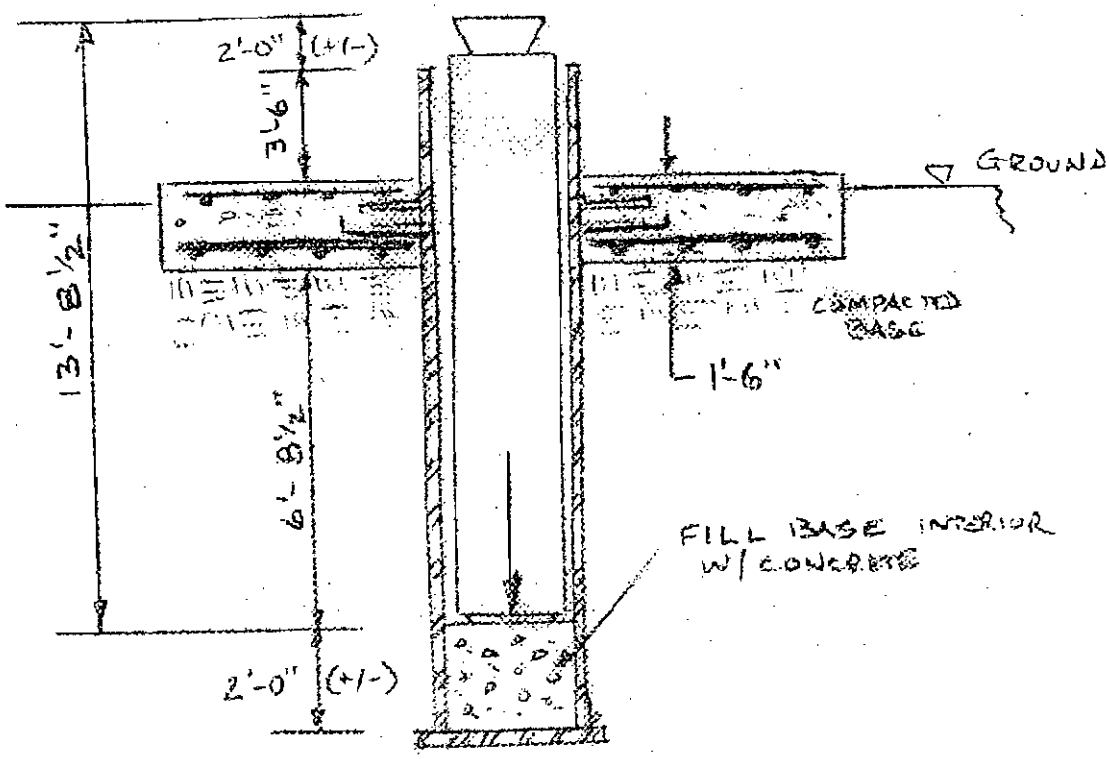
FIGURE II.HH-2
SUBUNITS

12/23/03

ATTACHMENT II.HH

PLANS AND SPECIFICATIONS FOR OPEN BURN UNITS

Figure II.HH-2(b), Open Burning Subunit 4 - Side View
Installation in 2012
(Note: Subunit 3 Scheduled for Removal in 2012.)



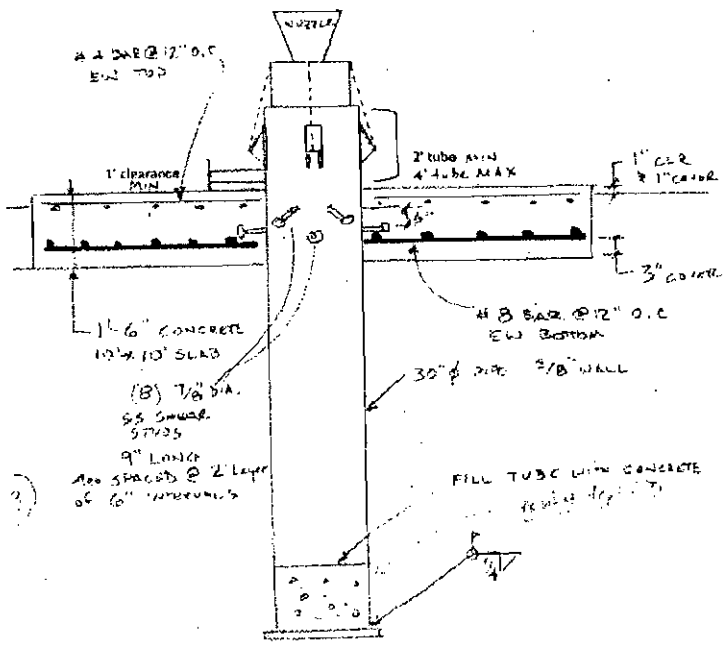


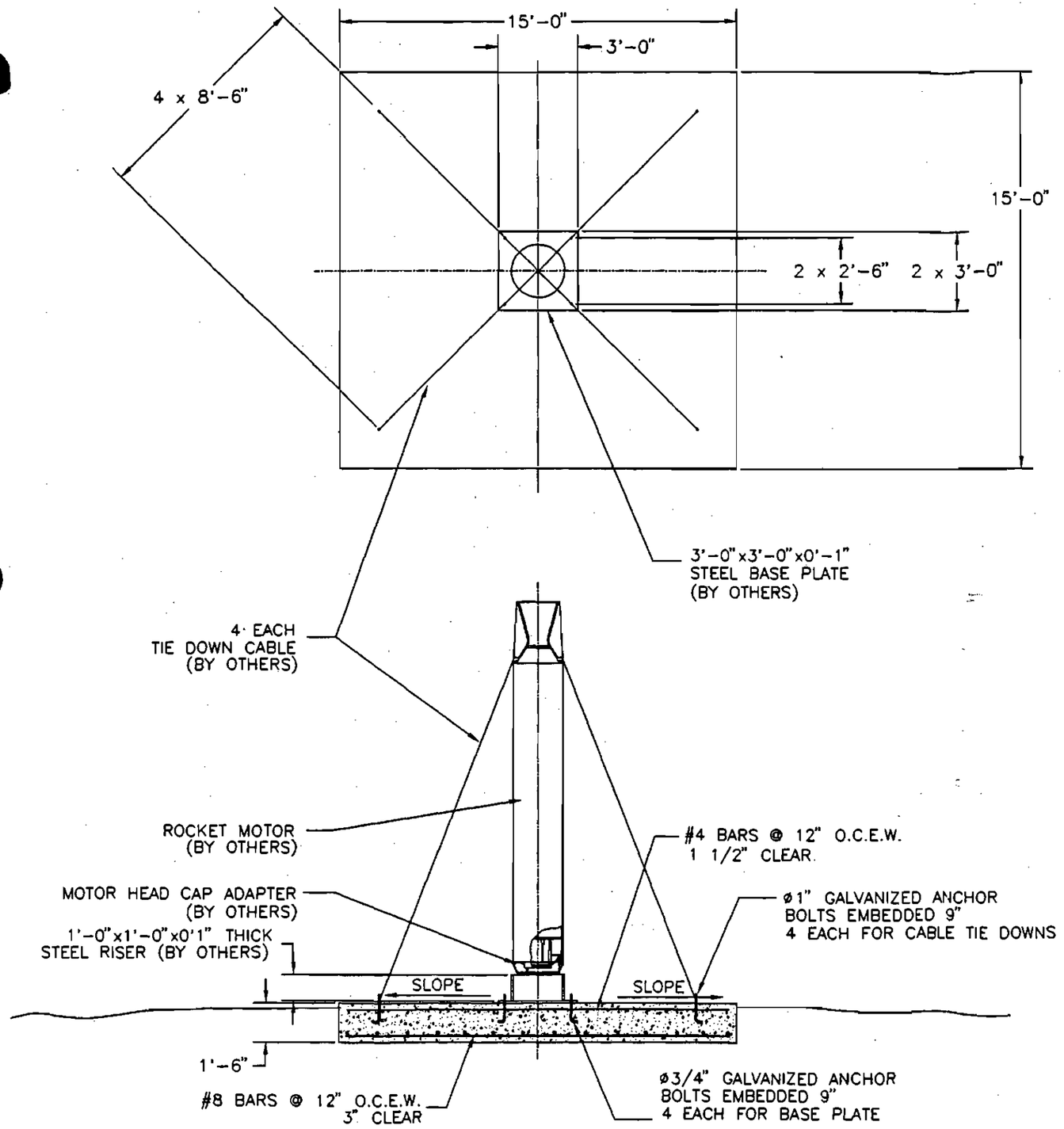
Figure A-8
Open Burning Area Subunit 4
October 2011

Also Permit Application Attachment-1e Appendix A

FIGURE II.HH-3

BURN PAD

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. REMOVE BURRS AND BREAK SHARP EDGES .005 - .010 MAX.
2. INTERPRET DWG. PER ANSI Y 14.5 1988



STRUCTURAL DESIGN DATA

FOUNDATION DESIGN LOADS

ROCKET MOTOR WEIGHT	3937 LBS.
ACTUAL THRUST	112,000 LBS.
FACTOR OF SAFETY (FOUNDATION)	2

DESIGN LOADS APPLIED AT ORIGIN OF ADAPTOR ANCHOR BOLT CIRCLE
ANCHOR BOLTS, ADAPTOR, AND TIE-DOWN CABLES BY OTHERS

STRUCTURAL CONCRETE NOTES

1. ALL CAST-IN-PLACE CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI.
2. ALL CONCRETE SHALL HAVE AN APPROVED AIR-ENTRAINING ADMIXTURE.
3. ALL REINFORCING BARS SHALL BE NEW BILLET STEEL CONFORMING TO THE STANDARDS OF ASTM A615, GRADE 60.
4. ALL CONCTETE REINFORCEMENT SHALL BE DETAILED, FABRICATED, LABELED, SUPPORTED, AND SPACED IN FORMS AND SECURED IN PLACE IN ACCORDANCE WITH THE PROCEDURES AND REQUIREMENTS OUTLINED IN THE LATEST EDITION OF THE "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE", ACI 318 AND THE "MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES", ACI 315.
5. MAXIMUM SLUMP SHALL BE 4". MINIMUM CEMENT CONTENT SHALL BE 6 SACKS.
6. MINIMUM CONCRETE COVER SHALL BE 3" FOR CONCRETE CAST AGAINST THE EARTH AND 1 1/2" FOR CONCRETE EXPOSED TO WEATHER.
7. MAXIMUM SIZE FOR COARSE AGGREGATE SHALL BE 3/4".
8. PROVIDE 1/16" PER 12" DRAINAGE SLOPE FROM CENTER OF PAD TO OUSIDE EDGES

FIGURE II.HH-3
BURN PAD

ITEM	QTY.	DESCRIPTION

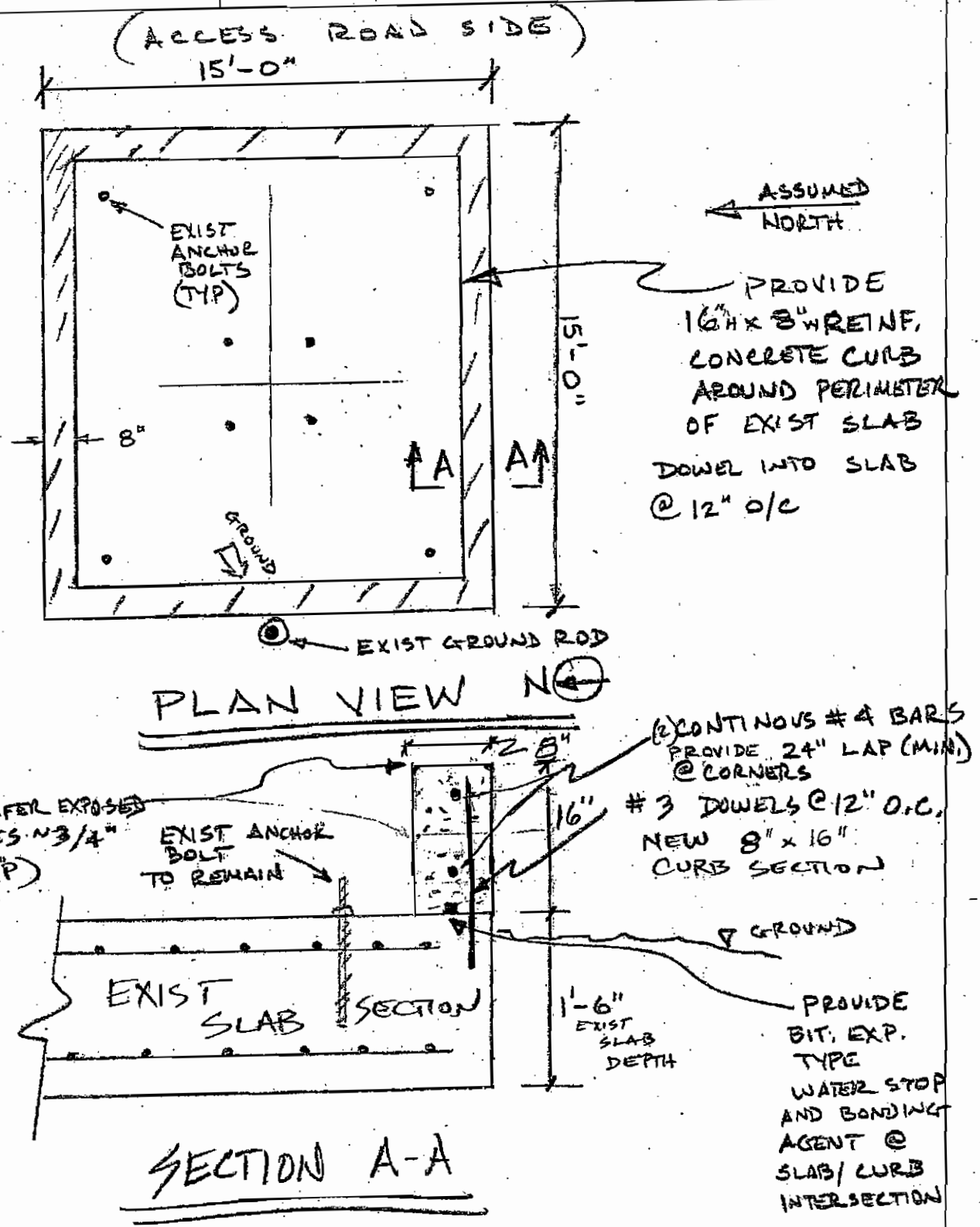
1-16-96

NEXT ASSEMBLY	UNIT OR PROJECT: TEST_PAD	SCALE: 1/30	MATERIAL	HEAT TREAT	DR. GARI CURRI; DES. ROB MADDO; CHK. G. BARFIELD; QL.; AP.
TOLERANCE ON DIMENSIONS UNLESS SHOWN OTHERWISE: ANGULAR ±	X.X ±.015, X.XX ±.030, X.XXX ±.005	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER WALLOPS FLIGHT FACILITY WALLOPS ISLAND, VIRGINIA 23337			
SURFACE FINISH PER ANSI/ASME B46.1	125 /	OPEN BURN PAD ASSEMBLY			D27152

FIGURE II.HH-4

BURN PAD BERM

STAEDTLER® No. 937 811E Engineer's Computation Pad



TYPICAL CURB SECTION CUT

NOTE: All concrete shall be air entrained 3000 psi concrete.

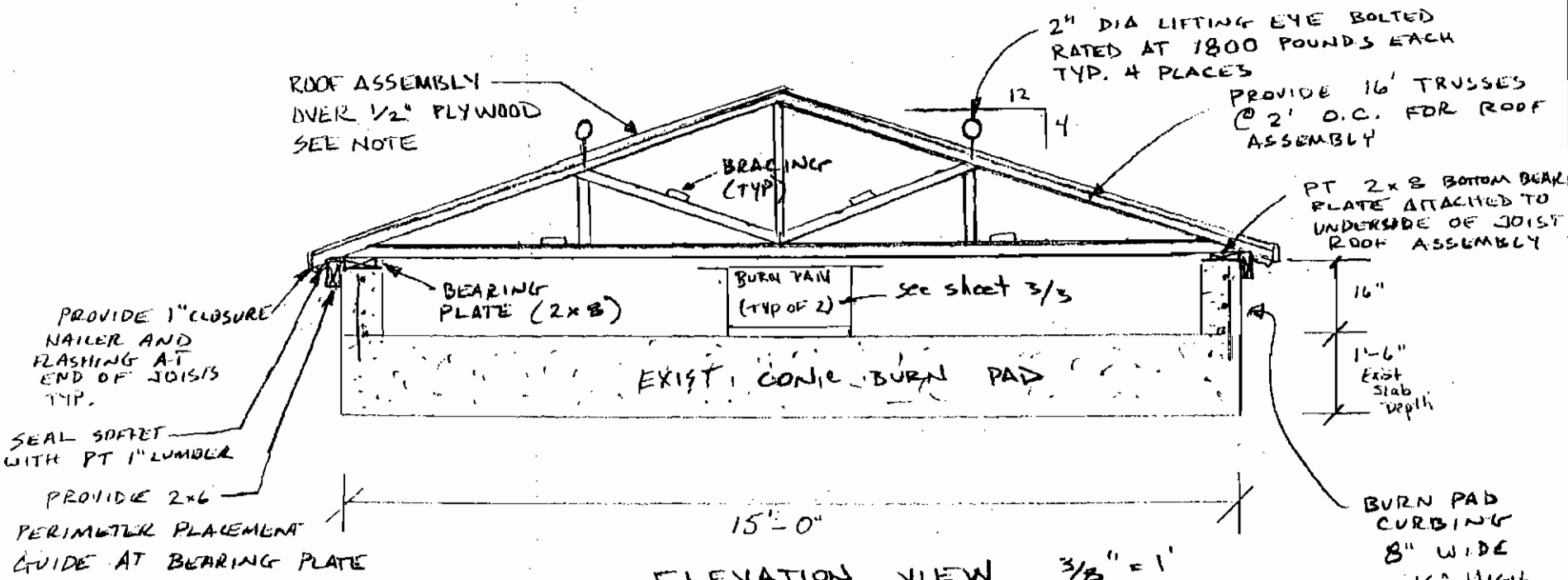
CURBING FOR OPEN BURN PAD

REVISION 1 05-05-05 MFS

FIGURE II.HH-4
BURN PAD BERM

FIGURE II.HH-5

BURN PAD COVER



ELEVATION VIEW 3/8" = 1'

NOTES:

1. TRUSSES AND ROOF SHALL BE RATED FOR 100 MPH WIND LOAD 35 PSF LIVE LOAD AND 20 PSF DEAD LOAD.
2. TRUSSES SHALL BE BRACED AND INSTALLED AS PER MANUFACTURERS PRINTED INSTRUCTIONS
3. ROOF ASSEMBLY SHALL INCLUDE 1/2" THICK PLYWOOD SHEATHING WITH 15 # ROOFING FELT WITH 24 GAGE METAL PANEL ATTACHED TO SHEATHING. PROVIDE RIDGE CAP AND
4. STRUCTURE SHALL BE CONSTRUCTED AS PER BOCA BUILDING CODE 1986 ED.
5. PROVIDE TIE DOWN SYSTEM FOR REMOVABLE ROOF ASSEMBLY TIE DOWN STRAPS WITH SCREW ANCHORS (2 STRAPS / 4 ANCHORS AT A MINIMUM).
6. PROVIDE EXTRA BRACING TO STABLIZE ROOF ASSEMBLY AS REQUIRED FOR ROOF FRAME TO BE LIFTED ON AND OF BURN PAD CURBING

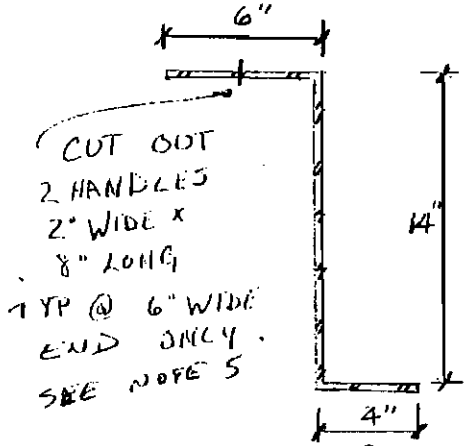
FIGURE II.HH-5
BURN PAD COVER

ROOF ASSEMBLY | TOM WILSON 2/25/98

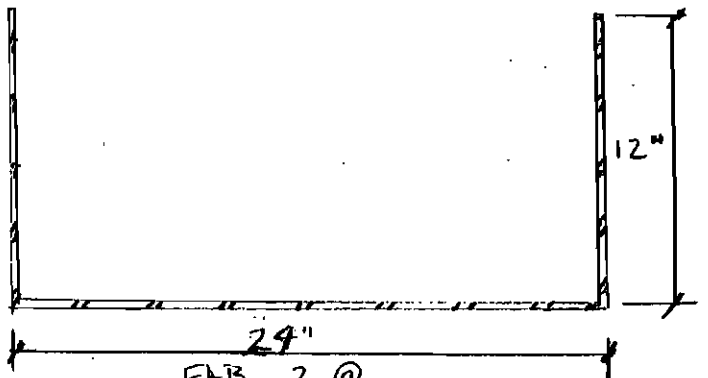
FIGURE II.HH-6

BURN PAN

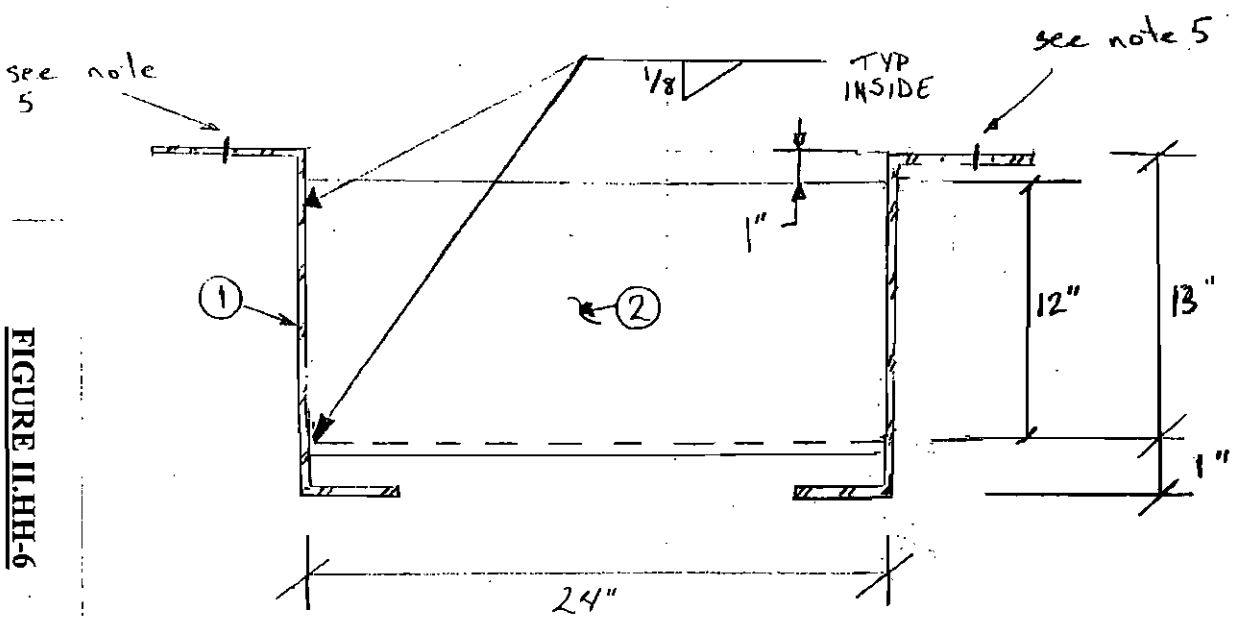
BURN PAN TYP OF 2



FAB 4 @
24" LONG
ITEM (1)



FAB 2 @
24" LONG
ITEM (2)



SECTION VIEW

1½ = 1

NOTES

1. All plates shall be 1/4" thick carbon-steel conforming to AST M A-36.
2. Welding should comply with the "structual welding code" prepared by the A.W.S., minimum weld size shall be 1/8" filled weld, electrodes shall be E 70 XX.
3. All steel should be clean and burr-free.
4. Bend all material as shown in shop. Max bend radius. Dimensions include bend radii.
5. PROVIDE (2) CUT OUT HANDLES (FREE OF BURRS) 2" WIDE x 8" LONG AT EACH 6" WIDE END of ITEM # 1.
6. SEAL WELD FINAL CONFAINER ITEM # 1 TO ITEM # 2 TO MAKE WATER TIGHT (LEAK PROOF).

FIGURE II.HH-6
BURN PAN

BURN PAN

TWJ 4/25/94

3/3

ATTACHMENT II.HH

PLANS AND SPECIFICATIONS FOR OPEN BURN UNITS

Open Burning Subunit 4 Design Plans and Specifications
Submittals dated January 25, 2012, Revision 1, April 27, 2012, and May 2, 2012
Installation in 2012
(Note: Subunit 3 Scheduled for Removal in 2012.)

National Aeronautics and
Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

April 27, 2012

Reply to Attn of: 250.W

Ms. Leslie Romanchik
Director, Office of Hazardous Waste
Virginia Department of Environmental Quality
P.O. Box 10009
Richmond, VA 23240

Subject: VDEQ Electronic Communication (e-mail) from R. Criqui to M. Simko, dated 3/12/2012

Ref: Class 2 Permit Modification Request for NASA Goddard Space Flight Center's Wallops Flight Facility, Wallops Island, Virginia, Open Burning Area Permit VA7800020888

The Wallops Flight Facility is submitting the Open Burning Area VA7800020888 Subunit 4 Design, Revision 1, dated April 2012, as requested in the above referenced e-mail. In particular, the design was revised to incorporate the following items:

1. The required Certification Statement is signed, dated, and stamped by the P. E.

2. The design approach is included in Section 3.

    - Design calculations are included in Section 4. Specific requests such as f'c equals 4000 pounds per square inch and maximum soil pressure equals 2.0 kilopounds per square foot are discussed in the Construction Notes and Section 3, respectively.
    - Abbreviations are explained throughout the text and in Section 4.
    - All units of measure are included.
    - Soil preparation is described in Section 2 and the Construction Notes.
    - The use of the drilling log is explained in Section 3.
    - An elevation view and plan view of Subunit 4 is included in Section 4. Weld description and reinforcement requirements are discussed throughout the design.

If you have any questions or comments concerning this report, please contact Ms. Marianne Simko at (757) 824-2127.

Bonnie H. Crawford

Bonnie H. Crawford
Environmental Protection Specialist

Enclosure

cc: (w/o Enclosure)
200/Ms. C. Massey
250/Mr. E. Connell
250/Ms. C. Turner
840/Mr. S. Kremer
840/Mr. J. Valiant

OPEN BURNING AREA

VA7800020888

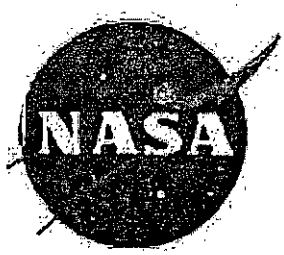
SUBUNIT 4 DESIGN

National Aeronautics and Space Administration

Goddard Space Flight Center

Wallops Flight Facility

Wallops Island, Virginia



REVISION 1

APRIL 2012

ENGINEERING REVIEW

4/27/12

Thomas F. Wilson
Senior Structural Engineer
NASA Wallops Flight Facility
Facilities Management Branch

(Date)

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

COMMONWEALTH OF VIRGINIA
PAUL C. BULL
Lic. No. 032982
PROFESSIONAL ENGINEER

4·27·12

Paul C. Bull, PE
Senior Civil Engineer
NASA Wallops Flight Facility
Facilities Management Branch

(Date)

TABLE OF CONTENTS

SECTION		PAGE NUMBER
1.0	INTRODUCTION	1
2.0	DESCRIPTION OF SUBUNIT 4	1
3.0	BASIS OF DESIGN	2
4.0	DESIGN CALCULATIONS	3

ENCLOSURE A Site Location Map

ENCLOSURE B Pipe Data

ENCLOSURE C Taurus Motor Data Sheet

ENCLOSURE D Drilling Log and Boring Location Map

1. INTRODUCTION

Wallops Flight Facility (WFF) is located in Accomack County, Virginia, on the Atlantic Coast of the Delmarva Peninsula. It is located approximately 145 kilometers (90 miles) north of Norfolk, Virginia, and is comprised of three separate landmasses: Wallops Main Base, Wallops Mainland, and Wallops Island. The Open Burning (OB) Area is located on the south end of Wallops Island (Enclosure A).

NASA uses open burning as the preferred method of treatment for waste rocket motors and igniters. This method is considered the safest treatment of these materials. NASA has been using the OB area since 1972. In 1988, NASA submitted a RCRA Part B Permit Application and operated under interim status until the final Permit for Open Burning Treatment of Hazardous Waste was issued on September 20, 2005.

The Wallops Flight Facility (WFF) is requesting to modify the Open Burning Area. On January 25, 2012, NASA submitted to the Virginia Department of Environmetnal Quality a Class 2 permit modification request. The Class 2 permit modification would install a new subunit between the Burn Pad and Subunit 1. Subunit 3 would be removed, leaving the number of subunits unchanged at 3. The new subunit would be designated Subunit 4. The number of subunits would remain unchanged at 3. This modification will offer a preferred method of open burning for permitted motors up to 28 inches in diameter.

2. DESCRIPTION OF SUBUNIT 4

Subunit 4 will be similar to the existing subunits at the OB area. The design function of the subunit is to hold an inverted, nozzle up, rocket motor during the open burning of hazardous waste rocket motor propellant. Please refer to Open Burn Subunit 4 Elevation View, page 4.

The subunit will consist of an ASTM A252 Grade 2 30-inch outside diameter structural pipe (Enclosure B) with a 5/8 inch wall thickness. Please refer to Open Burn Subunit 4 Elevation View. The pipe is designed to contain the rocket motor and provide structural rigidity. Four hook hold down assemblies will be welded onto the structural pipe with ¼ inch continuous fillet welds as shown on the Hook Hold Down Assembly Detail, page 5. Each Hook Hold Down Assembly will be used to anchor the rocket motor to the structutal steel pipe to prevent lateral movement. Headed Concrete Anchors (HCA) or headed stainless steel shear studs will be welded to the structural pipe in an alternate fashion as shown in the Open Burn Subunit 4 Elevation view. The HCA will be used to connect the structural steel pipe to the concrete foundation.

The pipe will be embedded in the soil so that 3.5 feet remain above the surface. The soil shall be prepared as described in Construction Notes #6. The upper 5 feet of soil levels on Wallops Island is generally fine sand (sp) and has fairly good load bearing capacity at upper levels. The pipe will be centered in a 10-foot square concrete foundation. The foundation will be constructed with reinforcement as shown in Open Burn Subunit Elevation and as described in the Construction Notes. Additional reinforcement will be added as shown in the Open Burn Subunit 4 Plan View around the hole created by the structural pipe to reduce cracking and increase strength in this area. Please also refer to the additional notes inserted on the drilling log in Enclosure D. The concrete shall be cast-in-place in accordance with Construction Notes #1 and #2.

The base of the structural pipe will be capped with an A36 32-inch diameter 5/8 thick steel plate. The bottom of the structural pipe will be be filled with 2 feet of concrete to prevent the release of hazardous constituents within the subunit.

A cover assembly will be constructed to prevent the collection of stormwater within the subunit when not in use. The cover assembly will be constructed of galvanized sheet metal of 1/16 inch thickness, 2 handles and four fasteners. The fasteners will attach the handles to the cover so that the cover can easily be removed.

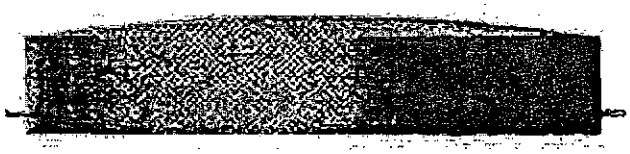


Figure 1 Cover Assembly

Anticorrosion and rust coating will be applied to cover assembly and the exterior of the structual pipe as described in Construction Notes #7 to protect the subunit from the corrosive coastal environment.

Additional construction notes can be found on page 6.

3. BASIS OF DESIGN

The design analysis will be checked against Taurus motor data sheet included in Enclosure C. The Taurus motor represents the maximum thrust which would be used in this subunit.

The design calculations begin on page 7 with a listing of data from Enclosure B Pipe Data, Enclosure C Taurus Motor Data Sheet, and Enclosure D Drilling Log. The location of Hole B-05 is shown on the map in Enclosure D. The boring was drilled in 2009 at a location several

yards south of the proposed Subunit 4. The topography and the soil structure of the area is expected to be identical. The maximum allowable soil bearing capacity is conservatively assumed to be 2000 psf and is consistent with the assumption used in the permit required calculations for Subunits 1 through 3, as well as all other spread footings located on Wallops Island.

The design calculations check resultant applied forces against allowable soil bearing capacity to ensure that the footing or foundation is adequately sized to support the downward motor thrust, the motor weight, and the pipe weight. The welds of the bottom steel plate to the structural pipe and the welds of the HCA to the structural pipe were checked against these same loads.

The footing was checked for 2-way or punching shear from localized forces and 1-way or bending shear. In both cases the design shear, ϕVc, was found to be less than the maximum shear, Vu. The bending reinforcement bar shear that could result from off center rocket motor thrust was also evaluated.

The structutal steel pipe was checked for tension force due to the thrust of the rocket motor straight downward and the shear force if the rocket shifts in the pipe creating an angular force. The bending force, Fb, which would be created if an explosion within the rocket motor caused a side blow-out was also checked.

The welds of these assemblies were checked for the resultant force, fr. Finally the number and diameter of the HCA were checked.

4. DESIGN CALCULATIONS AND CONSTRUCTION NOTES

Abbreviations and symbols are located on page 10.

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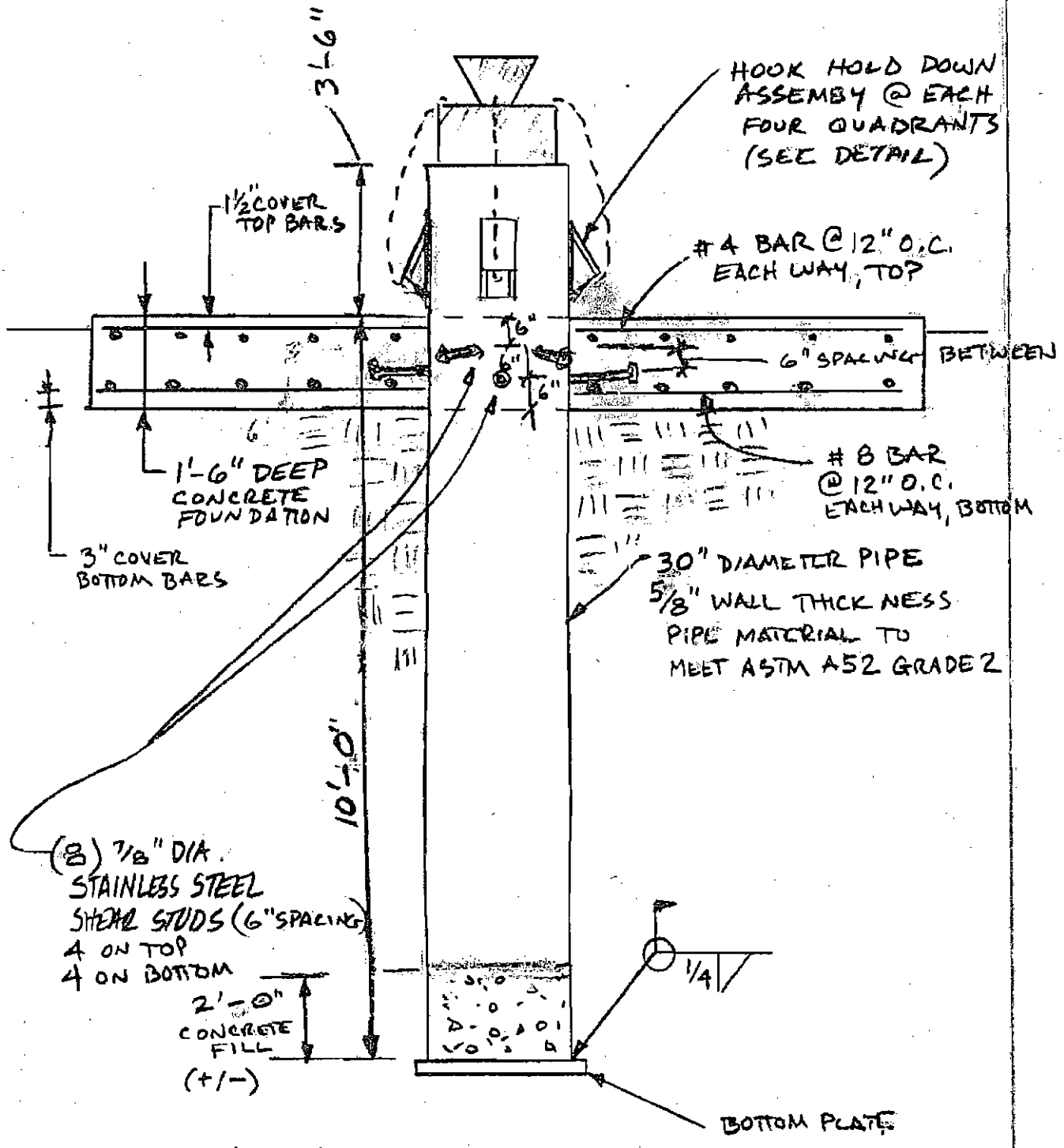

FIGURE 2

OPEN BURN - SUBUNIT 4

ELEVATION VIEW

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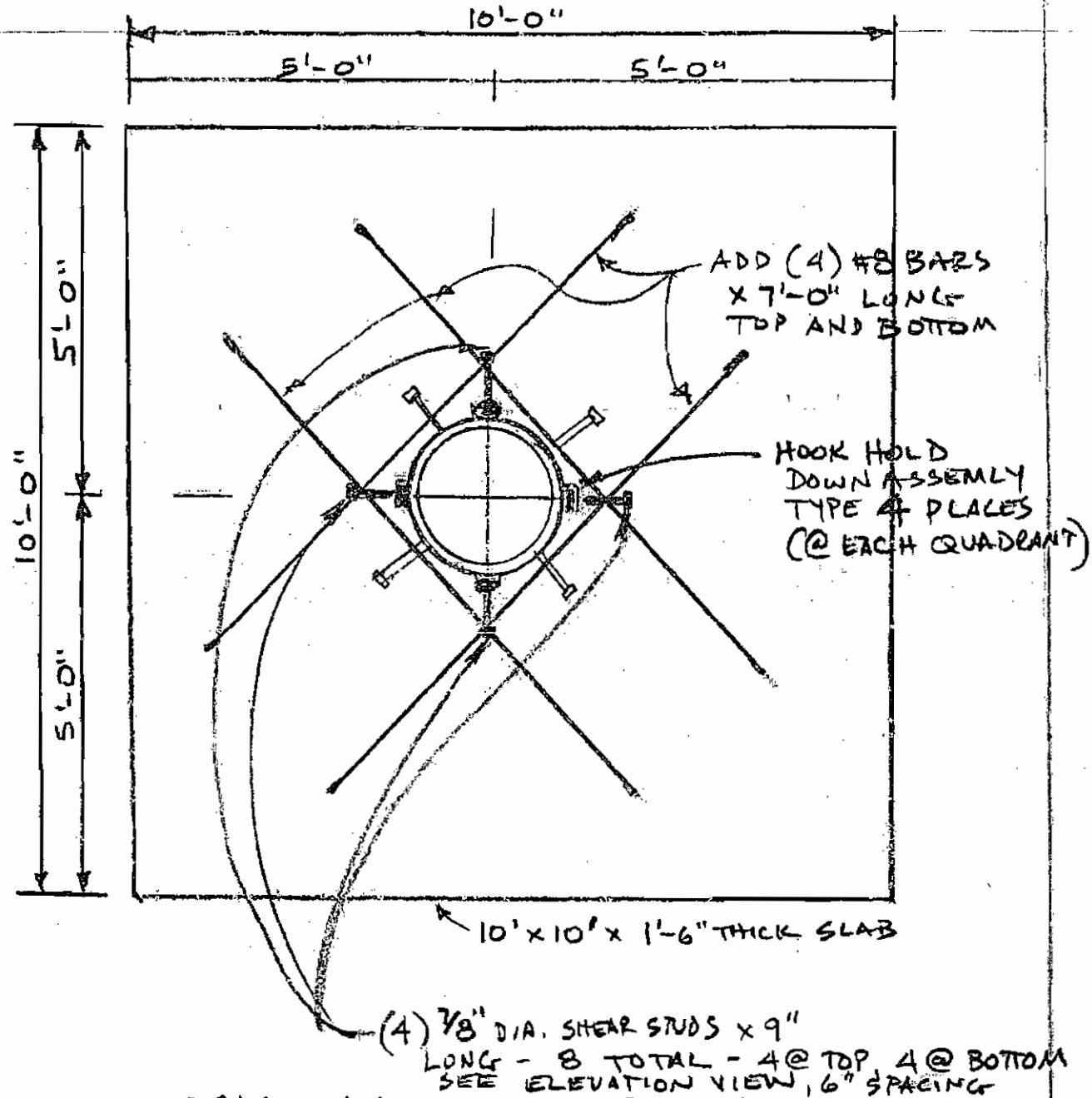
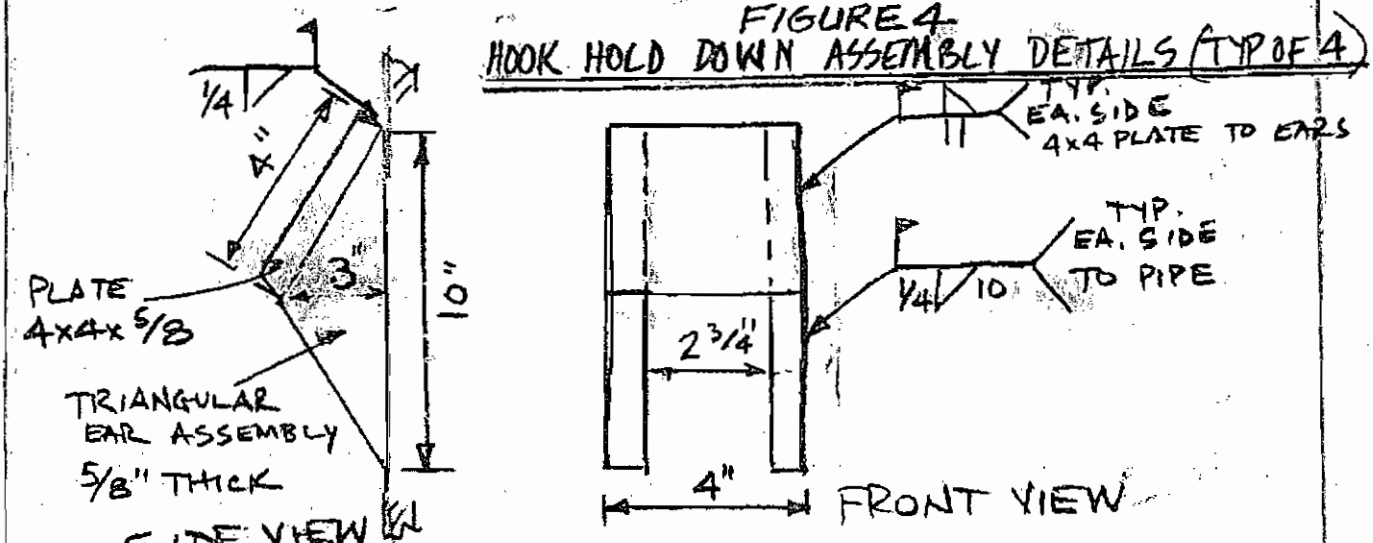


FIGURE 3 OPEN BURN-SUBUNIT 4 PLAN VIEW

FIGURE 4
HOOK HOLD DOWN ASSEMBLY DETAILS (TYP OF 4)



No. 23781 Engineer's Companion Pad

PROPERITIES OF 30" DIA, x 5/8" WALL PIPE : D=30", d=28.75"

ASTM A252 GRADE 2 STRUCTURAL PIPE (PILING PIPE)

Tensile strength (minimum) = 60,000 psi
Yield Strength (minimum) = 35,000 psi
Unit weight = 196 #/LF TOTAL WEIGHT PIPE = 2.8 K

Area, $A = \frac{\pi (D^2 - d^2)}{4} = 57.68 \text{ IN}^2$

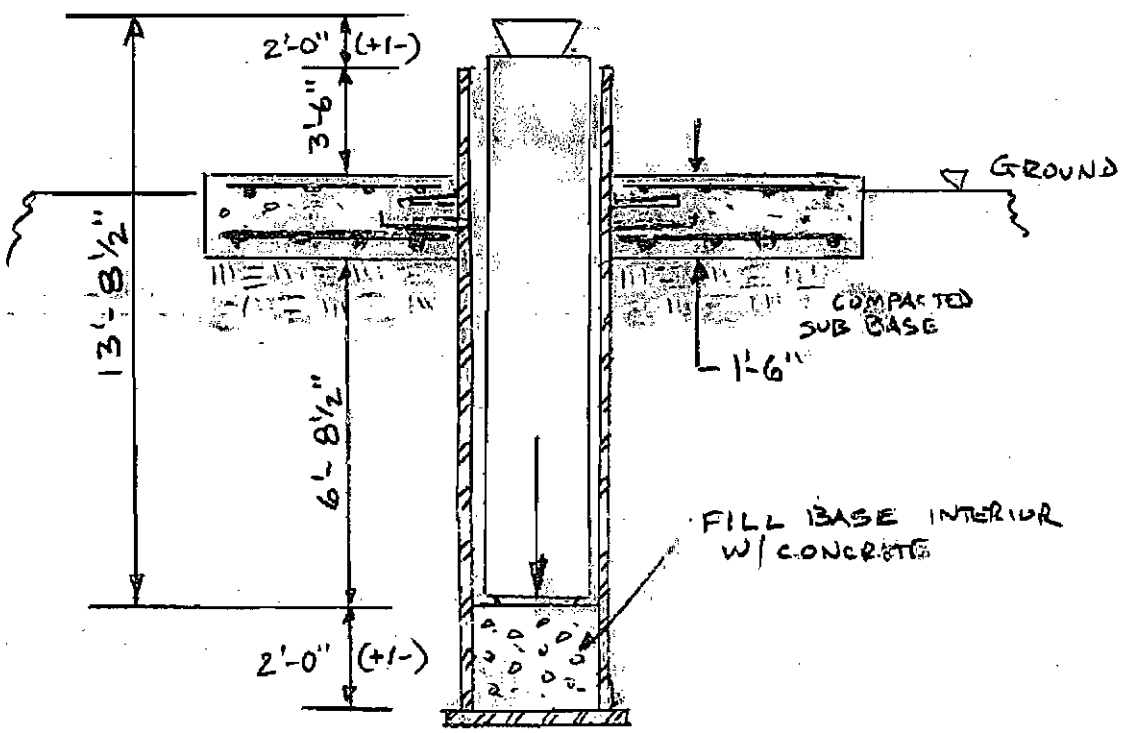
Section Modulus, $S = \frac{\pi (D^4 - d^4)}{32 D} = 415 \text{ IN}^3$

TAURUS ROCKET MOTOR LOADS / Properties

THRUST (MAX) = 121 K (SAY 125 K) over ~ 3.5 sec
MOTOR WEIGHT = 2.89 K (SAY 3 K)
MOTOR DIA. = ~23 → 24.5"
MOTOR LENGTH = 164.53" = ~ 13'-8 1/2" (INCLUDES NOZZLE)

CONCRETE PAD/
SOIL CONDITIONS (SEE ENCLOSURE 1, SOIL BORING)

MAX SOIL PRESSURE = 2.0 KSF
f'c = 4000 psi
Weight Concrete = 0.15 kcf (x 1.5' DEEP = 0.225 KSF)
TOP REINFORCEMENT = # 4 BARS @ 12" O.C.E.W.
Bottom Reinforcement = # 8 BARS @ 12" O.C.E.W



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CHECK SOIL BEARING

P = TOTAL LOAD ON SOIL (ROCKET THRUST LOAD) = 125^K (THRUST) + 3^K (MOTOR WEIGHT) + 2.8^K (PIPE WEIGHT) = 130.8 KIPS

SOIL RESISTANCE (ALLOW) LESS CONCRETE (2,000 PSF) − (225 PSF) = 1775 PSF P_2 = 1.775 ksf

$$P/P_2 = \frac{130.8 \text{ KIPS}}{1.775 \text{ K/SF}} = 73.7 \text{ SF REQ'D}$$

Actual Footer size = 10' SQ = 100 SF > 73.7 SF ∴ OK

CHECK WELD CAPACITY ON PIPE TUBE (BASE)

CIRCUM. = $\pi d = \pi(30") = 94.25"$

ASSUME 1/4" FILLET WELD, F_u = 50 KSI (MIN)
(MIN SIZE FOR 5/8" TO 5/8" STEEL, PER AISC TABLE J2.4)

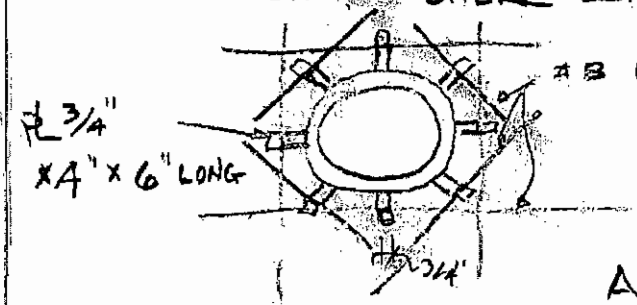
L = ALLOW LOAD / IN OF WELD, S = SIZE of weld, 1/4"

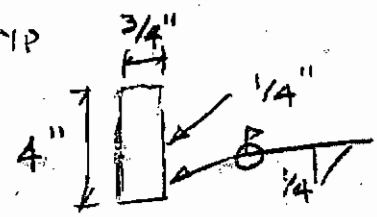
L = 0.707 (1/4)(.3)(50 KSI) = 2.65 KIP/IN (OF WELD) SHEAR

CAPACITY OF BASE = 94.25" (2.65 K/IN) = 250^K > 130.8^K ∴ OK

USE ALTERNATE HEADED CONCRETE ANCHORS (HCA's) OR PLATE CONNECTORS (BELOW):

CHECK SHEAR CONNECTORS @ 8 PLACES





A_W (ASSUME SIDES ONLY)

8 BARS × 2 SIDES × 4" WELD = 64 IN.

CAPACITY OF SHEAR CONNECTORS (64 IN WELD)(2.65 K/IN) = 170^K > 130.8^K ∴ OK

ANALYZE AS SQUARE FOOTING: (ASSUME 10' x 10' sq)

$P = 125^K + 3^K$ (ROCKET MOTOR) $+ 2.8^K$ (PIPE $= 130.8^K$

$P_a = 2.0$ ksf $- 0.15$ Kcf $\times 1.5' = 1.775$ ksf

$P_U = 1.7 * 130.8$ kips $/ (10' * 12''/1)^2 = 0.015$ ksi

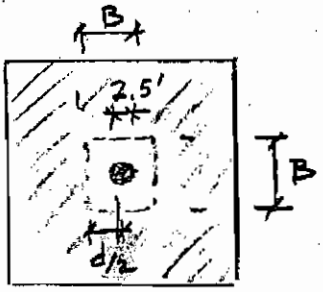
* check 2-way shear

$d = 18'' - 3'' - 1'' \; 14''$

$B = 30'' + 14'' = 44''$

$V_U = 0.015$ ksi $* [(10' * 12''/1)^2 - (44)^2]$

$V_U = 190.7$ kips



$V_C = 4\sqrt{f'_c}\, b_o d$

$= \dfrac{4\sqrt{4000}\,[4(44) * 14]}{1000} = 623.3^K$

$\phi V_C = .85(623.3^K) = 529.8^K > 190.7^K (V_U)$ ∴ OK

∴ No shear Reinf. Req'd

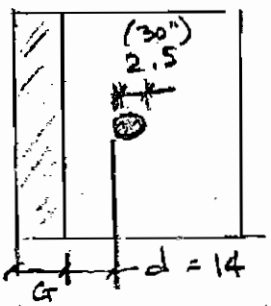
* check 1-way shear

$G = (5' * 12''/1) - 15'' - 14'' = 31''$

$V_U = 0.015(10 * 12''/1) * 31'' = 55.8^K$

$V_C = 2\sqrt{f'_c}\, b_w d$

$V_C = \dfrac{2\sqrt{4000}\,(10 * 12''/1)(14'')}{1000} = 212.5^K$



$\phi V_C = .85(212.5) = 180.6^K > V_U = 55.8^K$

∴ OK, No shear reinforcement Req'd.

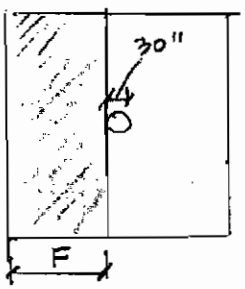
* check bending & rebar

$F = 60'' - 15'' = 45''$

$M_U = \rho_U \times b \dfrac{F^2}{2}$

$= 0.015$ ksi $* (10'(12''/1) * (45)^2/2$

$= 1{,}822.5$ IN-K



Req'd $K = M_U / \phi b d^2 = 1822.5$ IN-K $/ (0.9)(10 * 12''/1)(14)^2$

$= 0.0861$ ksi

req'd $\rho = (0.85 * 4\text{ ksi}/60\text{ ksi}) * \left(1 - \sqrt{1 - \dfrac{2(0.0861)}{.85 * 4\text{ ksi}}}\right)$

$= (0.0567)(0.0257) = 0.0015$

Req'd $A_S = 0.0015 * 10(12''/1) * 14 = 2.52$ IN^2/10 FT

2.52 IN^2 $/10 = 0.252$ IN^2/FT < 0.78 IN^2/FT (USED)

∴ OK

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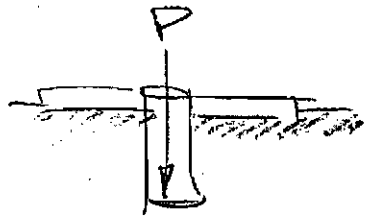
CHECK PIPE:

TENSION FORCE (ASSUME STRAIGHT FORCE DOWN AT BASE)

$f_T = P/A$



where P = ROCKET/THRUST LOAD
= 130.8 KIPS

and A = Area of pipe (steel cross section area)
= 57.68 IN²

$f_t = \frac{P}{A} = \frac{130.8 \text{ KIPS}}{57.68 \text{ IN}^2} = 2.27 \text{ KSI}$

MAX ALLOWABLE TENSION FORCE ON PIPE, $F_t = 0.6 F_y$

$F_t = 0.6 F_y = 0.6(35 \text{ KSI}) = 21.0 \text{ KSI}$

SINCE $F_{t(ALLOW)} = 21.0 \text{ KSI} > f_{t(ACTUAL)} = 2.27 \text{ KSI}$

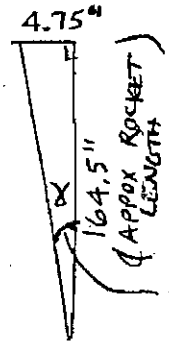
∴ OK

CHECK PIPE SHEAR FORCE: ASSUME ROCKET SHIFTS INSIDE TUBE, AND RESULTANT FORCE ACTS AT AN ANGLE

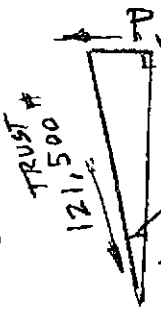
MAX ALLOWABLE SHEAR, F_v, on tube $F_v = .4 F_y$
$= .4(35 \text{ KSI})$
$= 14 \text{ KSI}$

Pipe Inside Diameter, ID = 28.75"
Outside Diameter of Rocket Casing OD = 24"

Room for displacement = ID − OD = 28.75" − 24.0" = 4.75"



$\tan\alpha = \frac{4.75}{164.5} = 1.65°$



$\tan 1.65° = \frac{f_v}{121{,}500 \text{ lbs}}$

$\frac{P_v}{A} = \frac{3{,}500 \text{ lbs}}{57.68 \text{ IN}^2} = 60.7 \text{ psi}$

$P_v = 3{,}500 \text{ lbs}$

$f_v = 60.7 \text{ psi}$ (ACTUAL) $< F_v = 14{,}000 \text{ psi}$ (ALLOWABLE) ∴ OK

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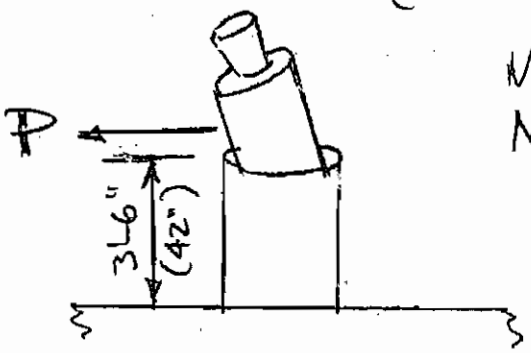
CHECK PIPE

BENDING FORCE

Assume side Blow out at top (Worst Case, Virtually Impossible)



$M_{MAX} = Pl$

$M_{MAX} = 125^{K}(42") = 5{,}250 \text{ IN-K}$

$S_{PIPE} = 415 \text{ IN}^3$

$f_{b_{ACTUAL}} = \frac{M}{S} = \frac{5{,}250 \text{ IN-K}}{415 \text{ IN}^3} = 12.65 \text{ KSI}$

$F_{b(ALLOWABLE)} = .6F_y = .6(35 \text{ KSI}) = 21 \text{ KSI}$

SINCE ALLOWABLE $F_b = 21.0 \text{ KSI} > \text{ACTUAL}, f_b = 12.65 \text{ KSI}$ ∴ OK

ABBREVATIONS / SYMBOLS

O.C. - on center
@ - at
E.W. - each way
DIA. - diameter
EA. - each
TYP. - typical
K - Kip (1,000 pounds)
KCF - Kips per cubic foot
KSF - kips per square foot
LF - Linear foot
IN. - INCH
#, LB - pound
L, l - Length
SQ - square
PL - plate
HCA - Headed Concrete Anchor
AISC - American Institute of Steel Construction
ID - Inside Diameter
OD - Outside Diameter
> - Greater than

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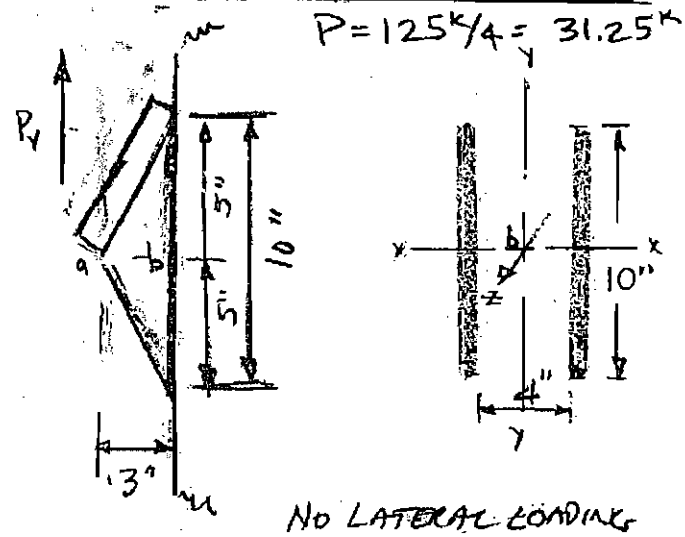
CHECK HOOR HOLD DOWN ASSEMBLY



WELD PROPERTIES

$A_w = 20"$

$S_x = \frac{d^2}{3} = \frac{10^2}{3} = 33.3\ IN^2$

$P = 31.25^K$

$M_x = 31.25^K(3") =$

$M_x = 93.75\ IN\text{-}K$

NO LATERAL LOADING

$f_v = \frac{P_v}{A} = \frac{31.25}{20} = 1.5625$

$f_b = \frac{93.75\ IN\text{-}K}{33.3\ IN^2} = 2.8153$

$f_R = \sqrt{(1.5625)^2 + (2.8153)^2} = 3.22\ K/IN$ OF WELD

$W_{REQD} = \frac{3.22\ K/IN}{0.707(0.3)(60KSI)} = 0.25$ IN REQUIRED

USE 1/4" FILLET WELD

∴ OK

Thrust over 4 points acting up is not realistic, as rocket will force downwards.

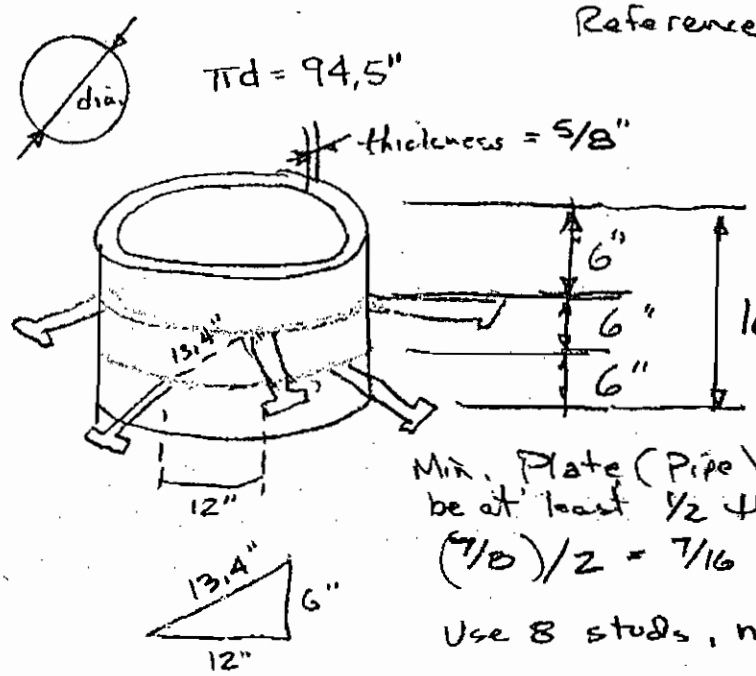
Very conservative, but still works

HEADED CONCRETE ANCHORS (HCA)

HEADED STAINLESS STEEL SHEAR STUDS

(Note: SS studs can be welded to Carbon Steel or SS)

Reference PCI 6th Edition



TRY 7/8" DIA STUDS
A = 0.60 in²

Min. Plate (Pipe) thickness should be at least 1/2 the dia of the stud
(7/8)/2 = 7/16 < 5/8 ∴ OK

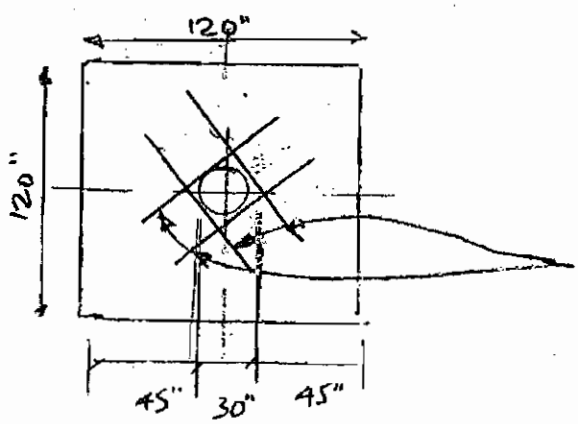
Use 8 studs, n = 8

STEEL CAPACITY, SHEAR STUD CAPACITY (ϕV_{ns}) where ϕ is strength reduction factor (FS) shear

$$\phi V_{ns} = \phi n_s A_n f_{ut}$$

$$\phi V_{ns} = 0.65(8)(.60)(65) = 202.8 \text{ kips} > 125 \text{ kips (THRUST)}$$

∴ OK

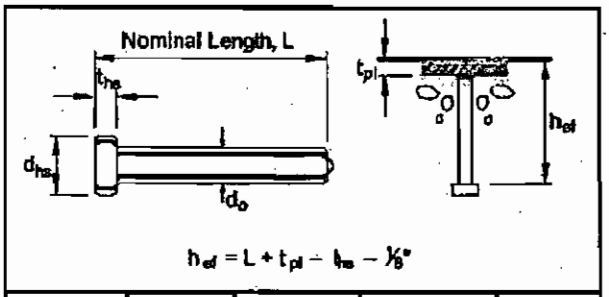


ADD FOUR #8 BARS x 7'-0" LONG @ 45° TOP and BOTTOM

CHECK STUDS (CONTINUED)

Stud Dimensions

- Table 6.5.1.2
- Page 6-12



Shank Diameter, d_o (in.)	Shank Area, A_{se} (in.^{2})	Head Diameter, d_{hs} (in.)	Head Thickness, t_{hs} (in.)	Bearing Area, A_{brg} (in.^{2})
¼	0.05	½	3/16	0.15
⅜	0.11	¾	9/32	0.33
½	0.20	1	5/16	0.59
⅝	0.31	1¼	5/16	0.92
¾	0.44	1¼	⅜	0.79
⅞	0.60	1⅜	⅜	0.88

Headed Concrete Anchors (HCA)

Steel Capacity

OR "SHEAR STUDS"

$$\phi V_s = \phi N_s = \phi \cdot n \cdot A_{se} \cdot f_{ut}$$

Where

ϕ = steel strength reduction factor
- = 0.65 (shear) ←
- = 0.75 (tension)

V_s = nominal shear strength steel capacity

N_s = nominal tensile strength steel capacity

n = number of headed studs in group

A_{se} = nominal area of the headed stud shank

f_{ut} = ultimate tensile strength of the stud steel, f_y = 60,000 psi (min)

Reference PCI, 6th Edition

Construction Notes

1. Cast-In-Place concrete for this structure shall be in accordance with the American Concrete Institute (ACI) "Building Code Requirements for Reinforced Concrete and Commentary" ACI 318-08 and ACI 318R-08.
2. Concrete shall be normal weight air-entrained and shall obtain a 28 day compressive strength (f'c) of 4000 PSI max course aggregate size shall be ¾".
3. Reinforcing materials shall be ASTM A615 grade 60, deformed, use grade 40 for ties spacers.
4. Minimum concrete cover for reinforcing steel is as indicated on drawings shall govern when in conflict with ACI 318-08. 3" cover bottom bars (min) 1 -1/2" cover for the top bars.
5. All reinforcing steel and pipe and other embedded items shall be accurately placed in the positions shown and adequately tied and supported to prevent displacement. Forms shall be installed to prevent sidewall pressure to blow out form. Rebar placement will also require inspection prior to pouring concrete.
6. Install 30" Diameter pipe into ground and compact soil around pipe. Provide soil stabilization and compaction as necessary. Recommend addition of Crusher Run base and vibratory compaction of subgrade. Disturb as little of subgrade as possible. Satisfactory inspection of subgrade shall be performed by Facilities Engineering Inspector prior to placing rebar.
7. All above ground welds to pipe shall be protected or performed after pipe is installed. Exterior of pipe below grade shall be coated with bituminous coating prior to placement. Apply bituminous (waterproof) coating in accordance with manufacturers printed instructions. Elevation and plumbness of pipe extending out of concrete is critical. Prevent water from entering pipe. Provide a cover assembly made of 1/16" thick (minimum) galvanized sheet metal. Covers shall have two handles and 4 fastener attachments so that it can be easily removed and/or secured to the top of the exposed pipe.
8. Welding shall conform to AWS D1.1 "Structural Welding Code-Steel." Weld electrodes shall be E70XX. Provide ¼" continuous fillet welds unless otherwise noted.
9. Structural steel plates and bars shall conform to ASTM A36.
10. Structural Pipe shall conform to ASTM A52 Grade 2.
11. Headed Concrete Anchors (HCA) or Shear Studs shall be installed conforming to ACI 318-08 Appendix D, Anchoring to Concrete. Studs strength shall be a minimum of Grade 60, Stainless Steel (SS).

ENCLOSURE (A)

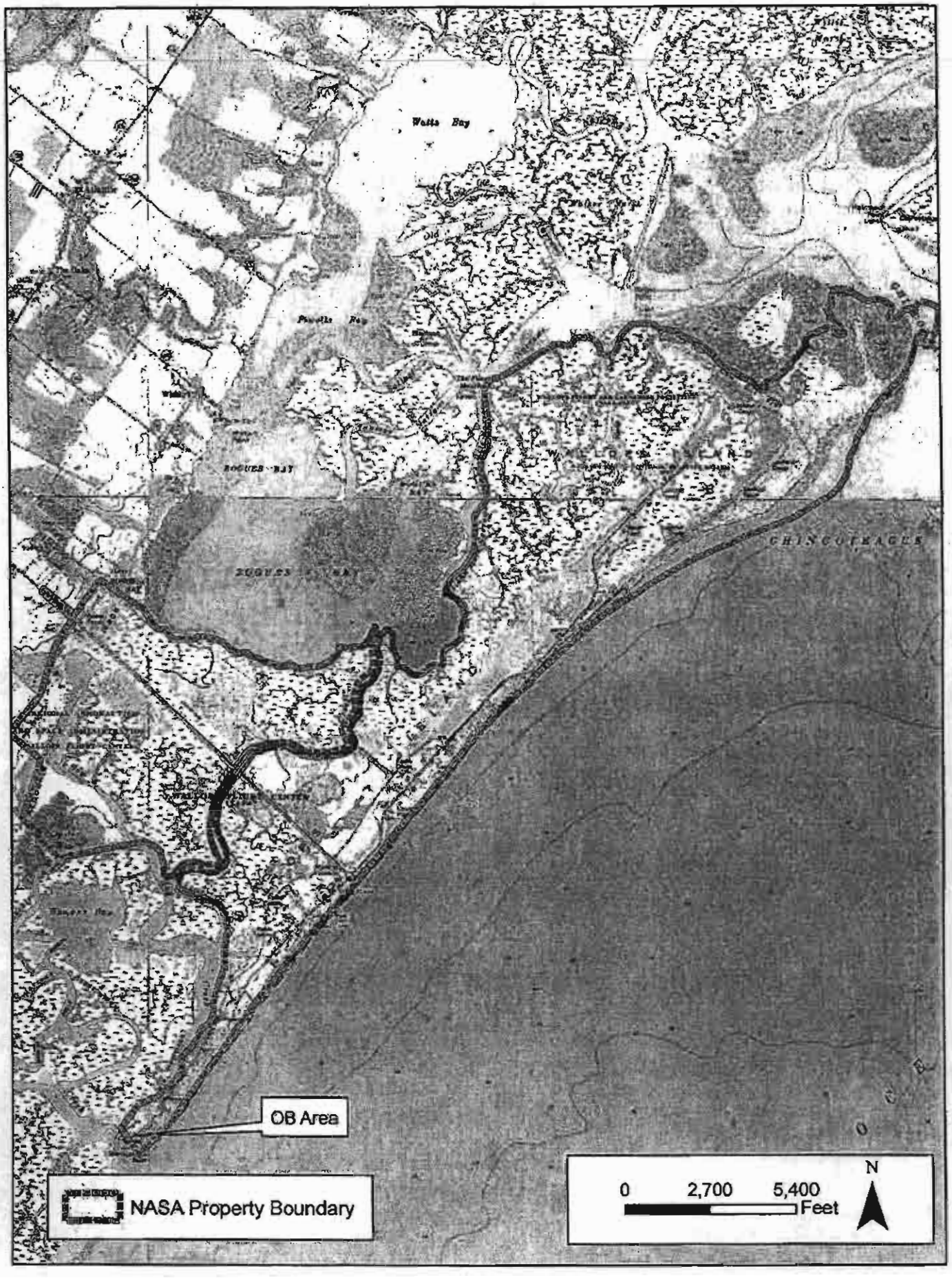


Figure A.2 NASA WFF Mainland and Island Topography

ENCLOSURE (B)

ASTM A252

Independence Tube has been producing square and rectangular products for over thirty-five years. Our experience with these products has led to the creation of our round and pipe size line. Independence Tube can now supply your pipe piling needs with the same excellence.

Independence Tube is now manufacturing ERW Pipe Piling to ASTM A252 in Grades 1, 2, and 3. Pipe Piling is produced from 6.625" O.D. to 12.750" O.D. in walls from .188" to .625" up to 78 feet long.

The most popular Pipe Piling sizes of 10.75" OD and 12.75" OD are produced in our Decatur, Alabama Division on a 4-week production cycle for your immediate needs.

When it comes to the versatility of designing with tube and pipe products, designers, architects, and engineers specify Independence Tube. *We have expanded our product line to expand your possibilities.*

	Grade 1	Grade 2	Grade 3
Tensile strength, min. psi	50,000	60,000	66,000
Yield strength, min. psi.	30,000	35,000	45,000
Elongation in 2 in. %	30	25	20

WEIGHT

Each length of pipe shall not vary more than 15% over or 5% under its theoretical weight, calculated using its length and its weight per unit length.

WALL THICKNESS TOLERANCE

Wall thickness at any point shall not be more than 12.5% under the specified nominal wall thickness.

OUTSIDE DIMENSION TOLERANCES

Outside diameter shall not vary more than ±1% From the specified outside diameter.

Call your Account Representative for floor stock availability or go on-line at www.Independencetube.com.

Independence Tube
Chicago Decatur Versailles

Your 1st Choice in Steel Tubular Products

Taurus Data Sheet:

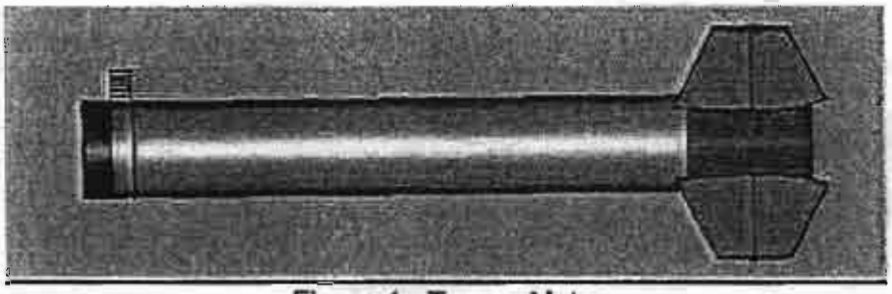


Figure 1. Taurus Motor

- **General Information:**

Sponsoring Agency:	Bureau of Naval Weapons
Manufacturer:	Allegany Ballistics Laboratory / Radford Army Ammunition Plant
Manufacturing Process:	Cartridge Loaded
Motor Designation:	M31A1, Improved Honest John
DOD Service:	ARMY
Hazard Classification:	1.1

- **Motor Data:**

Principal Diameter:	22.87 in
Total Length (including nozzle):	164.53 in
Inert Weight:	1227.3 lb
Propellant Weight:	1662.9 lb
Total Weight:	2890.2 lb
Mass Fraction:	0.575
Total Motor CG *:	70.2 in (loaded) 67.1 in (expended)

* CG distance from the head end

Table 1. Weight Breakdown for Taurus Motor [1]

Component	Nominal Weight (lb)
Case-Nozzle Assembly	1020.3
Igniter and Safearm Assembly	25.0
Beaker and Slivers	182.0
Inert Weight	1227.3
Propellant	1662.9
Total Weight	2890.2

ENCLOSURE (C)

- **Performance Data (Sea Level):**

	-40 °F	85 °F	130 °F
Burn Time (sec)	3.599	3.265	2.931
Action Time (sec)	3.916	3.587	3.257
Maximum Pressure (psia)	1095	1237	1379
Average Pressure during Action Time (psia)	974	1065	1155
Maximum Thrust (lb)	97,072	110,459	123,845
Average Thrust during Action Time (lb)	89,470	99,737	110,003
Total Impulse (lb-sec)	352,034	357,052	362,069
Propellant Specific Impulse (sec)	212	215	218

- **Physical Properties:**

- **Igniter**

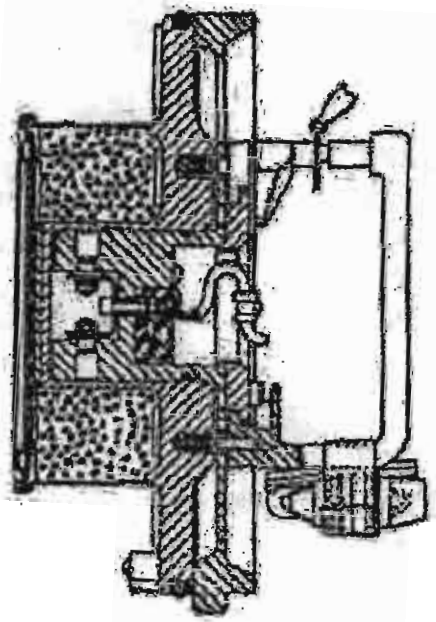


Figure 2. Taurus Igniter [1]

Name: XM58

Description:	Uses 2 Mk2 Mod 2 Squibs
Charge:	750 g USF-2D $BKNO_3$ pellets
Ignition delay:	0.033 sec
Igniter resistance:	0.5 ohm
Min current for reliable ignition:	2.9 amps

Safe/Arm Device: Manual alignment plates in igniter

- **Motor Case**

Material:	4130 Steel
Length	164.53 in
Outer Diameter:	22.75 in
Thickness (minimum):	0.156 in
Fabrication Method:	Roll and Weld
Hydrostatic Test Pressure:	1675 psig

- **Insulation**

Liner (between inhibitor and case):
- Weight: 44.5 lbs
- Composition: Vibradamp and Pyrolock
- Thickness: 0.060 in minimum body, 0.040 in minimum nozzle

Restrictor (inhibitor):
- Weight: 180 lb
- Composition: Cellulose Acetate
- Location: Forms casting mold for grain
- Thickness: 0.245 in

Head End Insulation:
- Weight: 1.0 lb
- Composition: Pyrolock

- **Nozzle / Exit Cone**

Shape:	15° half angle cone
Throat Area:	59.1 sq. in.
Expansion Ratio:	5.13
Thrust Coefficient:	1.49 (at –40 °F), 1.508 (at 130 °F)
Nozzle Material:	4130 Steel
Insert:	None

- **Propellant**

ENCLOSURE (2)

Name: ARP
Type: Double Base
Formulation:
49.9% Nitrocellulose
36.4% Nitroglycerine
13.7% Other Ingredients

Geometry:	4-point cruciform tapered inward from aft end
Flame Temp (@ P_c = 1000 psig):	4040 °F
Rb range:	0.35 to 0.90 (300 psi to 1500 psi)
Rb @ 1000 psi:	0.76 in/sec
Propellant density:	0.0581 lb/in^3
Isp:	~219 sec
Method of Manufacture:	Cast into inhibitor

Grain Dimension:
- Length: 122.87 in
- Diameter: 21.93 in
- Web Thickness: 2.51 in

Design Parameters (@ ignition):
- Burning Surface to Throat Area Ratio: 190
- Port to Throat Area Ratio: 2.64

Exhaust Gas Composition (@ 14.7 psia)
- 13.0% CO_2
- 39.6% CO
- 22.7% H_2O
- 12.9% H_2
- 11.8% N_2

Resonance Rods: Cruciform type of 1010-1020 steel covered with Pyrolock; attached to head closure

Grain Supports and Retainers: Pyrolock-covered steel plate held against grain by 6 springs; supported from the head closure

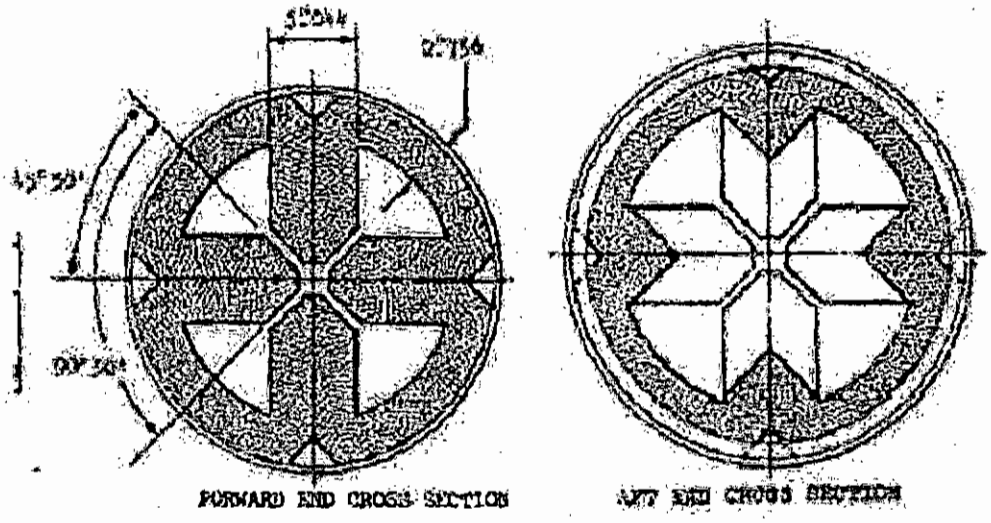


Figure 2. Taurus propellant grain cross section [1]

- **Storage Instructions**

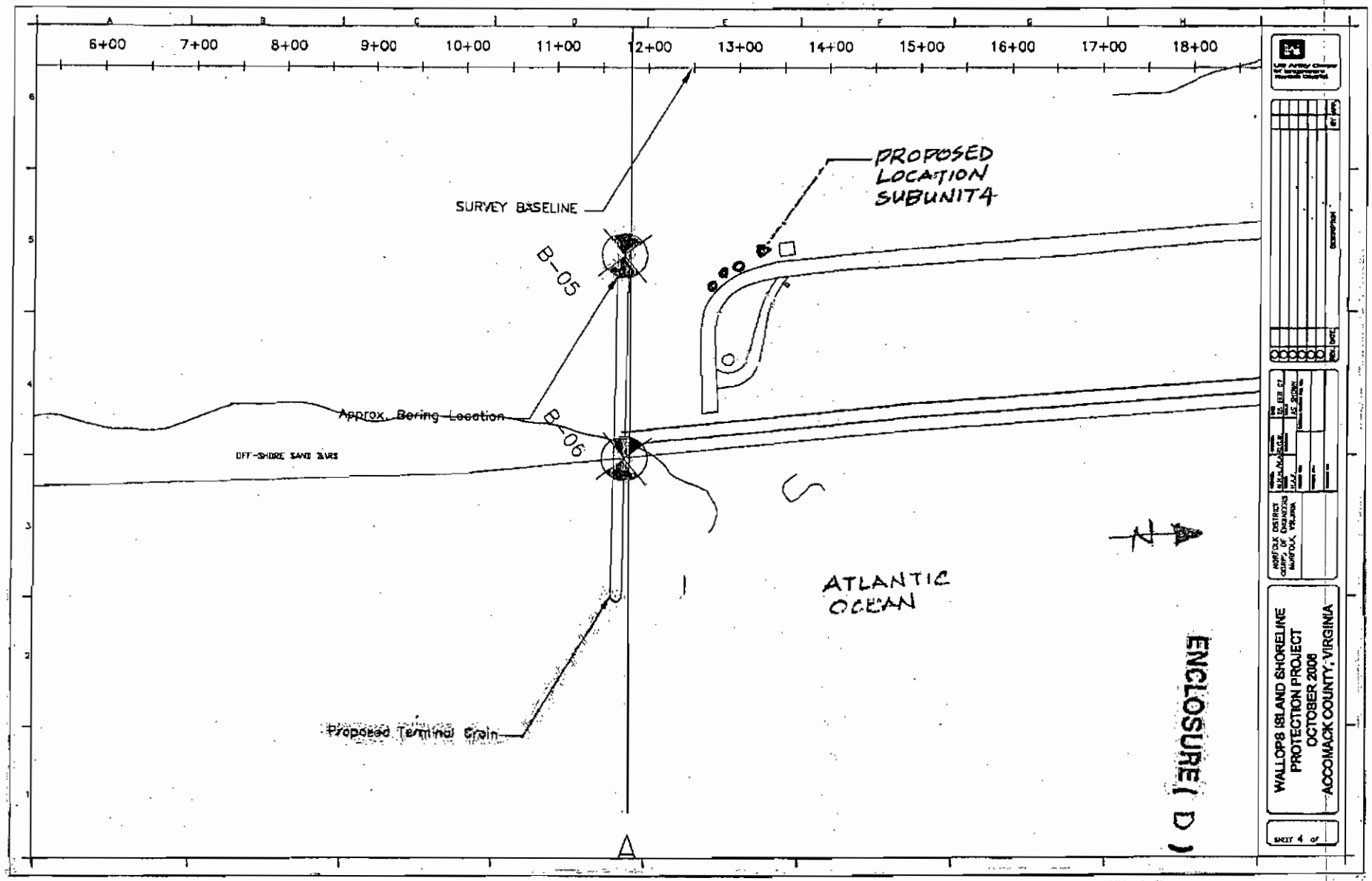
- **Performance**

- **Associated Procedures**

13-1-6	Taurus Static Firing
30-20-2	Taurus Motor First Stage Assembly
30-20-3	Taurus Orion Launcher Installation and Prelaunch
30-20-5	Modification of XM-58 Taurus Igniter for First Stage Motor
30-20-6	Modification of XM-58 Taurus Igniter for Second Stage Motor
VS60620	Taurus Motor Assembly BBXI and BBXII Vehicles
VS55943	Taurus Motor Removal, Inspection, Modification, and Installation into the Shipping Container
VS60914	Configuration of the AML 20K Launcher at PFRR Pad III for Taurus
VS60590	Configuration of MRL 7.5K Launcher at PFRR Pad 1 for Taurus Vehicles
VS60621	Modification of XM-58 Taurus Igniter for Second Stage Motor

- **References**

[1] CPIA. "Improved Honest John." February 1964. Unit 394.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SURVEY BASELINE
PROPOSED LOCATION SUBUNIT 4
B-05
B-06
Approx. Bering Location
OFF-SHORE SAND BARS
ATLANTIC OCEAN
Proposed Terminal Groin
ENCLOSURE D 1
WALLOPS ISLAND SHORELINE PROTECTION PROJECT
OCTOBER 2006
ACCOMACK COUNTY, VIRGINIA
SHEET 4 OF

ENCLOSURE (D) ENCLOSURE (D Hole No. B-05

DRILLING LOG	DIVISION CENAO	INSTALLATION Wallops Flight Facility	SHEET 1 OF 2 SHEETS

1. PROJECT Shoreline Restoration and Infrastructure Protection Program	10. SIZE AND TYPE OF BIT 2.75" Tri-Cone Rotary
2. LOCATION (Coordinates or Station) Wallops Island, Virginia N 3,836,963.1 E 12,349,669.0	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Fishburne Drilling Inc.	12. MANUFACTURER'S DESIGNATION OF DRILL CME-550X
4. HOLE NO. (As shown on drawing title and file number) B-05	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 13 / UNDISTURBED
5. NAME OF DRILLER Tim Donahue	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED — DEG. FROM VERT.	15. ELEVATION GROUND WATER NA
7. THICKNESS OF OVERBURDEN	16. DATE HOLE STARTED 2/10/2009 COMPLETED 2/10/2009
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE +13.5 ±
9. TOTAL DEPTH OF HOLE 50.0	18. TOTAL CORE RECOVERY FOR BORING %
	19. GEOLOGIST L. Jones

ELEVATION (feet) a	DEPTH (feet) b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	SAMPLE DEPTH (feet) e	SAMPLE BLOWS f	REMARKS (Drilling time, water loss, dept weathering, etc., if significant) g
13.5-5.5	0.0		(SP) Fine sand, dry, tan ASSUME 2000 psf bearing (conservative)	0' to 2'	1-2-3-3 N=5	H = Weight of Hammer
			— 3'-0" WATER	2' to 4'	3-2-3-3 N=5	
			(SP) same, saturated	4' to 6'	1-1-1-2 N=2	
8.0	5.5		(SP) Fine to medium sand, trace of fine gravel, saturated, orange-tan	6' to 8'	1-1-1-1 N=2	WATER @ 3'-0 BELOW GRADE
5.8	7.7		(CH) Clay lense	8' to 10'	2-3-3-5 N=6	
5.6	7.9		(SP) Fine sand, moist, light brownish tan			BLOW COUNTS DECREASE TO N = 2 @ 4'-0" BELOW GRADE
3.9	9.6		(SP) Fine sand, trace of shell fragments, moist, grayish light brown			
0.5	13.0		color change to light gray	13' to 15'	5-5-6-7 N=11	NOTES: → KEEP FOUNDATION UP HIGH 1'-6" BELOW GRADE AND COMPACT TO ACHIEVE HIGHER COMPRESSIVE STRENGTH.
-3.0	16.5		(SP) Fine to coarse sand, little shell fragments, moist, gray	18' to 20'	6-4-2-3 N=6	→ ASSUME 2000 PSF BASED ON SUBUNITS 1 THRU 3
-6.0	19.5		(SP) Fine to medium sand, trace of shell fragments, moist, gray			
-8.5	22.0		(CH) Silty clay, high plastic, moist, gray	23' to 25'	1-1-1-1 N=2	
-12.5	26.0		(SC) Clayey silty fine sand, medium plastic, moist, gray	28' to 30'	1-0-1-0 N=1	
-15.4	28.9		(CH) Silty clay, trace of fine sand, trace of peat, high plastic, moist, grey			
-18.5	32.0		(CH) Silty clay, high plastic, moist, gray	33' to 35'	1-1-0-1 N=1	
-20.7	34.2		(PT) Peat, little silty clay, low plastic, moist brown			
-22.5	36.0		(CH) Silty clay, high plastic, moist, gray	36' to 40'	H-1-1-1 N=2	

ENCLOSURE (D)

Hole No. B-05

DRILLING LOG	DIVISION: CENAO	INSTALLATION: Wallops Flight Facility	SHEET 2 OF 2 SHEETS

1. PROJECT: Shoreline Restoration and Infrastructure Protection Program	10. SIZE AND TYPE OF BIT: 2.75" Tri-Cone Rotary
2. LOCATION (Coordinates or Station): Wallops Island, Virginia N 3,836,963.1 E 12,349,669.0	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: Fishburne Drilling Inc.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-550X
4. HOLE NO. (As shown on drawing title and file number): B-05	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 13 / UNDISTURBED
5. NAME OF DRILLER: Tim Donahue	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: NA
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 2/10/2009 / COMPLETED 2/10/2009
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE: +13.5 ±
9. TOTAL DEPTH OF HOLE: 50.0	18. TOTAL CORE RECOVERY FOR BORING: %
	19. GEOLOGIST: L. Jones

ELEVATION (feet) a	DEPTH (feet) b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	SAMPLE DEPTH (feet) e	SAMPLE BLOWS f	REMARKS (Drilling time, water loss, dept weathering, etc., if significant) g
13.5-5.5	0.0					
-28.5	42.0		(ML-CL) Clayey silt, trace of very fine sand, low plastic, very moist, gray	43' to 45'	2-3-6-10 N=9	
-33.0	46.5		(SC) Clayey silty very fine sand, medium plastic, moist, bluish gray	48' to 50'	2-2-2-3 N=4	
-36.5	50.0		Boring terminated at a 50 foot depth.			

Criqui, Richard (DEQ)

From: Wilson, Thomas F. (WFF-2280) [thomas.f.wilson@nasa.gov]
Sent: Wednesday, May 02, 2012 2:33 PM
To: Criqui, Richard (DEQ)
Cc: Simko, Marianne F. (WFF-200.C)[EG&G, Inc. (WICC)]; Bull, Paul C. (WFF-2280)
Subject: Supplimental Info on Open Burn Area (VA7800020888) Subunit 4 Design
Attachments: S3009085012050212360.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Richard,
It was good to speak with you today. I have attached the backup information (design formulas) as per our discussion today.
As per our discussion you had questions concerning the concrete footing design on page 8 of the calcs. Page 8 of design calcs have various equations which I made to try to be somewhat consistent with the older original design (by DBF, Inc March 18, 2004) as well as what I had in my (referencing) text books.
I have attached referencing equations from Design of Reinforced Concrete by Jack McCormac, as well as derivation of percentage of steel required from Reinforced Concrete Design by Wang, both are attached. The McCormac book has the equations and good description of the shear (one way & punching) equations. The Wang formula for finding ρ is generally (in my experience) done by using tables (based on f'c, fy, and $M/\phi bd2$). Since I was using the old calcs as a template I used the long formula used by DBF. Either way is generally acceptable.
I also attached the table (A.6, McCormac) for finding the As (Area of Steel) that I used for the 0.78 square inches per foot that we have in the bottom of the slab (#8 bars at 12" on center).
I hope this helps in satisfactorily explaining the footing design to your office.
Feel free to contact me if you have any other questions or comments.
Best Regards,
-Tom

Thomas F. Wilson, Code 228
Senior Structural Engineer - Experimental Facilities Development
NASA Wallops Flight Facility, Bldg N-161, Rm 120
Wallops Island, Virginia 23337
757-824-1570 (Work)
757-824-1831 (Fax)
757-710-1456 (Cell)

Central Library, University of California, San Diego
(Courtesy of Glasbeen Graphics of La Jolla)

DESIGN OF REINFORCED CONCRETE

Jack C. McCormac
Clemson University

Thomas Y. Crowell
HARPER & ROW PUBLISHERS
New York Hagerstown San Francisco London

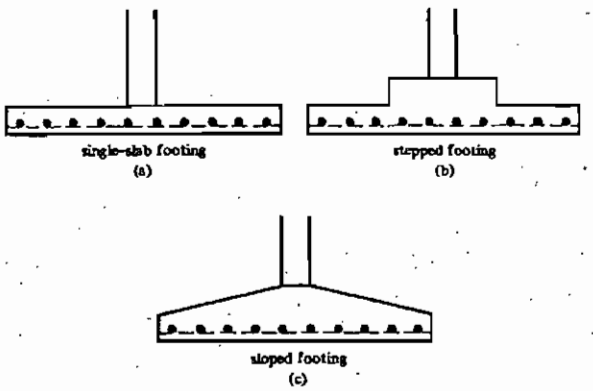


Figure 10.6

used where such shapes are dictated by the available space or where the cross sections of the columns are very pronounced rectangles.

Most footings consist of single slabs, such as the one shown in Figure 10.6(a), but if calculated thicknesses are greater than 3 or 4 ft, it may be economical to use stepped footings, that is, ones with pedestals or caps, as illustrated in Figure 10.6(b). The shears and moments in a footing are obviously larger near the column, with the result that greater depths are required in that area as compared to the outer parts of the footing. For very large footings, such as for bridge piers, stepped footings can give appreciable savings in concrete quantities.

Occasionally sloped footings [Figure 10.6(c)] are used instead of the stepped ones, but labor costs can be a problem. Whether stepped or sloped, it is considered necessary to place the concrete for the entire footing in a single pour to ensure the construction of a monolithic structure. If this procedure is not followed, it is desirable to use keys or shear friction reinforcing between the parts to insure monolithic action.

Before a column footing can be designed, it is necessary to make a few comments regarding shears and moments. This is done in the paragraphs to follow, while a related subject, load transfer from columns to footings, is discussed in the next section of this chapter.

Shears

There are two shear conditions that must be considered in column footings, regardless of their shapes. The first of these is one-way shear,

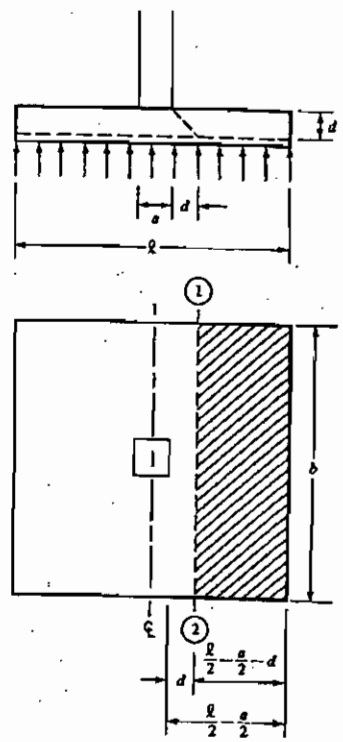


Figure 10.7 One-Way or Beam Shear

which is the same as that considered in wall footings in the preceding section. For this discussion reference is made to the footing of Figure 10.7. The total shear (V_u) to be taken along Section 1.2 equals the net soil pressure times the crosshatched area outside the section. In the expression to follow, b is the whole width of the footing from points 1 to 2. The maximum value of V_c if stirrups are not used equals ϕV_c equals $\phi 2\sqrt{f_c'}\,bd$ and the maximum depth required is as follows:

$$d = \frac{V_u}{\phi 2\sqrt{f_c'}\,b}$$

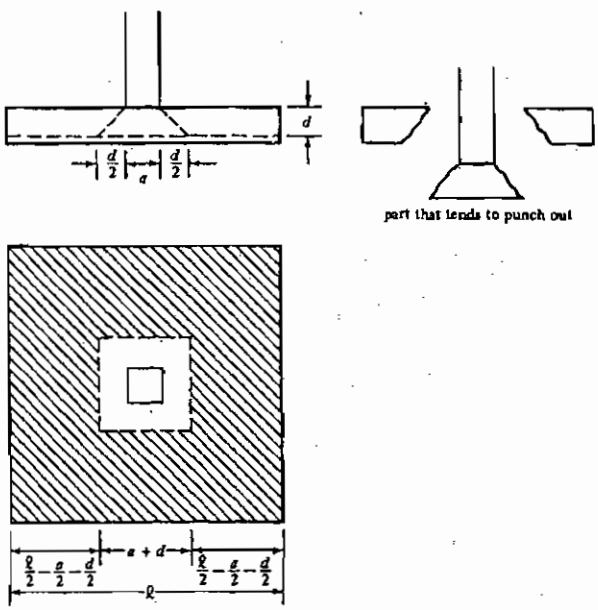


Figure 10.8 Two-Way or Punching Shear

The second shear condition is two-way or punching shear, with reference being made to Figure 10.8. The compression load from the column tends to spread out into the footing, opposing diagonal tension in that area, with the result that a square column tends to punch out a piece of the slab, which has the shape of a truncated pyramid. The ACI Code (11.11.1.2) states that the critical section for two-way shear is located at a distance $d/2$ from the face of the column and that the shear so computed must not exceed $\phi 4\sqrt{f'_c}\,b_o d$ if shear reinforcing is not provided.

The shear force V_u consists of all the net upward pressure on the cross-hatched area shown, that is, on the area outside the part tending to punch out. In the expression to follow, b_o is the perimeter around the punching area, equal to $4(a + d)$ in the figure, and the depth required for two-way shear is

$$d = \frac{V_u}{\phi 4\sqrt{f'_c}\,b_o}$$

Test have shown that when slabs are subjected to bending in two directions and when the long side of the supporting area is more than two times the short side the shear strength $V_c = 4\sqrt{f'_c}\,b_o d$ may be much too high. The Code 11.11.2 says that unless shear reinforcing is provided, V_c for punching or two-way shear may not exceed the following

$$V_c = \left(2 + \frac{4}{\beta_c}\right)\sqrt{f'_c}\,b_o d \leq 4\sqrt{f'_c}\,b_o d$$

In this expression β_c is the ratio of the long side of the loaded area to the short side of the loaded area. For nonrectangular loaded areas V_c can be obtained with the same expression if β_c is considered to equal the maximum length of the effective loaded area divided by the maximum width measured perpendicular to the length.

Moments

The bending moment in a square reinforced concrete footing is the same about both axes due to symmetry. It should be noted, however, that the effective depth of the footing cannot be the same in the two directions because the bars in one direction rest on top of the bars in the other direction. The effective depth used for calculations might be the average for the two directions or, more conservatively, the value for the bars on top. This lesser value is used for the examples in this text. Although the result is some excess of steel in one direction, it is felt that the steel in either direction must be sufficient to resist the moment in that direction. It should be clearly understood that having an excess of steel in one direction will not make up for a shortage in the other direction.

The critical section for bending is taken at the face of reinforced concrete columns or at a distance halfway from the edge of the base plate and the face of the column if structural steel columns are used (Code 15.4.2).

The determination of footing depths by the procedure described here will often require several cycles of a trial and error procedure. There are, however, many tables and handbooks available with which footing depths can be accurately estimated. One of these is the previously mentioned *CRSI Handbook*. In addition, there are many rules of thumb used by designers for making initial thickness estimates, such as 20% of the footing width or the column diameter plus 3 in. and so on.

The flexural steel percentage calculated for footings is very often less than $200/f_y$. The ACI Code (10.5.3), however, states that in slabs of uniform thickness the minimum area and maximum spacing of reinforcing bars in the direction of bending shall be as required for shrinkage and temperature reinforcement. Most designers feel that the combination of high shears and low ρ values that often occur in footings is not good practice and thus use $200/f_y$ as a minimum.

Example 10.2 illustrates the design of an isolated column footing.

EXAMPLE 10.2

Design a square column footing for a 16-in. square tied column that supports a dead load $D = 200^k$ and a live load $L = 160^k$. The column is reinforced with 8 #8 bars, the base of the footing is 5 ft below grade, and the soil weight is 100 #/ft³. $f_y = 40{,}000$ psi, $f_c' = 4{,}000$ psi, and $q_a = 5{,}000$ psf.

SOLUTION

Assume 22-in. footing ($d = 17.5$ in.)

$$q_e = 5{,}000 - \left(\tfrac{22}{12}\right)(150) - \left(\tfrac{48}{12}\right)(100) = 4408 \text{ psf}$$

$$A \text{ required} = \frac{360}{4.408} = 81.7 \text{ ft}^2$$

Use 9′0″ × 9′0″ footing = 81.0 ft²

Bearing pressure for strength design

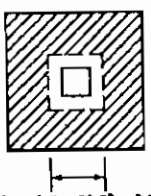
$$q_u = \frac{(1.4)(200) + (1.7)(160)}{81.0} = 6.81 \text{ ksf}$$

Depth required for two-way or punching shear (Figure 10.9)

$$b_o = (4)(33.5) = 134''$$

$$V_u = (81.0 - 2.79^2)(6.81) = 498.6^k$$

$$d = \frac{V_u}{\phi 4\sqrt{f_c'}\, b_o} = \frac{498{,}600}{(0.85)(4\sqrt{4{,}000})(134)} = 17.30 + 4.5 = 21.8'' < 22'' \quad \text{ok}$$



16 + 17.5 = 33.5″ = 2.79′

Figure 10.9

Depth required for one-way shear (Figure 10.10)

$$V_u = (9.00)(2.375)(6.81) = 145.6^k$$

$$d = \frac{V_u}{\phi 2\sqrt{f_c'}\, b} = \frac{145{,}600}{(0.85)(2\sqrt{4{,}000})(108)} = 12.54 + 4.5 = 17.04'' < 22'' \quad \text{ok}$$

use 22″ depth

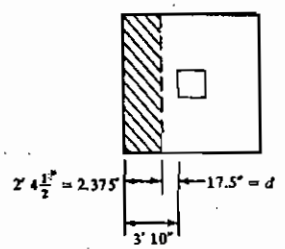


Figure 10.10

Steel area

$$M_u = (3.83)(9.00)(6.81)\left(\frac{3.83}{2}\right) = 449.5 \text{ ft-k}$$

$$\frac{M_u}{\phi b d^2} = \frac{(12)(449{,}500)}{(0.9)(108)(17.5)^2} = 181.2 \left(\rho < \frac{200}{f_y}\right)$$

Use $\rho = \dfrac{200}{40{,}000} = 0.005$

$$A_s = (0.005)(17.5)(108) = 9.45 \text{ in.}^2$$

use 10 #9 bars in both directions

Development length

required development $l_d = 25''$

actual development length furnished $= 46 - 3 = 43'' > 25''$ ok

10.7 LOAD TRANSFER FROM COLUMNS TO FOOTINGS

All forces acting at the base of a column must be satisfactorily transferred into the footing. Compressive forces can be transmitted directly by bearing, while uplift or tensile forces must be transferred by developed reinforcing.

A column transfers its load directly to the supporting footing over an area equal to the cross-sectional area of the column. The footing surrounding this contact area, however, supplies appreciable lateral support to the directly loaded part with the result that the loaded concrete in the footing can support more load. Thus for the same grade of concrete, the footing can carry more load than can the column.

At the base of the column, the permitted bearing strength is $\phi(0.85f_c'A_1)$ (where ϕ is 0.70), but it may be multiplied by $\sqrt{A_2/A_1} \leq 2$ for bearing

EXAMPLE 10.2

Design a square column footing for a 16-in. square tied column that supports a dead load $D = 200^k$ and a live load $L = 160^k$. The column is reinforced with 8 #8 bars, the base of the footing is 5 ft below grade, and the soil weight is 100 #/ft³. $f_y = 40{,}000$ psi, $f_c' = 4{,}000$ psi, and $q_a = 5{,}000$ psf.

SOLUTION

Assume 22-in. footing ($d = 17.5$ in.)

$$q_s = 5{,}000 - \left(\tfrac{22}{12}\right)(150) - \left(\tfrac{38}{12}\right)(100) = 4408 \text{ psf}$$

$$A \text{ required} = \frac{360}{4.408} = 81.7 \text{ ft}^2$$

Use 9′ 0″ × 9′ 0″ footing = 81.0 ft²

Bearing pressure for strength design

$$q_u = \frac{(1.4)(200) + (1.7)(160)}{81.0} = 6.81 \text{ ksf}$$

Depth required for two-way or punching shear (Figure 10.9)

$b_o = (4)(33.5) = 134''$

$V_u = (81.0 - 2.79^2)(6.81) = 498.6^k$

$$d = \frac{V_u}{\phi 4\sqrt{f_c'}\, b_o} = \frac{498{,}600}{(0.85)(4\sqrt{4{,}000})(134)} = 17.30 + 4.5 = 21.8'' < 22'' \quad \text{ok}$$

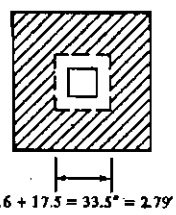


Figure 10.9

Depth required for one-way shear (Figure 10.10)

$V_u = (9.00)(2.375)(6.81) = 145.6^k$

$$d = \frac{V_u}{\phi 2\sqrt{f_c'}\, b} = \frac{145{,}600}{(0.85)(2\sqrt{4{,}000})(108)} = 12.54 + 4.5 = 17.04'' < 22'' \quad \text{ok}$$

use 22″ depth

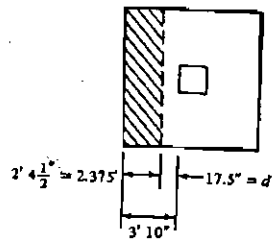


Figure 10.10

Steel area

$$M_u = (3.83)(9.00)(6.81)\left(\frac{3.83}{2}\right) = 449.5 \text{ ft-k}$$

$$\frac{M_u}{\phi b d^2} = \frac{(12)(449{,}500)}{(0.9)(108)(17.5)^2} = 181.2 \left(\rho < \frac{200}{f_y}\right)$$

Use $\rho = \dfrac{200}{40{,}000} = 0.005$

$A_s = (0.005)(17.5)(108) = 9.45 \text{ in.}^2$

use 10 #9 bars in both directions

Development length

required development $l_d = 25''$

actual development length furnished $= 46 - 3 = 43'' > 25''$ ok

10.7 LOAD TRANSFER FROM COLUMNS TO FOOTINGS

All forces acting at the base of a column must be satisfactorily transferred into the footing. Compressive forces can be transmitted directly by bearing, while uplift or tensile forces must be transferred by developed reinforcing.

A column transfers its load directly to the supporting footing over an area equal to the cross-sectional area of the column. The footing surrounding this contact area, however, supplies appreciable lateral support to the directly loaded part with the result that the loaded concrete in the footing can support more load. Thus for the same grade of concrete, the footing can carry more load than can the column.

At the base of the column, the permitted bearing strength is $\phi(0.85f_c'A_1)$ (where ϕ is 0.70), but it may be multiplied by $\sqrt{A_2/A_1} \leq 2$ for bearing

Table A.5 Minimum Beam Width (in.) According to the 1977 ACI Code[a,b]

Size of Bars	Number of Bars in Single Layer of Reinforcement							Add for Each Added Bar
	2	3	4	5	6	7	8	
#4	6.1	7.6	9.1	10.6	12.1	13.6	15.1	1.50
#5	6.3	7.9	9.6	11.2	12.8	14.4	16.1	1.63
#6	6.5	8.3	10.0	11.8	13.5	15.3	17.0	1.75
#7	6.7	8.6	10.5	12.4	14.2	16.1	18.0	1.88
#8	6.9	8.9	10.9	12.9	14.9	16.9	18.9	2.00
#9	7.3	9.5	11.8	14.0	16.3	18.6	20.8	2.26
#10	7.7	10.2	12.8	15.3	17.8	20.4	22.9	2.54
#11	8.0	10.8	13.7	16.5	19.3	22.1	24.9	2.82
#14	8.9	12.3	15.6	19.0	22.4	25.8	29.2	3.39
#18	10.5	15.0	19.5	24.0	28.6	33.1	37.6	4.51

Table shows minimum beam widths when stirrups are used.
For additional bars, add dimension in last column for each added bar.
For bars of different size, determine from table the beam width for smaller size bars and then add last column figure for each larger bar used.
[a] Assumes maximum aggregate size does not exceed three-fourths of the clear space between bars.
[b] Values given for smaller bars include minimum bend radius for stirrups.

Table A.6 Areas of Bars in Slabs (in.^{2}/ft)

Spacing, in.	Bar No.								
	3	4	5	6	7	8	9	10	11
3	0.44	0.78	1.23	1.77	2.40	3.14	4.00	5.06	6.25
3½	0.38	0.67	1.05	1.51	2.06	2.69	3.43	4.34	5.36
4	0.33	0.59	0.92	1.32	1.80	2.36	3.00	3.80	4.68
4½	0.29	0.52	0.82	1.18	1.60	2.09	2.67	3.37	4.17
5	0.26	0.47	0.74	1.06	1.44	1.88	2.40	3.04	3.75
5½	0.24	0.43	0.67	0.96	1.31	1.71	2.18	2.76	3.41
6	0.22	0.39	0.61	0.88	1.20	1.57	2.00	2.53	3.12
6½	0.20	0.36	0.57	0.82	1.11	1.45	1.85	2.34	2.89
7	0.19	0.34	0.53	0.76	1.03	1.35	1.71	2.17	2.68
7½	0.18	0.31	0.49	0.71	0.96	1.26	1.60	2.02	2.50
8	0.17	0.29	0.46	0.66	0.90	1.18	1.50	1.89	2.34
9	0.15	0.26	0.41	0.59	0.80	1.05	1.33	1.69	2.08
10	0.13	0.24	0.37	0.53	0.72	0.94	1.20	1.52	1.87
12	0.11	0.20	0.31	0.44	0.60	0.78	1.00	1.27	1.56

Table A.7 Design of Rectangular Beams and Slabs

n and f_c'	f_s	f_c	k	j	ρ_s	K
10 (2,500)	18,000	1,000	0.357	0.881	0.0099	157
		1,125	0.385	0.872	0.0120	189
	20,000	1,000	0.333	0.889	0.0083	148
		1,125	0.360	0.880	0.0101	178
	24,000	1,000	0.294	0.902	0.0061	133
		1,125	0.319	0.894	0.0075	160
9 (3,000)	18,000	1,200	0.375	0.875	0.0125	197
		1,350	0.403	0.866	0.0151	235
	20,000	1,200	0.351	0.883	0.0105	186
		1,350	0.377	0.874	0.0128	223
	24,000	1,200	0.310	0.897	0.0078	167
		1,350	0.336	0.888	0.0095	201
8 (4,000)	18,000	1,600	0.416	0.861	0.0185	286
		1,800	0.444	0.852	0.0222	341
	20,000	1,600	0.390	0.870	0.0156	272
		1,800	0.419	0.860	0.0188	324
	24,000	1,600	0.345	0.884	0.0116	246
		1,800	0.375	0.875	0.0141	295
7 (5,000)	18,000	2,000	0.438	0.854	0.0243	374
		2,250	0.467	0.844	0.0292	443
	20,000	2,000	0.412	0.863	0.0206	355
		2,250	0.441	0.853	0.0248	423
	24,000	2,000	0.368	0.877	0.0154	323
		2,250	0.396	0.868	0.0186	387

Note: ρ_s = required percentage of steel.

Table A.8 Balanced Ratio of Reinforcement ρ_b for Rectangular Sections with Tension Reinforcement Only

f_y \ f_c'		2,500 psi (17.2 MPa) $\beta_1 = 0.85$	3,000 psi (20.7 MPa) $\beta_1 = 0.85$	4,000 psi (27.6 MPa) $\beta_1 = 0.85$	5,000 psi (34.5 MPa) $\beta_1 = 0.80$	6,000 psi (41.4 MPa) $\beta_1 = 0.75$
Grade 40	ρ_b	0.0309	0.0371	0.0495	0.0582	0.0655
40,000 psi	$0.75\rho_b$	0.0232	0.0278	0.0371	0.0437	0.0492
(275.8 MPa)	$0.50\rho_b$	0.0155	0.0186	0.0247	0.0291	0.0328
Grade 50	ρ_b	0.0229	0.0275	0.0367	0.0432	0.0486
50,000 psi	$0.75\rho_b$	0.0172	0.0206	0.0275	0.0324	0.0365
(344.8 MPa)	$0.50\rho_b$	0.0115	0.0138	0.0184	0.0216	0.0243
Grade 60	ρ_b	0.0178	0.0214	0.0285	0.0335	0.0377
60,000 psi	$0.75\rho_b$	0.0134	0.0161	0.0214	0.0252	0.0283
(413.7 MPa)	$0.50\rho_b$	0.0089	0.0107	0.0143	0.0168	0.0189
Grade 75	ρ_b	0.0129	0.0155	0.0207	0.0243	0.0274
75,000 psi	$0.75\rho_b$	0.0097	0.0116	0.0155	0.0182	0.0205
(517.1 MPa)	$0.50\rho_b$	0.0065	0.0078	0.0104	0.0122	0.0137

K_t torsional stiffness of member; torsional moment per unit rotation about longitudinal axis of member (Sec. 16.20; Chaps. 17 and 19)

K_{ti} stiffness of rotational spring at end i of member ij, causing slip angle ψ_i (Chap. 17)

K_{tj} stiffness of rotational spring at end j of member ij, causing slip angle ψ_j (Chap. 17)

L_1 span measured in the direction of the equivalent frame for two-way systems, measured center-to-center of supports (Chap. 16)

L_2 span transverse to L_1, measured center-to-center of supports (Chap. 16)

L_e length of straight embedment provided beyond inflection point or beyond center of support at simple supports (cannot be taken greater than the larger of d or $12d_b$ for ACI-12.2.3)

L_d development length for a straight bar; distance bar must be embedded to develop its nominal tensile strength

L_{db} basic development length for a straight bar (before any modifications for favorable or unfavorable factors)

L_{dh} development length of standard hooked bar in tension (Fig. 6.11.2), measured from critical section to outside end of hook (straight embedment length between critical section and start of hook [point of tangency] plus radius of bend and one bar diameter) = L_{hb} times applicable modification factors

L_{hb} basic development length of a standard hooked bar in tension; basic value of L_{dh} defined by Fig. 6.11.2

L_n clear span

L_u unsupported length of a compression member (Sec. 13.7; Chap. 15)

m ratio of the volume of longitudinal bars to volume of closed hoops, $A_t s/[2A_c\,(x_1 + y_1)]$ (Sec. 19.6)

$f_y/(0.85f'_c)$, stress ratio

number of tension bars; for several sizes, $m = A_s/A_b$ for largest bar) (Sec. 4.12)

M_{1b} smaller of primary moments at ends of member in a *braced* frame

M_{1s} smaller of primary moments at ends of member in an *unbraced* frame

M_{2b} larger of primary moments at ends of member in a *braced* frame

M_{2s} larger of primary moments at ends of member in an *unbraced* frame

M_b portion transferred by flexure out of the total moment M to be transferred between column and slab at a joint (Sec. 16.18)

M_c $\delta_b M_{2b} + \delta_s M_{2s}$, magnified factored moment to use in design of compression member (Chap. 15)

M_{cr} cracking moment, $f_r I_g / y_t$

M_D dead load moment (Chaps. 14 and 21)

M_{D+L} dead load plus live load moment (Chap. 14)

M_{equiv} $C_m M_{max}$, equivalent primary uniform moment along a braced member (Chap. 15)

M_i primary bending moment (function of z) (Chap. 15)

M_m maximum primary bending moment

M_{max} maximum service moment for condition under which deflection is computed

M_n nominal moment strength

M_{n0} nominal moment strength when member is subject to flexure alone (Chap. 19)

M_{nb} nominal moment strength per unit distance along a yield line (Chap. 18)

M_{nc} nominal moment strength for beam having no compression steel, $C_c(d - a/2)$

M_{nec} $w_{nec}L^2/8$; $M_D - M_{prestress}$ (Chap. 21)

M_{ns} nominal moment strength added by compression steel, $C_s(d - d')$

M_{nx} nominal moment strength about the x axis, $P_n e_y$ (Sec. 13.21)

M_{ny} nominal moment strength about the y axis, $P_n e_x$ (Sec. 13.21)

M_o moment at midspan on a simply supported beam

nominal moment strength M_n for member subject to flexure alone (Chap. 13)

full statical moment on a two-way slab system (Sec. 16.3)

M_{oi} fixed end moment at end i of a flexural member ij (Sec. 16.10 and Chap. 17)

M'_{oi} sum of M_{oi} and moment necessary to cancel unwanted slope, $[(1 + F_{ij}S_{ji})M_{oi} - (F_{ij}S_{ji})M_{oj}]/T_s$

M_{oj} fixed end moment at end j of a flexural member ij (Sec. 16.10 and Chap. 17)

M'_{oj} sum of M_{oj} and moment necessary to cancel unwanted slope, $[(1 + F_{ji}S_{ij})M_{oj} - (F_{ji}S_{ij})M_{oi}]/T_s$ (Sec. 17.4)

M_{ox} nominal moment strength for bending about the x axis when axial compression is zero (Sec. 13.21)

M_{oy} nominal moment strength for bending about the y axis when axial compression is zero (Sec. 13.21)

M_+ net positive midspan moment

Reinforced Concrete Design

Fourth Edition

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1817

slab) of the T in tension, and also with the bottom (the stem of width b_w) of the T in tension. Such an analysis will show that with the *slab in compression*, Eq. (3.7.7) using $\rho = \rho_w = A_s/b_w d$ will give

$$\min \rho \geq \frac{(150 \text{ to } 250)^*}{f_y} \tag{3.7.9}$$

For the *slab in tension* on the T-section,

$$\min \rho \geq \frac{(300 \text{ to } 600)^\dagger}{f_y} \tag{3.7.10}$$

Thus, ACI-10.5.1 is a reasonable requirement for isolated rectangular beams and the usual positive moment orientation for T-sections. It is unconservative for T-sections with the slab in tension. The authors believe that minimum reinforcement should be used in both positive and negative moment regions, and particularly on cantilevers.

Note that ACI-10.5.2 permits a waiver of Eq. (3.7.8) whenever ϕM_n equals or exceeds $1.33 M_u$. The philosophy is that extra safety is a satisfactory substitute for having a ductile failure mode.

3.8 DESIGN OF RECTANGULAR SECTIONS IN BENDING WITH TENSION REINFORCEMENT ONLY

In the design of rectangular sections in bending with tension reinforcement only, the problem is to determine b, d, and A_s from the required value of $M_n = M_u/\phi$, and the given material properties f'_c and f_y.

The two conditions of equilibrium are

$$C = T \tag{3.8.1a}$$

and

$$M_n = (\text{C or } T)\left(d - \frac{a}{2}\right) \tag{3.8.1b}$$

Since there are three unknowns but only two conditions, there are many possible solutions. If the reinforcement ratio ρ is preset, then from Eq. (3.8.1a)

$$0.85 f'_c ba = \rho b d f_y$$

$$a = \rho\left(\frac{f_y}{0.85 f'_c}\right)d \tag{3.8.2}$$

Substituting Eq. (3.8.2) into Eq. (3.8.1b),

$$M_n = \rho b d f_y\left[d - \frac{\rho}{2}\left(\frac{f_y}{0.85 f'_c}\right)d\right] \tag{3.8.3}$$

*195 for flange width equal to four times web width and flange thickness equal to 20% of total

A strength *coefficient of resistance* R_n may be obtained by dividing Eq. (3.8.3) by bd^2 and letting

$$m = \frac{f_y}{0.85 f'_c} \tag{3.8.4a}$$

Thus

$$R_n = \frac{M_n}{bd^2} = \rho f_y(1 - \tfrac{1}{2}\rho m) \tag{3.8.4b}$$

The relationship between ρ and R_n for various values of f'_c and f_y is shown in Fig. 3.8.1.

In some situations the values of b and d may be preset, which is equivalent to having R_n preset; then ρ may be determined by solving the quadratic equation (3.8.4). Thus

$$R_n = \rho f_y(1 - \tfrac{1}{2}\rho m)$$

from which

$$\rho = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2mR_n}{f_y}}\right) \tag{3.8.5}$$

The procedure (without being concerned with certain practical decisions) to be used in the strength design of rectangular sections with tension reinforcement only involves the following steps:

1. Assume a value of ρ equal to or less than $0.75\rho_b$, but greater than the minimum ρ of $200/f_y$ (ACI-10.5). The balanced value ρ_b may be obtained from basic principles or from Eq. (3.5.4),

$$\rho_b = \frac{0.85\beta_1 f'_c}{f_y}\left(\frac{87{,}000}{87{,}000 + f_y}\right)$$

and

for $f'_c \leq 4000$ psi $\quad \beta_1 = 0.85$

for $f'_c > 4000$ psi $\quad \beta_1 = 0.85 - 0.05\left(\dfrac{f'_c - 4000}{1000}\right) \geq 0.65$

2. Determine the required bd^2 from

$$\text{required } bd^2 = \frac{\text{required } M_n}{R_n}$$

in which

$$R_n = \rho f_y(1 - \tfrac{1}{2}\rho m)$$

with

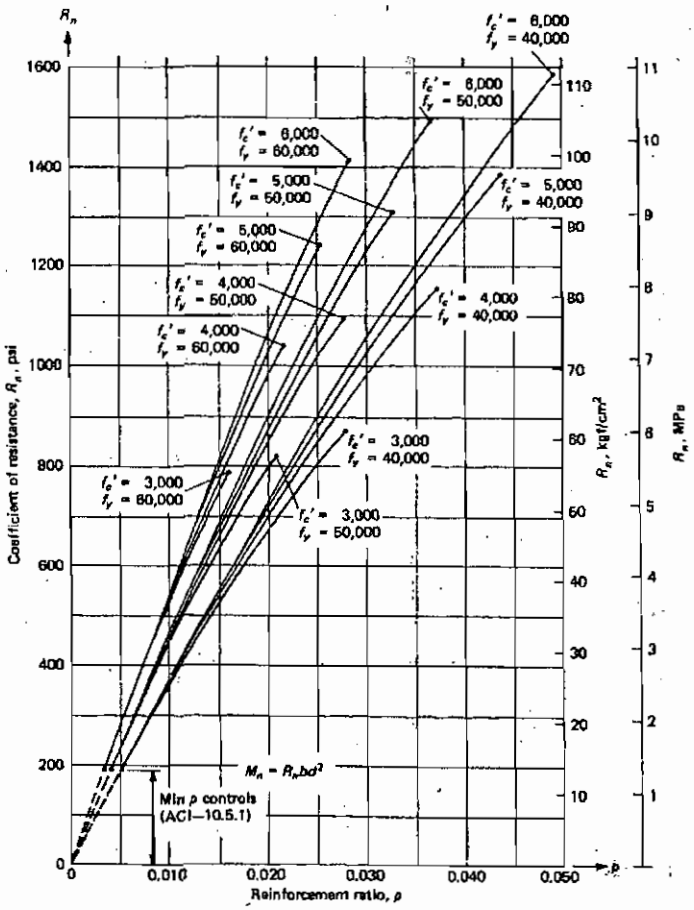

Figure 3.8.1 Strength curves (R_n vs ρ) for singly reinforced rectangular sections. Upper limit of curves is at $0.75\rho_b$.

3. Choose a suitable set of values of b and d so that the provided bd^2 is approximately equal to the required bd^2. (Note: Actually d is not chosen, rather the overall depth h is chosen and d is computed from h while maintaining the desired minimum protective cover.)

a. By formula (most exact),

$$\rho = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2mR_n}{f_y}}\right)$$

b. By curves (Fig. 3.8.1)

c. By approximate proportion (on the safe side if revised R_n is smaller than original R_n), the revised ρ is

$$\rho \approx (\text{original } \rho)\frac{(\text{revised } R_n)}{(\text{original } R_n)}$$

It may be noted from Fig. 3.8.1 that the relationship between R and ρ is approximately linear over short distances, even though the actual equation is a quadratic one.

5. Compute A_s from

$$A_s = (\text{revised } \rho)(\text{actual } bd)$$

6. Select reinforcement and check the strength of the section to be certain that

$$\phi M_n \geq M_u \qquad \text{or} \qquad M_n \geq \frac{M_u}{\phi}$$

EXAMPLE 3.8.1 Determine a set of values of b, d, and A_s that will carry a factored bending moment M_u of 400 ft-kips. Use $f_c' = 4000$ psi and $f_y = 40{,}000$ psi.

Solution: (a) Establish the limits within which the reinforcement ratio ρ can be chosen. From Eq. (3.5.4),

$$\rho_b = \frac{0.85\beta_1 f_c'}{f_y}\left(\frac{87{,}000}{87{,}000 + f_y}\right) = \frac{0.85(0.85)(4)}{40}\left(\frac{87}{87 + 40}\right) = 0.0495$$

$$\max \rho = 0.75\,\rho_b = 0.0371$$

From ACI-10.5.1,

$$\min \rho = \frac{200}{f_y} = \frac{200}{40{,}000} = 0.005$$

(b) Choose reinforcement ratio ρ, determine corresponding required beam size, and select actual beam size. Arbitrarily assume that $\rho = 0.0$ (any choice within prescribed limits is acceptable here),

$$m = \frac{f_y}{0.85f_c'} = \frac{40}{0.85(4)} = 11.76$$

$$R_n = \rho f_y(1 - \tfrac{1}{2}\rho m) = 0.03(40{,}000)[1 - \tfrac{1}{2}(0.03)(11.76)] = 988 \text{ psi}$$

$$\text{required } M_n = \frac{M_u}{\phi} = \frac{400}{0.90} = 444 \text{ ft-kips}$$

$$\text{required } M_n = 444(12{,}000)$$

MODULE III

OPERATING CONDITIONS

MODULE III - OPERATING CONDITIONS

III.A. GENERAL DESCRIPTION OF OPEN BURNING (OB)

Rocket motor propellants and igniters treated at the OB area are thermally treated within the rocket motor or igniter casing, which serves as a containment device. The existing area consists of three OB sub-units and a burn pad used to thermally treat various rocket motor propellants and igniters in order to render them non-reactive. The rocket motor with igniter is placed inside a steel subunit. The subunit acts as a secondary containment device and is made from a larger rocket motor casing.

Motors with diameters larger than the steel subunits are burned on the open burning pad assembly. Motors are inverted and attached to the motor head assembly fixture in the center of the pad. Four cable tie downs are attached to the motor for lateral stability. The propellants and igniters are reactive, but are not likely to detonate during treatment due to their inherent design.

Occasionally, propellant is burned which is not in a rocket motor casing. Rocket motor propellants are modified or downloaded periodically at Building M-15, Rocket Motor Storage Building, to meet specific project needs. When this occurs, the propellant trimmings are placed in a non-static cloth bag inside an approved container, labeled as Hazardous Waste, and placed in the Satellite Accumulation Area. Accumulated waste propellant will be burned at the OB area during the next scheduled rocket motor burn event or when stored quantities approach 208 liters (55 gallons). Hazardous waste is manifested prior to transportation from the Main Base to the OB area. When this material is ready for burning, the propellant is placed in the burn pan on the burn pad and ignited with a fabricated squib (igniter). The material usually burns completely leaving no residue. Ejected material and residue are also burned in this manner.

III.B. STANDARD OPERATING PROCEDURES

Standard operating procedures for treatment of rocket motors were developed and approved by the Branch Head of the Carrier Systems Branch and Range Safety Office for each type of rocket motor and igniter. These procedures are included in Exhibit II.CC-1 in Attachment II.CC - Inspection Schedule.

Only certified rocket motor operators and technicians (see Section II.EE - Personnel Training) are to perform the open burning preparation and operation activities.

OB operations will not be conducted in adverse conditions. Weather conditions will be closely monitored so that OB operations are not disrupted by adverse weather. Adverse conditions include, but are not limited to, cold weather, precipitation, electrical storms, flooding, and high winds. Additional considerations that prohibit OB operations include rocket launches and other range activities.

After initiation of the igniter, open burning completely treats the propellant within the rocket motor casing. A minimum 1-hour cooling time is allowed to pass prior to inspection of the OB area.

The rocket motor casing is removed from the open burning area and is taken to the NASA scrap yard on the Main Base located near the main gate. The completed work instructions and inspection checklists are kept in the OB files in Building X-55.

III.C. ROCKET MOTORS AND IGNITERS

The general chemical composition of typical propellants and igniters that are thermally treated at the OB area is given in Table III-1. Each type of rocket motor and igniter varies in the type and quantity of reactive constituents. The percent composition of the chemicals is proprietary/classified information and, therefore, not provided in most cases by the manufacturer.

Typical rocket motors and igniters thermally treated at this facility and the amount of propellant in each rocket motor are summarized in Table III-2.

Safe disposal of motors and igniters, which are determined to be a solid waste and classified as a hazardous waste requires thermal treatment. Treatment at the OB area will be based on published data and inspection information for the motors and igniters. General information and Material Safety Data Sheets (MSDS) for propellants and igniters is available in the General Services Building X-55 on Wallops Island. This data is sufficient to determine the chemical suitability of the material for OB. This information will be reviewed prior to treatment; if there is a question as to the suitability of a particular motor or igniter for OB, additional data will be gathered to resolve the issue. The rocket motor or igniter will be visually inspected prior to treatment to ensure that it can be safely and effectively treated.

Based on the information in Table III-1, the waste accepted for thermal treatment will be considered hazardous prior to treatment because of its reactivity characteristic; Hazardous Waste Code D003. The rocket motors and igniters are considered hazardous waste because they meet the characteristic of reactivity. Rocket motors treated at the OB area are reactive because they are Class 1.1 (previously called Class A explosives) through 1.3 explosives (previously called

Class B explosives). Hazard characteristics analyses will not be performed at this point to avoid the dangers associated with the handling of reactants

Rocket motors are designed for complete combustion of all products. Typically, after OB treatment is complete, no materials remain in the motor or are expelled from the motor. A Post Burn inspection is conducted; refer to Attachment II.CC Inspection Schedule and Exhibit II.CC-2 Post Burn Inspection Log. The OB area will be visually examined after each use to verify that no materials were ejected. If materials are expelled they will be collected for further OB treatment. Rocket motor casings and igniters will be inspected for visible signs of untreated material. The primary constituents of the residue (if present) after thermal treatment will be trace amounts of reactant material and, in some cases, propellant sealant. The residue will be removed and re-ignited on the burn pad. The process will be repeated until thermal treatment is complete. Any unburnable material is to be containerized, sampled for characterization, if necessary, in accordance with 40 CFR 261 and the OB Area Waste Analysis plan, and disposed of through WFF's hazardous waste disposal contractor. The container will be stored at Building U-81, less-than-90-day-accumulation area for less than 90 days. The rocket motor casings and igniters, after treatment and removal of any residue, are classified as RCRA "empty" and will be labeled "excess" and sold as scrap metal.

III.D. PROPELLANT TREATMENT RATE

The maximum amount of propellant to be treated of per year is 68 metric tons (75 tons).

III.E. WASTE GENERATED OFFSITE

Rocket motor propellants and igniters designated for thermal treatment may originate from storage buildings on the WFF Main Base or Wallops Island. Manifests and shipping documents will be inspected and reviewed to ensure that the materials received match the identity of the waste designated for thermal treatment. Rocket motor propellants and igniters are delivered directly to the OB area for burning. They are delivered to the OB area when scheduled for open burning. Rocket motor propellants and igniters are not stored at the OB area.

III.F. CONTROL OF EJECTED WASTE DURING BURNING

Rocket motors are designed for complete combustion of all products. Typically, after OB treatment is complete, no material remains in the motor or has been expelled from the motor. The casing remains intact. The chemical compounds are designed and blended in the correct proportions to react stoichiometrically, resulting in complete combustion of the reactants.

On occasion, thermal treatment of rocket motors may create less than 0.45 kilograms (1 pound) of residual material during burning. The residual material is

typically the result of the incomplete burning of the acetate liner that separates the propellant from the casing.

A small portion of residue or propellant may be ejected during treatment, but this does not typically occur. The OB area will be visually examined after each use to verify that no materials were ejected. If materials are expelled, they are to be collected for further OB treatment. Refer to Attachment II.CC Inspection Schedule and Exhibit II.CC-2 Post Burn Inspection Log regarding Post Burn inspections.

Ejected material is collected and burned on the pad. When conditions prevent immediate burning, ejected material would be stored in non-conductive containers at Building U-81 until the next OB event or for less than 90 days whichever, occurs sooner. During storage, the residue is to be characterized.

Igniters, like rocket motors, are designed for complete combustion with no materials remaining after treatment. If residue is produced, it is typically less than 10 grams (0.4 ounces). Residue is collected, characterized, and reignited or disposed of off site in less than 90 days.

III.G. DETERIORATION OR MALFUNCTION PROCEDURES

The requirements of 40 CFR 264.15(c) require the owner/operator to "remedy any deterioration or malfunction of equipment or structures which the inspection reveals to ensure that the problem does not lead to an environmental or human health hazard." All facility or equipment deteriorations or malfunctions found during inspection will be corrected before OB continues. In the event of an accidental release or emergency situation, specific response procedures are included in the Attachment II.FF - Contingency Plan. These response procedures are based on guidance from the NPR 8715.2 NASA Emergency Preparedness Plan Procedures and Guidelines, NPR 8715.3 NASA Safety Manual w/Changes through Change 1, 6/19/02, RSM 2002 Range Safety Manual and WSM 2002 Wallops Safety Manual.

III.H. PREVENTION OF ACCUMULATED PRECIPITATION

The accumulation of precipitation within the containment devices is prevented at the OB area. The rocket motors that house the propellant and/or igniter to be burned, serve as their own containment device. The motors and igniters will not be transported to the OB area for treatment unless weather conditions are favorable. After treatment, the rocket motor casings are inspected for unburned reactants, reignited if necessary, cleaned of any remaining residue, removed from the site and recycled as scrap metal. Approximately 0.45 kilograms (1 pound) of residue may be generated after each motor treatment and less than 10 grams (0.35 ounces) of residue after each igniter treatment.

The bottom of each subunit is capped and sealed to prevent percolation of precipitation into the groundwater. The subunits are also provided with stainless steel precipitation covers. These covers offer additional protection against potential rainfall accumulation. Each cover is equipped with handles to allow personnel to easily move the cover on and off the subunit. The covers fit tightly and remain on the subunits during non-operational periods.

The burn pad is flat and above grade. A cover and berm prevent run-on and runoff from occurring. The pad will remain covered when not in use. This will prevent precipitation from accumulating on the pad. The soil around the pad is graded to prevent run-on.

III.I. RESIDUE AND SOIL MANAGEMENT

Management of the residue is performed to prevent environmental contamination through the air, soil, subsurface, and surface water pathways. Residue is potentially generated at two locations in and around the OB subunits: within the device (motor), as a result of the thermal treatment process; and surrounding the subunits or burn pad in the event material is ejected. Following a burn, a Post Burn inspection is performed; refer to Attachment II.CC Inspection Schedule and Exhibit II.CC-2 Post Burn Inspection Log. The casing and surrounding soil are to be inspected and any residue collected. Collected soil and residue are placed in separate containers. The residue is placed on the burn pad for reigniting to help ensure that all materials have reacted. A squib (igniter) is fabricated and used to ignite the material. After reigniting the residue, any material remaining is placed in the soil container.

Containerized material (soil and residue) is characterized to determine waste characteristics in accordance with the OB Waste Analysis Plan, Attachment II.BB, and disposed of at an appropriate solid waste or hazardous waste management facility. Residue found or known to exhibit a hazardous waste characteristic is packaged, labeled, and disposed of as a RCRA hazardous waste.

Analytical results are kept in the Open Burning area files, Building X-55, for a minimum of three years following disposal at a RCRA-permitted hazardous waste facility. The residue is temporarily held onsite at Building U-81 for less than 90 days. The rocket motor casings and igniters, after treatment and removal of any residue, are classified as RCRA "empty" and will be sold as scrap metal.

III.J. FIRE HAZARD MINIMIZATION

Ejection of burning materials during treatment could result in the deposition of hot embers on the ground adjacent to the containment device. This fire hazard is minimized at the OB area since it is located in sparse vegetated sandy soil surrounded almost entirely by water or marsh. In addition, the WFF fire department will be onsite during OB operations. Procedures and equipment will

be immediately available for fire protection during treatment operations, as discussed in Attachment II.FF - Contingency Plan.

III.K. MINIMUM PROTECTIVE DISTANCES

The minimum safety distance for open burning is applied for Wallops Island operations. The largest motor, which could be treated at the OB area is an Aries with a propellant weight of 4,704 kilograms (10,370 pounds). The minimum distance to the property of others must be 690 meters (2,260 feet) based on the quantity of propellant treated at Wallops Island.

As shown on Figure II.AA-4, although the minimum protective distance is outside of the property boundaries, it is uninhabited. The WFF Security Office controls access to Wallops Island. During an operation, access is restricted to personnel involved in operations only. The U.S. Coast Guard and the U.S. Navy control the navigable waters surrounding Wallops Island. Refer to Figure II.AA-4 for Island map and boundaries.

III.L. REQUIREMENTS FOR IGNITABLE, REACTIVE, OR INCOMPATIBLE WASTES

The waste propellants and igniters to be treated by OB are of similar composition and are compatible. The residue remaining after OB will be considered reactive until poven otherwise. The requirements for handling this material are stated in Attachment II.DD – Security Provisions and Procedures to Prevent Hazards.

III.M WASTE MINIMIZATION PLAN

Waste will be minimized at the OB area through the extensive process of determining other uses for each rocket motor. Rocket motors, which do not meet contractor performance standards, may be used on missions where minor flight performance is not an issue.

Rocket motors also may be used by NASA on university, on student, or other missions. Rocket motors may be tested to determine the extent of deviation from performance standards. Other users will also be found for rocket motors. In addition, many times rocket motors manufactured by commercial manufacturers can be returned.

III.N. OPEN BURNING OF PEP-CONTAMINATED SOLVENTS

No solvents of any kind are to be burned at the WFF OB unit.

TABLE III-1 ROCKET PROPELLANT AND IGNITERS

Name	Chemical Formula	Hazardous Waste ID Number
Nitrocellulose	$C_{12}H_{16}(ONO_2)_4O_6$	D003
Nitroglycerin	$C_3H_5N_3O_9$	D003
Nitroguanidine	$CH_4N_4O_2$	D003
Ammonium Perchlorate	NH_4ClO_4	D003
(PPG) Polypropylene glycol	$HO(C_3H_6O)_nH$	Unlisted
(TEA) Triethanol amine	$(HOCH_2CH_2)_3N$	Unlisted
Poly 1,4-butylene glycol	$HOCH_2CH_2CH_2CH_2OH$	Unlisted
(TDI) Toluene di isocyanate	$CH_3C_6H_3(NCO)_2$	Unlisted
Carbon Black	C	Unlisted
(FeAA) Iron acetylacetate	$C_{15}H_{21}O_6Fe$	Unlisted
Sulfur	S	Unlisted
(DOZ) Dioctyl azelate	$(CH_2)_7[COOCH_2CH(C_2H_5)C_4H_9]_2$	Unlisted
(NDPA) n-phenyl-beta-napthylamine	$C_{10}H_7NHC_6H_5$	Unlisted
(PS) Polysulfide	$[-CH_2S_2S_2-]_n$	Unlisted
(MAPO) tris 1-(2-methyl) aziridinyl phosphine oxide	$C_9H_{18}N_3OP$	Unlisted
(Parabar 441) 2,6-di-tert-butyl-p-cresol	$[C(CH_3)_3]_2CH_3C_6H_2OH$	Unlisted
(TA) Triacetin	$C_3H_5(OCOCH_3)_3$	Unlisted
(2-NDPA) 2-nitrodiphenyl amine	$C_6H_5NHC_6H_4NO_2$	Unlisted
(DPA) di-n-propyl adipate	$(C_6H_5)_2NH$	Unlisted
Pb (lead) salicylate	$Pb(OOCC_6H_4OH)_2.H_2O$	Unlisted
Candelilla wax (main constituent)	$C_{13}H_{64}$	Unlisted
Monobasic copper salicylate	$Cu(OOCC_6H_4ON)_2.H_2O$	Unlisted
(PU) Polyurethane	$R_1NHCOOR_2$	Unlisted
Aluminum Al	$C_8H_8O_8N_8$	D003
(HMX) "Her majesty's explosive", cyclotetra-methylenetetranitramine		D003
Resorcinol	$C_6H_4(OH)_2$	Unlisted
(PVC) Polyvinylchloride	$(-H_2CCHCl-)_x$	Unlisted
(DOA) Dioctyladipate	$[CH_2CH_2COOH_2CH(C_2H_5)C_4H_9]_2$	Unlisted
(DEP) Diethyl phthalate	$C_6H_4(CO_2C_2H_5)_2$	Unlisted
(DMP) Dimethylaminomethyl-substituted phenols	$C_6H_4OHCH_2N(CH_3)_2$	Unlisted
Graphite	C	Unlisted
Magnesium oxide	MgO	Unlisted
Nylon	$(C_6H_{11}NO)_N$	Unlisted
Zirconium carbide	ZrC	Unlisted

TABLE III-1 ROCKET PROPELLANT AND IGNITERS (continued)

Name	Chemical Formula	Hazardous Waste ID Number
(HX-752) Propylene imine product of isophalic acid	$CH_2HCNHCH_2$	Unlisted
(Flexzone/DTBH) Phenylene diamine/ hydroquinone	$C_6H_4(NH_2)_2$	Unlisted
Phosphorus	P	Unlisted
(PBCT) Polybutadiene carboxy terminated	$(C_4H_6)_{100}\,C_2H_2O_4$	Unlisted
Pb (lead) 2-ethyl hexoate	$PbC_5H_{11}COOC_2H_4$	Unlisted
Ferric (iron) oxide	Fe_2O_3	Unlisted
Copper chromate	$CuCrO_4 \cdot 2CuO \cdot 2H_2O$	Unlisted
Potassium perchlorate	$KClO_4$	D003
(DOS) Dioctylsebacate	$(C_4H_8COOC_8H_{17})_2$	Unlisted
Octylene oxide	Mixed $CH_3(CH_2)_5CHCH_2O$ & $CH_3(CH_2)_4CHCH(CH_3)O$	Unlisted
(ERL 2795) Epoxy resin	$-OCH_2CHOCH_2$	Unlisted
Chromium 2-ethyl hexoate	$CrC_5H_{11}COOC_2H_4$	Unlisted
Lecithin	$C_8H_{17}O_5NRR'$	Unlisted
Substituted Ferrocene	$(C_5H_5)_2\,Fe$	Unlisted
(LBR) Lead beta-resorcylate	$C_{14}H_{10}O_8Pb$	Unlisted
(PBAA) Polybutadiene acrylic acid	$C_{70}H_{104}O_4$*	Unlisted
Circo Oil	$C_{15}H_{32}$	Unlisted
(PMAPO) bis 1-(2 methyl) aziridinyl phosphine oxide	$C_{12}H_{17}N_2OP$	Unlisted
(PBHT) Polybutadiene hydroxy terminated	$C_{73}H_{110}O_6$*	Unlisted
(DDI) Desmodour diiocyanate	$C_{38}H_{72}N_2O_2$	Unlisted
Hycar 1300 Synthetic elastomers	$C_{70}H_{100}N_{3.5}O_{1.5}$*	Unlisted
Polyester resin	$(C_7H_{12}O_2)_x$	Unlisted
Cobalt Octoate	$C_4H_9CH(C_2H_5)COOH$	Unlisted
Cumene Hydrogen Peroxide	$C_6H_5C(CH_3)_2OOH$	Unlisted
Copper Oxide	Cu_2O	Unlisted
Zinc Stearate	$Zn(C_{18}H_{35}O_2)_2$	Unlisted

* - Formula approximations for polymers

TABLE III-2 - ROCKET MOTORS TO BE THERMALLY TREATED

Motor	Propellant (lbs.)	Length (in.)	Diameter (in.)
2.75" FFAR	5.9	48.0	2.75
Aries	10,370	158	143
Antares X259 IIA	2,834	113	30.5
Apache	131	107.5	7
Arcas	40.12	26	4.25
Black Brant III	447	147	10.2
Black Brant VC	2,198	210	17.2
Black Brant V	2,198	223	17.2
Cajun	118.5	107.7	7
Castor	8,202.3	243.6	31.0
Honest John	2,050	197.4	23
HYDAC	415.7	144	9
Javelin III	258	104	9
Lance	2,800	20.5	1.8
M37A1 Spin Rocket	2	13.5	3.75
M57A1	3,665.2	85.25	38
Malemute	1,115	114	17.25
Mk 70 Terrier	same as Terrier	157	18
Nihka	756	76	17.2
Nike	750	145.2	16.5
Orion	604	105.5	14.0
Sargeant	5,900	414	70
Sidewinder	60	75.5	5
Signal Flare	<1	1.875	1.25
25" Spherical Motor	5	25.0	25.0
Star 6B	13.45	17	6.5
Super Arcas	40	76	4.5
Super Loki	38	78.1	4
Talos	2,803	134.5	30.875
Taurus	1,663	166.125	23
Terrier	1,202	157	18
Tomahawk	387	142	9
Ute I	550	77	16.5
VAM-20	260	74.5	12
Viper	148.8	107	6.5
Zap	33.5	176.5	5
Zuni	50	176.5	5

Shaded rocket motors are not currently in inventory.

MODULE IV

SITE-WIDE CORRECTIVE ACTION

MODULE IV

SITE-WIDE CORRECTIVE ACTION

The United States Environmental Protection Agency (US EPA) and NASA WFF entered into an Administrative Agreement on Consent under RCRA §7003 (Docket No: RCRA-03-2004-0201TH). This Agreement was signed in September 2004 and directs NASA to conduct the on-going remedial investigation activities in accordance with the requirements of CERCLA (42 USC§9601-9675) under the authority of RCRA §7003 to fulfill the requirements of 40 CFR 264.101.

The Agreement is included as Exhibit IV-1.

EXHIBIT IV-1

ADMINISTRATIVE AGREEMENT ON CONSENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

RECEIVED

JUN 08 2005

DEQ
OFFICE OF REMEDIATION PROGRAM

September 27, 2004

Dr. Edward J. Weiler, Director
National Aeronautics and Space Administration
Goddard Space Flight Center
8800 Greenbelt Road
Greenbelt, MD 20771

Re: Administrative Agreement On Consent
National Aeronautics and Space Administration
U.S. EPA Docket No. RCRA-03-2004-0201TH

Dear Dr. Weiler:

Enclosed is a copy of the fully executed Administrative Agreement on Consent (Agreement) for the above-referenced matter. The Agreement integrates existing CERCLA response activities, currently being conducted by NASA at Wallops Island (Site), with RCRA corrective actions required under RCRA Section 7003.

Pursuant to RCRA Section 7003(a), EPA provided notice to the Virginia Department of Environmental Quality (VADEQ) that EPA and NASA were entering into the Agreement. As you are aware, VADEQ raised an objection to two provisions contained in the Agreement. The provisions at issue are contained in Sections VI.A.2 (Work to be Performed) and XXI (Other Applicable Laws). VADEQ asserts that the CERCLA Section 121 permit exemption applies to NPL sites only. VADEQ further contends that in accordance with CERCLA Section 120(a)(4), state laws, including state laws requiring permits, shall apply to CERCLA removal or remedial actions at facilities when such facilities are not included on the NPL, as is the case with NASA Wallops.

As we have discussed, VADEQ's position is contrary to EPA's interpretation of the above-referenced provisions. EPA Region III has discussed this issue with EPA's Office of General Counsel and, as reflected in the Agreement, EPA's position is that while NASA must meet both EPA and Commonwealth regulations that are applicable or relevant and appropriate

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requirements (ARARs) as provided under CERCLA, NASA is exempt from obtaining Federal, Commonwealth, and/or local permits for any CERCLA removal or remedial action conducted entirely on-Site.

EPA, VADEQ and NASA have worked closely together at the Site, and despite the differing opinions discussed above, will continue to do so, to ensure that all Site related response activities are protective of human health and the environment.

The Agreement is subject to a thirty-day public comment period. Upon conclusion of the comment period, EPA will proceed with final issuance as provided for in Section VIII of the Agreement. When EPA finalizes its arrangements for public notice, I will forward the details to you.

Sincerely,

James J. Burke

James J. Burke, Director
Waste and Chemical Management Division

Enclosure

cc: Karen Sismour, VADEQ
David Stewart, NASA GSFC

UNITED STATES

ENVIRONMENTAL PROTECTION AGENCY

REGION III

IN THE MATTER OF: National Aeronautics and Space Administration Wallops Island, Virginia RESPONDENT NASA GSFC Wallops Flight Facility Route 803 Wallops Island, Virginia 23337 EPA I.D. No. VA8800010763 GSFC/NASA Wallops Flight Facility Route 798 Wallops Island, Virginia 23337 EPA I.D. No. VA7800020888 FACILITY	ADMINISTRATIVE AGREEMENT ON CONSENT U.S. EPA Docket Number: RCRA-03-2004-0201TH Proceeding under Section 7003 of the Resource Conservation and Recovery Act, as amended, 42 U.S.C. § 6973.

ADMINISTRATIVE AGREEMENT ON CONSENT

RECEIVED

JUN 08 2005

DEQ
OFFICE OF REMEDIATION PROGRAM

ADMINISTRATIVE AGREEMENT

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ATTACHMENT

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UNITED STATES

ENVIRONMENTAL PROTECTION AGENCY

REGION III

IN THE MATTER OF: National Aeronautics and Space Administration Wallops Island, VA RESPONDENT NASA GSFC Wallops Flight Facility Route 803 Wallops Island, Virginia 23337 EPA I.D. No. VA8800010763 GSFC/NASA Wallops Flight Facility Route 798 Wallops Island, Virginia 23337 EPA I.D. No. VA7800020888 FACILITY	ADMINISTRATIVE AGREEMENT ON CONSENT U.S. EPA Docket Number: RCRA-03-2004-0201TH Proceeding under Section 7003 of the Resource Conservation and Recovery Act, as amended, 42 U.S.C. § 6973.

ADMINISTRATIVE AGREEMENT ON CONSENT

The parties to this Administrative Agreement on Consent ("Consent Agreement" or "Agreement"), the United States Environmental Protection Agency ("EPA") and the National Aeronautics and Space Administration ("NASA") (collectively, the "Parties"), having agreed to enter into this Consent Agreement, it is therefore agreed that:

I. JURISDICTION

1. This Consent Agreement is issued pursuant to the authority vested in the Administrator of the EPA by Section 7003 of the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 (collectively referred to hereinafter as "RCRA"), 42 U.S.C. Section 6973. The authority vested in the Administrator has been delegated to the Regional Administrators by EPA Delegation No. 8-22-C dated March 20, 1985 and further delegated to the Director of the Waste and Chemicals Management Division on September 1, 1998.

2. On March 6, 1986, EPA granted the Commonwealth of Virginia (the "Commonwealth" or "Virginia") authorization to operate a state hazardous waste program in lieu of the federal program, pursuant to Section 3006(b) of RCRA, 42 U.S.C. § 6926(b) and since that time, EPA has authorized revisions to Virginia's hazardous waste program. The Commonwealth, however, does not have authority to enforce Section 7003 of RCRA. The Commonwealth has been given notice of this Consent Agreement pursuant to Section 7003(a) of RCRA, 42 U.S.C. § 6973(a).

3. EPA enters into this Consent Agreement with NASA, the owner and operator of the following two facilities: (1) Wallops Main Base located at NASA GSFC /Wallops Flight Facility, Route 803 Wallops Island, Virginia 23337 (EPA I.D. No. VA8800010763) (the "Main Base Parcel") and (2) Wallops Island located at GSFC/NASA Wallops Flight Facility, Route 798, Wallops Island, Virginia 23337 (EPA I.D. No. VA7800020888) (the "Wallops Island Parcel"). NASA consents to this Consent Agreement and agrees to comply with its terms and will not contest EPA's authority to enter into this Consent Agreement and to enforce its terms. Further, NASA will not contest EPA's authority to compel compliance with this Consent Agreement in any subsequent enforcement proceedings, require NASA's full or interim compliance with the terms of this Consent Agreement, or impose sanctions for violations of this Consent Agreement.

II. PARTIES BOUND

1. This Consent Agreement shall apply to and be binding upon EPA, NASA and their agents, successors and assigns.

2. No change in ownership of any property covered by this Consent Agreement, or in the organization or status of NASA, shall in any way alter, diminish, or otherwise affect NASA's obligations and responsibilities under this Consent Agreement.

3. NASA is responsible for complying with this Consent Agreement and for ensuring that all work performed pursuant to this Consent Agreement is conducted in accordance with the requirements of this Consent Agreement. NASA shall provide written notification of the requirements of this Consent Agreement as well as provide an opportunity to review it upon request to all supervisory personnel, contractors, subcontractors, laboratories, and consultants retained to conduct or monitor any portion of the work performed pursuant to this Consent Agreement and shall do so within seven (7) calendar days of the effective date of this Consent Agreement or date of such retention, whichever is later. All contracts, agreements or other arrangements with such persons shall require such persons to conduct or monitor the work in accordance with the requirements of this Consent Agreement. Notwithstanding the terms of any such contract, agreement or arrangement, NASA is responsible for complying with this Consent Agreement and for ensuring that all such persons perform such work in accordance with this Consent Agreement.

4. In the event of any change in ownership or operation of the Main Base Parcel and/or the Wallops Island Parcel, NASA shall notify EPA in writing of the nature of any such change no later than fifteen (15) calendar days after the effective date of such change. In addition, NASA shall provide a copy of this Consent Agreement to any successor to the Main Base Parcel and/or the Wallops Island Parcel at least fifteen (15) calendar days prior to the effective date of such change. Nothing stated in this Paragraph 4 shall relieve NASA from complying with the terms and conditions of this Consent Agreement in the time and manner specified herein.

III. STATEMENT OF PURPOSE

1. In entering into this Consent Agreement, the mutual objectives of EPA and NASA are: (1) to control the human and ecological exposure to releases of hazardous substances, solid wastes, hazardous wastes and/or hazardous constituents from any medium; (2) to perform Early Actions ("EA"), as necessary, to prevent or mitigate threats to public health or the environment; (3) to perform a Remedial Investigation ("RI") to determine fully the nature and extent of any release of hazardous substances, solid wastes, hazardous wastes and/or hazardous constituents at or from the Main Base and/or Wallops Island Parcels; (4) to perform a Feasibility Study ("FS") to identify and evaluate alternatives for remedial action(s) necessary to prevent or mitigate migration or releases of hazardous substances, solid wastes, hazardous wastes and/or hazardous constituents at or from the Main Base and/or Wallops Island Parcels; and (5) to implement and monitor, if applicable, the remedial alternative(s) approved by EPA.

IV. FINDINGS OF FACT

1. NASA is a federal agency and is a "person" as defined in Section 1004(15) of RCRA, 42 U.S.C. § 6903(15). NASA is subject to the requirements of Section 6001 of RCRA, 42 U.S.C. § 6961, including compliance with the requirements of RCRA in the same manner as a person, as defined in Section 1004(15) of RCRA, 42 U.S.C. § 6903(15).

2. NASA has owned and operated the Wallops Flight Facility ("WFF") located on Route 175, in Wallops Island, Accomack County, Virginia since 1959. The WFF consists of three landmasses: Wallops Main Base, Wallops Mainland and Wallops Island. This Consent Agreement is issued to NASA for the Wallops Main Base ("Main Base Parcel") and Wallops Island ("Wallops Island Parcel"). The Wallops Island Parcel includes the Wallops Mainland.

3. On September 29, 1992, NASA submitted to Virginia a Notification of Regulated Waste Activity, pursuant to Section 3010 of RCRA, 42 U.S.C. § 6930, in which NASA stated that it had handled, stored, treated, transported and/or disposed of hazardous wastes with the following hazardous wastes identification numbers at the Main Base Parcel: D001, D002, D003, D004, D006, D007, D008, D009, D011, D018, D026, D035, D037, D039, F001, F002, F003, F005, F006, U019, U165, U210, U220 and M001, as identified in 40 C.F.R. §§ 261.21 through 261.24, 261.31 and 261.33.

4. NASA's activities at the Main Base Parcel include metal plating and etching, cleaning of tools and machines, generation of acidic overflow from recovery of photographic silver, handling of aircraft fuel spills and contaminated aircraft fuels, waste oil disposal and storage of aviation fuel. During these activities, NASA has used volatile organic compounds ("VOCs"), semi-volatile organic compounds ("SVOCs"), polychlorinated biphenyls ("PCBs"), and total petroleum hydrocarbons ("TPHs") in its operations at the Main Base Parcel.

5. In 1990, NASA conducted a site investigation ("SI") of an area at the Main Base Parcel known as the Waste Oil Dump ("WOD"). In the SI Report, NASA states that waste oils were transported to the WOD and dumped onto the soil surface. Sample results obtained during the SI revealed the presence of metals, VOCs, and SVOCs in the soils at the WOD. Groundwater sampling results obtained during the SI in the WOD area showed that groundwater associated with the WOD had been contaminated with lead and chromium at concentrations exceeding their respective Maximum Contaminant Levels ("MCLs") promulgated by EPA pursuant to the Safe Drinking Water Act, 42 U.S.C. §§ 300f et seq.

6. In March 2001, NASA completed a Remedial Investigation and Feasibility Study

("RI/FS") for the WOD and reported the results in a RI/FS Report. EPA reviewed the surface soil sample results summarized in the RI/FS Report and identified ten chemicals that were present at levels above applicable screening values for either human or ecological receptor exposure. These chemicals are considered Chemicals of Potential Concern ("COPCs") and require further evaluation. The applicable screening values for human and ecological risk include either Region III Risk Based Concentrations ("RBCs"), Biological Technical Assistance Group ("BTAG") values, or site specific background levels. EPA also reviewed groundwater sample results summarized in the RI/FS Report and identified three constituents as COPCs because they were present at levels above their respective MCLs or their applicable action level. A summary of these COPCs is presented in Table 1, below.

Table 1

Chemicals of Potential Concern ("COPC")	Maximum Concentration	Screening Values ([A]RBCs (residential) or [B]BTAG)	Risk category
Surface Soils			
Benzo(a)pyrene	1,200 µg/kg	87 µg/kg 100.0 µg/kg	[A]Human Health [B]Ecological
Aluminum	1.06 x 10^7 µg/kg	1,000 µg/kg	[B]Ecological
Arsenic	2900 µg/kg	430 µg/kg	[A]Human Health
Benzo(g,h,i)perylene	550 µg/kg	100.0 µg/kg	[B]Ecological
Chrysene	405 µg/kg	100.0 µg/kg	[B]Ecological
Indo(1,2,3-cd)pyrene	140 µg/kg	100.0 µg/kg	[B]Ecological
4,4'-DDE	310 µg/kg	< 100.0 µg/kg	[B]Ecological
4,4"-DDT	260 µg/kg	< 100.0 µg/kg	[B]Ecological
Chromium (not speciated)	11000 µg/kg	7500 µg/kg	[B]Ecological
Lead	60,500 µg/kg	10.0 µg/kg	[B]Ecological
Groundwater			
Arsenic	88.2 µg/l	10 µg/l	[C]Human Health

Chemicals of Potential Concern ("COPC")	Maximum Concentration	Screening Values ([A]RBCs (residential) or [B]BTAG)	Risk category
Groundwater			
Lead	62.8 µg/l	*0 mg/l	[C]Human Health
Thallium	3.0 µg/l	2 µg/l	[C]Human Health

[A]RBCs - EPA Region III Risk Based Concentrations for a residential scenario (updated April 2003)
[B] BTAG - Region III Biological Technical Assistance Group based on soil fauna levels (dated August 9, 1995)
[C]MCLs - Maximum Contaminant Levels or MCLs (dated July 2002)
* - Action level for lead is 0.015 mg/l
ug/kg - micro grams per kilogram
ug/l - micrograms per liter
mg/l - milligrams per liter

Manganese, vanadium, Total Petroleum Hydrocarbon (TPH)-Gasoline Range Organics (GRO) and TPH-Diesel Range Organics (DRO), detected at concentrations of 3,510 ug/l, 3.09 ug/l, 4,000 ug/l and 83,000 ug/l respectively, were also identified as COPCs for the human health risk assessment in the RI/FS. Manganese and vanadium do not have promulgated screening levels and are noncarcinogens that have associated toxic effects. The detection of TPH-GRO and TPH-DRO provide qualitative information that gasoline and diesel type materials are present in the groundwater despite the removal action that was conducted.

7. As part of the RI/FS, NASA conducted an Ecological Risk and Human Health Risk Assessment ("Risk Assessment"). For the human health risk evaluation, the Risk Assessment indicated that future use of groundwater as a potable source at the Main Base Parcel may pose potentially significant health risks to residential adults and children.

8. On August 25, 1992, NASA submitted to Virginia a Notification of Regulated Waste Activity, pursuant to Section 3010 of RCRA, 42 U.S.C. § 6930, in which NASA stated that it had handled, stored, treated, transported and/or disposed of hazardous wastes with the following hazardous wastes identification numbers at the Wallops Island Parcel: D001, D002, D003, D007, D008, D035, D039, F003, F005, F006, U220, U133, P068 and M001 as identified in 40 C.F.R. §§ 261.21 through 261.24 and 261.33.

9. NASA has identified the following areas where former waste disposal activities may have occurred at the Wallops Island Parcel: an open burn waste treatment area, launch sites, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, and tracking facilities.

10. NASA investigated an area on Wallops Island known as the Debris Pile as part of a SI that was conducted in March of 1996. As a result of that investigation, in 1996, NASA conducted a magnetometer survey in the Debris Pile. NASA determined that the pile was approximately 400 feet long with a width ranging from approximately 10 feet to 40 feet. NASA also took three subsurface soil samples and compared them with a background soil sample that was collected during the same event. Elevated levels of SVOCs and metals were detected in three of the samples, pesticides were detected in one sample and petroleum hydrocarbons in two of the samples.

11. Based on the findings above, EPA has determined that NASA's past handling, storage, treatment, transportation and/or disposal of solid wastes, hazardous wastes and/or hazardous constituents at the Main Base Parcel and the Wallops Island Parcel may present an imminent and substantial endangerment to health or the environment.

12. The Parties agree that for petroleum releases, NASA, with oversight by the Virginia Department of Environmental Quality (VDEQ), will manage the response actions.

13. The Parties agree that currently, formerly used defense (FUD) sites that are located at the Main Base and have been identified by the United States Corps of Engineers ("Corp"), are being managed by the Corps.

V. CONCLUSIONS OF LAW AND DETERMINATIONS

1. NASA is a person within the meaning of Section 1004(15) of RCRA, 42 U.S.C. § 6903(15).

2. The COPCs listed in Table 1 in Section IV of this Consent Agreement are "solid wastes" as defined in Section 1004(27) of RCRA, 42 U.S.C. § 6903(27) and/or "hazardous wastes" as defined in Section 1004(5) of RCRA, 42 U.S.C. § 6903(5), within the meaning of Section 7003 of RCRA, 42 U.S.C. § 6973.

3. NASA is a person who has contributed to the handling, storage, treatment, and/or disposal of solid wastes and/or hazardous wastes at the Main Base Parcel and the Wallops Island Parcel, which may present an imminent and substantial endangerment to health or the environment.

4. The actions required by this Consent Agreement are necessary to protect public health and the environment.

VI. WORK TO BE PERFORMED

1. EPA acknowledges that NASA has previously undertaken and remains engaged in response measures at the Main Base and Wallops Island Parcels pursuant to NASA's authority under the Comprehensive Environmental Response, Compensation and Liability Act, as amended by the Superfund Amendments and Reauthorization Act of 1986, 42 U.S.C. §§ 9601 et seq ("CERCLA"). The Parties intend that such response measures will be integrated herein to achieve the purposes of this Consent Agreement. It is the intent of the Parties that work done and generated pursuant to NASA's authority under CERCLA prior to the effective date of this Agreement, be used to meet the requirements of this Consent Agreement as elements of the required action or Work to be Performed to the maximum extent feasible, upon submission to, and formal approval by, EPA.

2. Pursuant to Section 7003 of RCRA, 42 U.S.C. Section 6973, NASA agrees to and is hereby ordered to perform the following acts in the manner and by the dates specified herein. All work undertaken pursuant to this Consent Agreement shall be developed and performed, as appropriate and approved by EPA, in accordance with applicable law and relevant EPA guidance documents. Relevant guidance is available at: http://www.epa.gov/oerrpage/superfund/action/process/sfproces.htm, and are incorporated herein by reference.

3. The term "days" as set forth herein means calendar days unless otherwise specified.

4. The term "Site" as set forth herein means the Main Base and Wallops Island Parcels.

A. RCRA-CERCLA INTEGRATION

1. EPA and NASA intend to integrate NASA's CERCLA response obligations and RCRA corrective action obligations which relate to the release(s) of hazardous substances, solid waste, hazardous waste, hazardous constituents, pollutants and/or contaminants covered by this Agreement.

2. As provided in CERCLA Section 121(e)(1), NASA shall not be required to obtain permits for any CERCLA removal or remedial action conducted entirely on Site and any CERCLA response actions undertaken at the Main Base and Wallops Island Parcels shall be conducted as provided for in CERCLA, 42 U.S.C. § 9601, et seq. and the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), 40 C.F.R. Part 300.

3. Nothing in this Agreement shall alter NASA's authority with respect to removal actions conducted pursuant to CERCLA Section 104(a)(2), 42 U.S.C. § 9604(a)(2).

B. EARLY ACTIONS

1. NASA has recently completed CERCLA removal actions at the Main Base Parcel and the Wallops Island Parcel (as documented in the Administrative Record Index included as Attachment 1), and to the best of NASA's knowledge, Early Actions may not be necessary at this time. In the event that NASA and/or EPA determine that additional Early Actions are appropriate, these Early Actions will be addressed in accordance with this Section VI.B.

2. NASA shall evaluate available data and submit to EPA for approval a proposal for Early Actions ("EA") at the Main Base Parcel and the Wallops Island Parcel, as may be appropriate, as part of the description of current conditions provided in the Site Management Plan, as required by Section VI.C. of this Consent Agreement. Within forty-five (45) calendar days after EPA's review and approval of NASA's proposal, NASA shall submit to EPA an EA Workplan in accordance with Paragraphs IV.B. 7 through 10, immediately below, relevant guidance documents and applicable law. Upon receipt of EPA's approval of the EA Workplan, NASA shall implement the EPA-approved EA Workplan in accordance with the terms and conditions set forth therein.

3. If, after EPA's review of the description of current conditions, EPA determines that an early action(s) is necessary to address an immediate or potential threat to health or the environment at the Main Base Parcel and/or the Wallops Island Parcel, EPA will so notify NASA and shall identify an early action(s) which NASA shall perform. Such notification shall set forth the basis for EPA's determination. Within forty-five (45) calendar days of receipt of EPA's notification, NASA shall submit to EPA for approval an EA Workplan in accordance with Paragraphs VI.B. 7 through 10, immediately below, relevant guidance documents and applicable law. Upon receipt of EPA's approval of the EA Workplan, NASA shall implement the EPA-approved EA Workplan in accordance with the terms and conditions set forth therein.

4. If EPA and NASA agree that an Early Action(s) is necessary for circumstances other than those set forth in Paragraph VI.B.2, immediately above, at the Main Base Parcel and/or the Wallops Island Parcel, NASA shall identify an Early Action(s) which NASA shall perform. Within thirty (30) calendar days of identifying such Early Action(s), NASA shall submit to EPA for approval an EA Workplan in accordance with Paragraphs VI.B. 7 through 10, immediately below, relevant guidance documents and applicable law. Upon receipt of EPA's approval of the EA Workplan, NASA shall implement the EPA-

approved EA Workplan in accordance with the terms and conditions set forth therein.

5. In the event NASA identifies an immediate or potential threat to health or the environment at the Main Base Parcel and/or the Wallops Island Parcel resulting from new releases of hazardous substances, solid waste, hazardous waste and/or hazardous constituents not previously identified to EPA, NASA shall notify the EPA and Virginia Department of Environmental Quality ("VDEQ") Project Coordinators, orally within forty-eight (48) hours of discovery and notify EPA and VDEQ in writing within five (5) calendar days of such discovery summarizing the immediacy and magnitude of the threat to health and/or the environment. Upon written request from EPA setting forth the basis for its determination that an early action is necessary to address an immediate or potential threat to health or the environment, NASA shall submit to EPA for approval an EA Workplan, in accordance with Paragraphs VI.B. 7 through 10, immediately below, relevant guidance documents and applicable law. The EA Workplan shall identify one or more early actions that will address such threat as necessary to protect public health and the environment. Upon receipt of EPA's approval of the EA Workplan, NASA shall implement the EPA-approved EA Workplan in accordance with the terms and conditions set forth therein. If EPA determines that immediate action is required, the EPA Project Coordinator may orally authorize NASA to act prior to EPA's receipt of the EA Workplan.

6. If at any time EPA identifies an immediate or potential threat to health or the environment at the Main Base Parcel and/or the Wallops Island Parcel resulting from new releases of hazardous substances, solid waste, hazardous waste and/or hazardous constituents at or from those operable units and/or Areas of Concern not previously identified to EPA, EPA will notify NASA in writing. Within thirty (30) calendar days of receiving EPA's written notification setting forth the basis for its determination that an early action is necessary to address such threat, NASA shall submit to EPA for approval an EA Workplan in accordance with Paragraphs VI.B. 7 through 10, immediately below, relevant guidance documents and applicable law. The EA Workplan shall identify one or more early actions that will address such threat as necessary to protect public health and/or the environment. Upon receipt of EPA's approval of the EA Workplan, NASA shall implement the EPA-approved EA Workplan in accordance with the terms and conditions set forth therein. If EPA determines that immediate action is required, the EPA Project Coordinator may orally require NASA to act prior to NASA's receipt of EPA's written notification.

7. All EA Workplans shall ensure that the early actions are designed to mitigate immediate or potential threat(s) to health or the environment, and should be consistent with the cleanup objectives of, and contribute to the performance of any long-term remedy(ies) which may be required at the Main Base Parcel and/or the Wallops Island Parcel.

8. Each EA Workplan shall include the following sections, as appropriate, and approved by EPA: Early Action(s) Objectives, Public Involvement Plan, Data Collection Quality Assurance, Data Management, Design Plans and Specifications, Operation and Maintenance, Project Schedule for expeditious completion of Early Actions, Early Actions Construction Quality Assurance, and Reporting Requirements.

9. Concurrent with submission of an EA Workplan, NASA shall submit to EPA an EA Health and Safety Plan.

10. Upon receipt of EPA-approval of an EA Workplan, NASA shall implement the EPA approved EA Workplan in accordance with the terms and conditions contained therein.

C. SITE MANAGEMENT PLAN

1. Within sixty (60) calendar days from the effective date of this Agreement, NASA shall submit to VDEQ and EPA for approval a Site Management Plan ("SMP") for Fiscal Years 2005 and 2006 (FY 2005 - 2006). The SMP shall be used as a management tool in planning, reviewing and setting priorities for all response activities at the Site. The SMP shall be a two-year planning device and shall contain a timetable, plan or schedule which indicate the time and sequence of activities that will occur at the Site over the ensuing two fiscal years. To ensure that the SMP continues to function as a two-year planning device that is reflective of both ongoing and planned future activities, NASA shall update the SMP on an annual basis. Each annual update shall amend, revise and/or supplement the SMP, as appropriate, so that the SMP continues to address events that will occur at the Site over the following two fiscal years. For the purpose of the SMP, a fiscal year is the yearly time frame used by the United States Government that commences on October 1st of the given calendar year and ends on September 30th of the following calendar year.

2. The SMP shall, at a minimum:

   a. Provide a background of current and historic Site operations;

   b. Describe current Site conditions;

   c. Identify each operable unit ("OU") and Area of Concern ("AOC") at the Site and describe the nature of the proposed action(s) at each area, including those actions which are necessary to mitigate any immediate threat to public health or the environment;

d. List the schedules and the deadlines for all submissions and remedial, removal and response actions which are ongoing, planned and/or proposed over the course of the ensuing two fiscal years, including any deadlines already required by EPA in this Agreement.

3. Upon receipt of EPA approval of the SMP for Fiscal Years 2005 and 2006 and every subsequent SMP, NASA shall implement the EPA-approved SMP in accordance with the terms and schedules contained therein.

D. REMEDIAL INVESTIGATION

1. In accordance with the schedule established in the EPA-approved SMP, NASA shall submit to EPA a Workplan for a Remedial Investigation ("RI Workplan") at the Main Base and Wallops Island Parcels. The RI Workplan is subject to approval by EPA and shall be developed in accordance with, at a minimum, relevant EPA guidance documents and applicable law.

2. The RI Workplan shall be designed to determine the presence, magnitude, extent, direction, and rate of movement of any hazardous substances, solid wastes, hazardous wastes and/or hazardous constituents within and beyond the boundaries of the Main Base Parcel and Wallops Island Parcel. The RI Workplan shall document the procedures NASA shall use to conduct those activities necessary to: (A) characterize the source(s) of contamination; (B) characterize the potential pathways of contaminant migration; (C) define the degree and extent of contamination; (D) identify actual or potential human and/or ecological receptors; and (E) support the development of alternatives from which a remedial action(s) will be selected by EPA. NASA may propose to implement the work contained in the RI Workplan in a phased approach. A specific schedule for expeditious implementation of all activities shall be included in the RI Workplan.

3. The RI Workplan shall include: (A) a Project Management Plan; (B) a Data Collection Quality Assurance Plan; (C) a Data Management Plan; and (D) a Community Relations Plan.

4. Concurrent with the submission of the RI Workplan, NASA shall submit an RI Health and Safety Plan.

5. Upon receipt of EPA approval of the RI Workplan, NASA shall implement the EPA-approved RI Workplan in accordance with the terms and schedules contained therein. Upon completion of implementation of the RI Workplan, NASA shall submit to EPA for approval an RI Report, in accordance with the requirements and schedule contained in the

EPA-approved RI Workplan.

E. FEASIBILITY STUDY

1. In accordance with the schedule established in the EPA-approved SMP, NASA shall submit to EPA for approval a Feasibility Study ("FS") Report for the Main Base and Wallops Island Parcels. The FS Report shall be developed in accordance with relevant EPA guidance documents and applicable law as provided in Section VI.2.

F. PUBLIC COMMENT AND PARTICIPATION

1. After approval of the FS Report, EPA will make both the RI Report and the FS Report ("RI/FS"), a description of NASA's proposed remedial action(s), if any are so proposed by NASA, and NASA's justification for proposing selection of such remedial action(s) (the "Proposed Remedial Action Plan") available to the public for review and comment for at least thirty (30) calendar days.

2. Following the public review and comment period for the Proposed Remedial Action Plan, EPA will notify the public of the remedial action(s) agreed upon by NASA and EPA in a Record of Decision ("ROD"). If the remedial action(s) selected by EPA after consideration of public comments differs significantly from the remedial action(s) recommended in the ROD, EPA will explain in the ROD the basis for such difference.

3. Any decisions or determinations made by NASA and EPA pursuant to the Consent Agreement will be available for public review on Mondays through Fridays, from 9:00 a.m. to 4:00 p.m., by contacting the EPA Project Coordinator, Michelle Price-Fay, at (215) 814-3397 or the NASA Project Coordinator, Susan Fields, at (757) 824-1327.

G. REMEDIAL DESIGN/REMEDIAL ACTION(S)

1. Upon issuance of the ROD(s), said ROD(s) shall be incorporated into and become enforceable under this Consent Agreement.

2. Remedial Design

   a. In accordance with the schedule established in the EPA-approved SMP, NASA shall submit to EPA for approval a Remedial Design ("RD") Workplan. The RD Workplan shall provide for the design of the remedy set forth in the ROD(s). The

RD Workplan shall be developed in accordance with the ROD, relevant EPA guidance documents and applicable law. Upon its approval by EPA, the RD Workplan shall be incorporated into and become enforceable under this Agreement.

b. In accordance with the EPA-approved RD Workplan, NASA shall submit to EPA for approval a RD Report. The RD Report shall be developed in accordance with the ROD(s), relevant EPA guidance documents and applicable law.

3. Remedial Action Workplan

a. In accordance with the schedule established in the EPA-approved SMP, NASA shall submit to EPA for approval a Remedial Action ("RA") Workplan. The RA Workplan shall provide for construction and implementation of the remedy set forth in the ROD(s). The RA Workplan shall be developed in accordance with relevant EPA guidance documents and applicable law. Upon its approval by EPA, the RA Workplan shall be incorporated into and become enforceable under this Agreement.

b. In accordance with the EPA-approved RA Workplan, NASA shall submit to EPA for approval an RA Report. The RA Report shall be developed in accordance with relevant EPA guidance documents and applicable law.

4. Remedial Action Completion

a. NASA shall commence and complete implementation of the Remedial Action(s) selected in the ROD in accordance with the schedules and specifications set forth in the EPA-approved RD Report; the EPA-approved RA Workplan; and relevant EPA guidance documents and applicable law.

b. In accordance with the schedule established in the EPA-approved SMP, NASA shall submit to EPA for approval a Remedial Action Completion ("RAC") Report. The RAC Report shall be developed in accordance with relevant EPA guidance documents and applicable law and shall describe activities performed during implementation, provide actual specifications of the implemented remedial action(s), and provide a preliminary assessment of Remedial Action performance.

c. EPA shall determine, on the basis of the RAC Report and any other relevant information, whether the implemented Remedial Action(s) is consistent with the EPA-approved RD Report. If EPA determines that the implemented remedial action(s) is consistent with the EPA-approved RD Report and that the Remedial

Action(s) have achieved or are achieving all of the requirements set forth in the ROD and the performance criteria set forth in the RD Report, EPA shall approve the RAC Report.

d. If EPA determines that the implemented Remedial Action(s) is inconsistent with the EPA-approved RD Report and/or that the Remedial Action(s) have not achieved or are not achieving all of the requirements set forth in the ROD and the performance criteria established in the EPA-approved RD Report, EPA shall notify NASA in writing of those activities that must be undertaken to complete the Remedial Action(s) requirements and shall set forth a schedule for the completion of those activities. NASA shall complete the activities in accordance with the schedule set forth in the EPA notification.

5. Remedial Action Monitoring Plan/Operation and Maintenance/Assessment Reports

a. In accordance with the schedule established in the EPA-approved RAC Report, NASA shall submit to EPA for approval a Long-Term Remedial Action Monitoring Plan (if necessary), and an Operation and Maintenance Plan to VDEQ for review and EPA for approval in accordance with the schedule provided in the SMP, Section VI.C. Both the Long-Term Remedial Action Monitoring Plan and Operation and Maintenance Plan(s) finalized under this Agreement shall contain schedules for completion of the work describe therein, and these schedules, upon EPA approval, shall be incorporated into the SMP and become an enforceable part of this Agreement.

b. If based on the RA Assessment Report or any other information, EPA determines that the Remedial Action(s) are not meeting the objectives of addressing the contaminants in the soil, sediments, surface water and/or groundwater to attain the performance criteria established in the RA Design Report, EPA shall notify NASA in writing of those activities that must be undertaken to meet the objectives of the Remedial Action(s) and shall set forth a schedule for the completion of those activities. NASA shall complete the activities in accordance with the schedule set forth in the EPA notification.

c. No later than five years after the commencement of the Remedial Action and every five (5) years thereafter until receipt of approval by EPA of a Certificate of Completion submitted pursuant to paragraph VI.E.4.g, below, NASA shall submit a RAC Five-Year Remedial Assessment Report. Such Report shall contain an evaluation of the past and projected future effectiveness of the Remedial Action(s) in addressing the contaminants in the soil, sediments, surface water and/or groundwater to attain the performance criteria established in the RA Design

Report.

d. NASA may, as part of a RAC Five-Year Assessment Report, request that EPA approve, for the purposes of this Consent Agreement, an Alternative and/or Supplemental Remedial Action(s).

e. In the event EPA approves an Alternative and/or Supplemental Remedial Action(s) either in response to a request by NASA pursuant to paragraph VI.G.5.d, immediately above, or on its own initiative, EPA may provide NASA with a period of thirty (30) calendar days from the date NASA receives written notice from EPA of the approval of an Alternative and/or Supplemental Remedial Action(s) within which to reach an agreement with EPA regarding performance of the Alternative and/or Supplemental Remedial Action(s) in lieu of, or in addition to, the Remedial Action(s). Any such agreement between EPA and NASA shall be incorporated into and become enforceable under this Consent Agreement and NASA shall implement the activities required under any such agreement in accordance with any schedule and provisions contained therein.

f. Nothing in paragraph VI.G.5.e, immediately above, shall limit EPA's authority to require performance of Alternative and/or Supplemental Remedial Action(s) or to take any other appropriate action under RCRA, 42 U.S.C. §§ 6901 et seq. CERCLA 42 U.S.C. §§ 9601 et seq., or any other legal authority, including the issuance of a unilateral administrative order.

g. Within ninety (90) calendar days after NASA has fully performed the Remedial Action and the media cleanup standards described in the ROD have been attained, NASA shall submit a Certification of Completion for all Remedial Action(s) to EPA for approval in accordance with Section XIII.(NOTIFICATION) of this Consent Agreement. The Certification of Completion shall provide documentation sufficient to support a determination that media cleanup standards have been attained and include all available documentation supporting such a determination.

H. SUBMISSIONS/EPA APPROVAL/ADDITIONAL WORK

1. EPA will review Reports and Workplans submitted by NASA pursuant to this Agreement, and any other documents submitted pursuant to and/or agreed upon in this Consent Agreement ("Submissions") with the exception of progress reports, and will notify NASA in writing of EPA's approval or disapproval of each such Submission. In the event of EPA's disapproval, EPA shall specify in writing any deficiencies in the

Submission. Such disapproval shall not be subject to the dispute resolution procedures of Section XV, below.

2. Within forty-five (45) calendar days of receipt of EPA's comments on the Submission, or fifteen (15) calendar days in the case of an EA Workplan, NASA shall submit to EPA for approval a revised Submission, which responds to any comments received and/or corrects any deficiencies identified by EPA. EPA will review the revised submission and will either approve or disapprove of the Submission and notify NASA. Within thirty (30) calendar days after receipt of any such disapproval, NASA shall modify its Submission in conformance with EPA comments or initiate dispute resolution. Any Submission approved or revised by EPA under this Consent Agreement shall be deemed incorporated into and made an enforceable part of this Consent Agreement.

3. Beginning the first day of the sixth full month following the effective date of this Consent Agreement, and every six months on the first day of the month, throughout the period that this Consent Agreement is effective, NASA shall provide EPA with semiannual (every 6 months) progress reports. The semiannual progress reports shall provide information on the status of current response activities.

4. Four (4) copies of all Submissions as well as progress reports described in Paragraph VI.H.3 immediately above, required by this Consent Agreement shall be hand-delivered or sent via overnight mail, Return Receipt Requested, to the Project Coordinator designated pursuant to Section XII, "PROJECT COORDINATORS," below.

5. All work performed pursuant to this Consent Agreement shall be under the direction of the NASA Project Coordinator. Within ten (10) calendar days after the effective date of this Consent Agreement, NASA shall submit to EPA, in writing, the name, title, and qualifications of any contractors or subcontractors selected by NASA to be used in carrying out the terms of this Consent Agreement. Notwithstanding NASA's selection of the NASA Project Coordinator or any contractor and/or subcontractor, nothing herein shall relieve NASA of its obligation to comply with the terms and conditions of this Consent Agreement. EPA shall have the right to disapprove at any time based on performance and/or eligibility concerns, the use of the NASA Project Coordinator or any contractor or subcontractor selected by NASA. EPA's disapproval shall not be subject to review under Section XV of this Consent Agreement ("DISPUTE RESOLUTION") or otherwise. Within fifteen (15) calendar days of receipt from EPA of written notice disapproving the use of any NASA Project Coordinator or within 120 calendar days of receipt from EPA of written notice disapproving the use of any contractor or subcontractor, NASA shall notify EPA, in writing, of the name, title and qualifications of the personnel who will replace the personnel disapproved by EPA. NASA shall notify EPA within ten (10) calendar days prior to changing voluntarily the NASA Project

Coordinator, and/or contractors or subcontractors to be used in carrying out the terms of this Consent Agreement, and shall submit to EPA in writing, the name, title, and qualifications of such person(s).

6. If at any time after the effective date of this Consent Agreement, NASA proposes to change a contractor and/or subcontractor, NASA shall notify EPA and obtain a notice of acceptance of such change(s) from EPA before a new contractor and/or subcontractor performs, directs or supervises any work under this Consent Agreement. If EPA disapproves the selection of a proposed contractor and/or subcontractor, EPA will notify NASA in writing. NASA shall submit to EPA a list of at least three contractors and/or subcontractors, including the qualifications of each, that would be acceptable to NASA within thirty (30) calendar days of receipt of EPA's notice. EPA will provide written notice of the names of any contractor and/or subcontractor whose selection it would approve. NASA may select any contractor and/or subcontractor from that list and shall notify EPA of the name of the contractor and/or subcontractor selected within twenty-one (21) calendar days of receipt of EPA's written notice.

7. EPA may determine that certain tasks and deliverables including, but not limited to, investigatory work or engineering evaluation require additional work. These tasks and deliverables may or may not have been in the SMP, FS, RD, RA, RAC and/or Five-Year Assessment Report, or in the EA, RI, RD or RA Workplans and/or any other documents submitted pursuant to and/or agreed upon in this Consent Agreement. If EPA determines that such additional work is necessary, EPA shall request, in writing, that NASA perform the additional work and shall specify the reasons for EPA's determination that additional work is necessary. Within thirty (30) calendar days after the receipt of such request, NASA shall have the opportunity to meet or confer with EPA to discuss the additional work EPA has requested. In the event that NASA agrees to perform the additional work, this Consent Agreement shall be modified in accordance with Section XXIII, "SUBSEQUENT MODIFICATION," below, and such work shall be performed in accordance with this Consent Agreement. In the event NASA declines or fails to perform the additional work, EPA reserves the right to order NASA to perform such additional work and to disapprove of the SMP, RI, FS, RD, RA , RAC and/or Five-Year Assessment Reports, or the EA, RI, RD or RA Workplans.

8. Any reports, plans, specifications, schedules, other submissions and attachments required by this Consent Agreement are, upon written approval by EPA, incorporated into this Consent Agreement. Any noncompliance with such EPA-approved reports, plans, specifications, schedules, other submissions, and attachments shall be considered a violation of this Consent Agreement and shall subject NASA to the stipulated penalty provisions included in Section XIV, "DELAY IN PERFORMANCE/STIPULATED PENALTIES."

VII. QUALITY ASSURANCE

1. Throughout all sample collection and analysis activities, NASA shall use EPA-approved quality assurance, quality control, and chain-of-custody procedures, as specified in the EPA-approved RI Workplan. In addition, NASA shall:

   a. Ensure that the laboratories it uses for analyses perform such analyses according to the EPA methods included in "Test Methods for Evaluating Solid Waste" (SW-846, November 1986) or other methods deemed satisfactory to EPA. If methods other than EPA methods are to be used, NASA shall submit all analytical protocols to be used for analyses to EPA for approval at least thirty (30) calendar days prior to the commencement of analyses and shall obtain EPA approval prior to the use of such analytical protocols.

   b. Ensure that laboratories it uses for analyses participate in a quality assurance/quality control program equivalent to that which is followed by EPA. As part of such a program, and upon request by EPA, such laboratories shall perform analyses of samples provided by EPA to demonstrate the quality of the analytical data.

   c. Inform the EPA Project Coordinator at least fourteen (14) calendar days in advance of any laboratory analysis regarding which laboratory will be used by NASA and ensure that EPA personnel and EPA authorized representatives have reasonable access to the laboratories and personnel used for analysis.

VIII. PUBLIC COMMENT AND REVIEW OF AGREEMENT

1. Within thirty (30) calendar days of the date that EPA signs this Consent Agreement, EPA shall announce the availability of this Agreement to the public for review and comment. EPA shall accept comments from the public for a period of thirty (30) calendar days after such announcement. If sufficient interest warrants, as determined by EPA, a public meeting will be held. At the end of the comment period, EPA shall review all comments received during the above-described thirty (30) day period and/or at such public meeting, and shall either:

   a. determine that the Agreement should be made effective in its present form in which case EPA shall so notify NASA in writing and send NASA a copy of this Agreement executed by EPA. The Consent Agreement shall become effective on

the date of the receipt of such notice and copy of the Consent Agreement; or

b. determine that modification of the Consent Agreement is necessary, in which case EPA shall notify NASA in writing as to the nature of all required changes. If NASA agrees to the modifications, the Consent Agreement shall be so modified and shall become effective upon the receipt by NASA of an executed copy of the modified Consent Agreement.

2. In the event that the parties are unable to agree on modifications required by EPA as a result of public comment, this Agreement shall be withdrawn by EPA. In such an event, EPA reserves the right to take such action as may be necessary to protect public health and the environment, including but not limited to, issuance of a subsequent order to NASA or any other person in connection with the Main Base and/or Wallops Island Parcels under Section 7003 of RCRA.

IX. ON-SITE AND OFF-SITE ACCESS

1. On and after the effective date of this Consent Agreement, NASA shall provide to EPA and its employees, agents, consultants, contractors and other authorized and/or designated representatives, for the purposes of conducting and/or overseeing the work required by this Consent Agreement, or by any EPA-approved workplan prepared pursuant hereto, access to all property owned or controlled by NASA wherein work must be undertaken. NASA shall grant access to EPA and/or its authorized representatives who are U.S. Citizens and who provide valid government-issued photo identification. For Foreign Nationals, NASA shall grant access to EPA and/or its authorized representatives in accordance with the Procedural Requirements for Processing Requests for Access to NASA Installations or Facilities by Foreign Nationals or U.S. Citizens Who are Representatives of Foreign Entities (NPR 1371.2A, or most current version http://nodis3.gsfc.nasa.gov/displayAll.cfm?Internal_ID=N_PR_1371_002A_&page_name=all). Generally, requests for a visit by a Foreign National to a NASA Center are approved or disapproved within twenty (20) working days. If after the effective date of this Agreement, NASA's security requirements change such that access cannot be provided in the manner set forth herein, NASA must notify EPA in writing within ten (10) calendar days of such changes. Such access shall permit EPA and its employees, agents, consultants, contractors and other authorized and designated representatives to conduct all activities described in Paragraph IX.3 of this Consent Agreement. Such requirements shall not be applied to unreasonably hinder or delay the EPA from carrying out its responsibilities and authority pursuant to this Agreement.

2. To the extent that property wherein work required by this Consent Agreement must be

undertaken is presently owned or controlled by parties other than NASA, NASA shall use its best efforts to obtain site access agreements from the present owners. Best efforts shall include, but not be limited to, agreement to reasonable conditions for access and/or the payment of reasonable fees. Such access agreements shall be finalized as soon as practicable but no later than forty-five (45) calendar days after receiving EPA's written approval to proceed. Such agreements shall provide reasonable access for NASA and its employees, agents, consultants, contractors and other authorized and designated representatives to conduct the work, and for EPA and its designated representatives to conduct the activities outlined in Paragraph IX.3, below. In the event that any property owner refuses to provide such access or access agreements are not obtained within the time designated above, whichever occurs sooner, NASA shall notify EPA at that time, in writing, of all efforts to obtain access and the circumstances of the failure to obtain such access. EPA may then take steps to provide such access. NASA shall reimburse EPA for all costs incurred in obtaining access, including, but not limited to, attorneys fees and the amount of any just compensation and costs incurred by EPA.

3. In accordance with law and regulation and within the constraints of NASA Security requirements, as appropriate, EPA and its employees, agents, contractors, consultants and other authorized and designated representatives shall have the authority to enter and freely move about the location where the corrective actions and/or work is being performed at all reasonable times for the purposes of, inter alia: inspecting work required by this Consent Agreement, or by any EPA approved workplan prepared pursuant hereto, records, operating logs and contracts related to the Main Base and Wallops Island Parcels; reviewing the progress of NASA in carrying out the terms of this Consent Agreement; conducting such tests as EPA deems necessary; using a camera, sound recording or other documentary type equipment; and verifying the data submitted to EPA by NASA. NASA shall permit such persons to inspect and copy all records, files, photographs, documents and other writings, including all sampling and monitoring data, in any way pertaining to the work. The EPA shall have the right to enter all areas of the Site that are entered by contractors performing work under this Agreement.

4. Upon denial of any aspect of access, NASA shall provide an immediate explanation of the reason for the denial, including reference to the applicable regulations and upon request, a copy of such regulations. Within forty-eight (48) hours, NASA shall expeditiously provide a recommendation for accommodating the access request in an alternate manner.

5. Notwithstanding any provision of this Consent Agreement, EPA retains all of its access and information-gathering authorities and rights under RCRA and any other applicable statute and regulation.

X. SAMPLING AND DATA/DOCUMENT AVAILABILITY

1. NASA shall submit to EPA the results of all sampling and/or tests or other data generated by, or on behalf of, NASA in accordance with the requirements of this Consent Agreement, applicable law and relevant EPA guidance documents.

2. NASA shall notify EPA and the VDEQ, in writing, at least fourteen (14) calendar days in advance of any field activities, including but not limited to, well drilling, installation of equipment, or sampling. At the request of EPA, NASA shall provide or allow EPA or its authorized representatives to take split or duplicate samples of all samples collected by NASA pursuant to this Consent Agreement. Nothing in this Consent Agreement shall limit or otherwise affect EPA's authority to collect samples pursuant to applicable law, including, but not limited to, RCRA and CERCLA.

3. NASA may assert a business confidentiality claim covering all or part of any information submitted to EPA pursuant to this Consent Agreement in the manner described in 40 C.F.R. Section 2.203(b). Any assertion of confidentiality shall be adequately substantiated by NASA when the assertion is made in accordance with 40 C.F.R. Section 2.204(e)(4). Information subject to a confidentiality claim shall be disclosed only to the extent allowed by, and in accordance with, the procedures set forth in 40 C.F.R. Part 2, Subpart B. If no such confidentiality claim accompanies the information when it is submitted to EPA, it may be made available to the public by EPA without further notice to NASA. NASA shall not assert any confidentiality claim with regard to any physical, sampling, monitoring, or analytical data.

4. If NASA wishes to assert a privilege with regard to any document which EPA seeks to inspect or copy pursuant to this Consent Agreement, NASA shall identify the document, the privilege claimed, and the basis thereof in writing. For the purposes of this Consent Agreement, privileged documents are those documents exempt from discovery from the United States in litigation under the Federal Rules of Civil Procedure. NASA shall not assert a privilege with regard to analytical, sampling and monitoring data.

XI. RECORD PRESERVATION

NASA agrees that it shall preserve, during the pendency of this Consent Agreement and for a minimum of at least six (6) years after its termination, all data, records and documents in its possession or in the possession of its divisions, officers, directors, employees, agents, contractors, successors, and assigns which relate in any way to this Consent Agreement or to hazardous waste management and/or disposal at the Main Base and/or Wallops Island Parcels.

After six (6) years, NASA shall make such records available to EPA for inspection or shall provide copies of such records to EPA. NASA shall notify EPA at least thirty (30) calendar days prior to the proposed destruction of any such records, and shall provide EPA with a reasonable opportunity to inspect, copy and/or take possession of any such records. NASA shall not destroy any record to which EPA has requested access for inspection and/or copying until EPA has obtained such access or withdrawn its request for such access. Nothing in this Section XI shall in any way limit the authority of EPA under Section 3007 of RCRA, 42 U.S.C. Section 6927, or any other access or information-gathering authority.

XII. PROJECT COORDINATORS

1. EPA hereby designates Mrs. Michelle Price-Fay as the EPA Project Coordinator. NASA hereby designates Ms. Susan Fields as the NASA Project Coordinator. Each Project Coordinator shall be responsible for overseeing the implementation of the Consent Agreement. The EPA Project Coordinator will be EPA's primary designated representative at the Main Base and Wallops Island Parcels. To the maximum extent possible, all communications between NASA and EPA, and all documents, reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Consent Agreement, shall be directed through the Project Coordinators.

2. Each party agrees to provide at least seven (7) calendar days written notice to the other party prior to changing Project Coordinators.

3. If EPA determines that conditions or activities at the Main Base and/or Wallops Island Parcels, whether or not in compliance with this Consent Agreement, have caused or may cause a release or threatened release of hazardous substances, solid wastes, hazardous wastes, hazardous constituents, pollutants or contaminants which threaten or may pose a threat to the public health or welfare or to the environment, EPA may direct that NASA stop further implementation of this Consent Agreement for such period of time as may be needed to abate any such release or threatened release and/or to undertake any action which EPA determines is necessary to abate such release or threatened release.

4. The absence of the EPA Project Coordinator from the Main Base and/or Wallops Island Parcels shall not be cause for the delay or stoppage of work.

XIII. NOTIFICATION

1. Unless otherwise specified, reports, correspondence, approvals, disapprovals, notices, or

other submissions relating to or required under this Consent Agreement shall be in writing and shall be sent as follows:

a. Four copies of all documents to be submitted to the EPA shall be sent to:

Mrs. Michelle Price-Fay
U.S. EPA, Region III (3HS13)
1650 Arch Street
Philadelphia, PA 19103-2029

b. Documents to be submitted to NASA shall be sent to:

Ms. Susan Fields
NASA Goddard Space Flight Center
Wallops Flight Facility
Building F-160 Room W157 Code 250. W
Wallops Island, Virginia 23337

c. One copy of all documents to be submitted to EPA shall also be sent to:

Mr. Paul Herman
Virginia Department of Environmental Quality
Office of Remediation Programs
629 East Main Street
Richmond, VA 23219

2. Any notice, report, certification, data presentation, or other document submitted by NASA pursuant to this Consent Agreement which discusses, describes, demonstrates, or supports any finding or makes any representation concerning NASA's compliance or noncompliance with any requirement of this Consent Agreement shall be certified by a duly authorized representative of NASA. A person is a "duly authorized representative" only if: (1) the authorization is made in writing; (2) the authorization specifies either an individual or position having responsibility for overall operation of the Site or activity (a duly authorized representative may thus be either a named individual or any individual occupying a named position); and (3) the written authorization is submitted to the Project Coordinator designated by EPA Section XII, "Project Coordinators," of this Order.

3. The certification required by paragraph 2, above, shall be in the following form:

I certify that the information contained in or accompanying this [type of submission] is true, accurate, and complete.

As to **[the/those identified portion(s)]** of this **[type of submission]** for which I cannot personally verify **[its/their]** accuracy, I certify under penalty of law that this **[type of submission]** and all attachments were prepared in accordance with procedures designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, or the immediate supervisor of such person(s), the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Signature : _____

Name : _____

Title : _____

XIV. DELAY IN PERFORMANCE/STIPULATED PENALTIES

1. Unless there has been a written modification of a compliance date by EPA, or excusable delay as defined below in Section XVII, "FORCE MAJEURE AND EXCUSABLE DELAY," in the event that NASA fails to comply with any requirement set forth in this Consent Agreement, NASA shall pay stipulated penalties, as set forth below, upon receipt of written demand by EPA. Compliance by NASA shall include commencement or completion, as appropriate, of any activity, plan, study or report required by this Consent Agreement in an acceptable manner and within the specified time schedules in and approved under this Consent Agreement. Stipulated penalties shall accrue as follows:

   a. For failure to commence, perform or complete work as prescribed in this Consent Agreement: $1,500 per day for one to seven days or part thereof of noncompliance, and $3,000 per day for each day of noncompliance, or part thereof, thereafter;

   b. For failure to submit any draft or final Workplan, plans, or reports as required by this Consent Agreement: $1,000 per day for one to seven days or part thereof of noncompliance, and $2,500 per day for each day of noncompliance, or part thereof, thereafter;

c. For failure to submit progress reports as required by this Consent Agreement: $500 per day for one to seven days or part thereof of noncompliance, and $1,000 per day for each day of noncompliance, or part thereof, thereafter;

d. For failure to comply with the provisions of this Consent Agreement after receipt of notice of noncompliance by EPA: $2,000 per day for one to seven days or part thereof of noncompliance, and $3,500 per day for each day of noncompliance, or part thereof, thereafter; in addition to any stipulated penalties imposed for the underlying noncompliance;

e. For any failure to comply with this Consent Agreement not described in subparagraphs a through d above: $1,000 per day for one to seven days or part thereof of noncompliance, and $2,000 per day for each day of noncompliance, or part thereof, thereafter.

2. All penalties shall begin to accrue on the date that complete performance is due or a violation occurs, and shall continue to accrue through the final day of or correction of the violation. Nothing herein shall prevent the simultaneous accrual of separate stipulated penalties for separate violations of this Consent Agreement.

3. All penalties owed to EPA under this Section XIV shall be due within thirty (30) calendar days of receipt of a demand for payment unless NASA invokes the dispute resolution procedures under Section XV, below. Such notification shall describe the noncompliance and shall indicate the amount of penalties due.

4. All penalty payments shall be made by certified or cashier's check payable to the Treasurer of the United States of America and shall be remitted to:

Regional Hearing Clerk
U.S. Environmental Protection Agency
Region III
P.O. Box 360515
Pittsburgh, Pennsylvania 15251-6515

All payments shall reference the name of the Main Base and Wallops Island Parcels, NASA's name and address, and the EPA Docket Number of this Consent Agreement. Copies of the transmittal of payment shall be sent simultaneously to the EPA Project Coordinator and the Regional Hearing Clerk (3RC00), U.S. Environmental Protection Agency, Region III, 1650 Arch Street, Philadelphia, Pennsylvania 19103-2029.

5. NASA may dispute EPA's demand for payment of stipulated penalties for any alleged violation of this Consent Agreement by invoking the dispute resolution procedures below under Section XV, "DISPUTE RESOLUTION." Stipulated penalties shall continue to accrue, but need not be paid, for any alleged noncompliance which is the subject of dispute resolution during the period of such dispute resolution. To the extent that NASA does not prevail upon resolution of the dispute, NASA shall remit to EPA within seven (7) calendar days of receipt of such resolution any outstanding penalty payment, in the manner described above in Paragraph 4 of this Section XIV. EPA may, in its sole discretion not subject to dispute resolution, reduce or waive any outstanding penalty payment. To the extent NASA prevails upon resolution of the dispute, no penalties shall be payable.

6. Neither the filing of a petition to resolve a dispute nor the payment of penalties shall alter in any way NASA's obligation to comply with the requirements of this Consent Agreement.

7. The stipulated penalties set forth in this Section XIV shall not preclude EPA from pursuing any other remedies or sanctions which may be available to EPA by reason of NASA's failure to comply with any of the requirements of this Consent Agreement.

8. Nothing in this Section is intended to limit NASA's ability to request an extension of a deadline or schedule as otherwise permitted under this Consent Agreement.

XV. DISPUTE RESOLUTION

1. Except as specifically set forth elsewhere in this Agreement, if a dispute arises under this Agreement, the procedures of this Section shall apply. The Parties to this Agreement shall make reasonable efforts to informally resolve disputes at the Project Coordinator or immediate supervisor level. If resolution cannot be achieved informally, the procedures of this Section shall be implemented to resolve a dispute.

2. Within thirty (30) calendar days after any action which leads to or generates a dispute, the disputing party shall submit to EPA a written statement of dispute setting forth the nature of the dispute, the work affected by the dispute, the disputing party's position with respect to the dispute and the information relied upon to support such position.

3. Upon receipt of the written statement of dispute, EPA and NASA shall engage in informal dispute resolution among the Project Coordinators and/or their immediate supervisors. They shall have fourteen (14) business days to resolve the dispute. During this informal dispute resolution period, EPA and NASA shall confer as many times as are

necessary to discuss and attempt resolution of the dispute. If at the conclusion of the fourteen (14) business day period EPA and NASA cannot resolve the dispute, either side shall have ten (10) business days from the conclusion of the fourteen (14) business day dispute resolution period to present the dispute to the Dispute Resolution Committee as set forth in paragraph XV.4., immediately below. If neither EPA nor NASA elevates the dispute within the ten (10) business day period, NASA shall be deemed to have agreed with EPA's position with respect to the dispute.

4. The Dispute Resolution Committee ("DRC") will serve as a forum for resolution of disputes for which agreement has not been reached through informal dispute resolution. The Parties shall each designate one individual and an alternate to serve on the DRC. The individuals designated to serve on the DRC shall be employed at the policy level or be delegated the authority to participate on the DRC for the purposes of dispute resolution under this Agreement. The EPA's representative on the DRC is the Waste and Chemicals Management Division Director of EPA Region III. NASA's designated member is the Chief of the Goddard Space Flight Center Safety and Environmental Division. Written notice of any delegation of authority from the Party's designated representative on the DRC shall be provided to the other Party.

5. Following elevation of a dispute to the DRC, the DRC shall have twenty-one (21) calendar days to unanimously resolve the dispute and issue a written decision signed by all Parties. If the DRC is unable to unanimously resolve the dispute within this twenty-one (21) day period, the written statement of dispute shall be forwarded to the Senior Executive Committee ("SEC") for resolution.

6. The SEC will serve as the forum for resolution of disputes for which agreement has not been reached by the DRC. The EPA's representative on the SEC is the Regional Administrator of EPA Region III. NASA's representative on the SEC is the Assistant Administrator for Institutional and Corporate Management. The SEC members shall, as appropriate, confer, meet and exert their best efforts to resolve the dispute and issue a unanimous written decision signed by all parties. If unanimous resolution of the dispute is not reached within twenty-one (21) calendar days, the EPA Regional Administrator shall issue a written position on the dispute. The NASA Assistant Administrator may, within twenty-one (21) calendar days of the Regional Administrator's issuance of EPA's position, issue a written notice elevating the dispute to the Administrator of U.S. EPA for resolution in accordance with all applicable laws and procedures. In the event that the NASA Assistant Administrator elects not to elevate the dispute to the EPA Administrator within the designated twenty-one (21) day escalation period, the decision will become final and the work will proceed in accordance with the Regional Administrator's written position with respect to the dispute.

7. Upon escalation of a dispute to the Administrator of EPA pursuant to Section XV.6 above, the Administrator will review and resolve the dispute within twenty-one (21) calendar days. Upon request, and prior to resolving the dispute, the EPA Administrator shall meet and confer with the NASA Administrator to discuss the issue(s) under dispute. Upon resolution, the EPA Administrator shall provide the Parties with a written final decision setting forth resolution of the dispute. The duties of the EPA Administrator set forth in this Section shall not be delegated.

8. The pendency of any dispute under this Section shall not affect NASA's responsibility for timely performance of the work required by this Agreement, except that the time period for completion of work affected by such dispute may be extended for a period of time usually not to exceed the actual time taken to resolve any good faith dispute in accordance with the procedures specified herein. All elements of the work required by this Agreement, which are not affected by the dispute, shall continue to be completed in accordance with the applicable schedule.

9. When dispute resolution is in progress, work affected by the dispute will be discontinued if the Waste and Chemicals Management Division Director for EPA Region III directs, in writing, that work related to the dispute be stopped because, in EPA's opinion, such work, among other things, is inadequate or defective. To the extent possible, EPA shall consult with NASA prior to initiating a work stoppage. After stoppage of work, if NASA believes that the work stoppage is inappropriate or may have potential significant adverse impacts, NASA may meet with the EPA to discuss the work stoppage. Following this meeting, and further consideration of the issues, the EPA Division Director will issue, in writing, a final decision with respect to the work stoppage. The final written decision of the U.S. EPA Waste and Chemicals Management Division Director may immediately be subjected to formal dispute resolution. Such dispute may be brought directly to either the DRC or the SEC, at the discretion of NASA.

10. Within twenty-one (21) calendar days of resolution of a dispute pursuant to the procedures specified in this Section, NASA shall incorporate the resolution and final determination into the appropriate plan, schedule or procedures and proceed to implement this Agreement according to the amended plan, schedule or procedures.

11. Resolution of a dispute pursuant to this Section of the Agreement constitutes a final resolution to any dispute arising under this Agreement. All Parties shall abide by all terms and conditions of any final resolution of dispute obtained pursuant to this Section of this Agreement.

XVI. ENFORCEABILITY

1. Violation of this Agreement, or failure or refusal to comply with this Agreement, may subject NASA to a citizens suit under RCRA for civil penalties of up to six thousand five hundred dollars ($6,500) for each day the violation occurs, as provided in Section 7003(b) of RCRA, 42 U.S.C. § 6973(b).

2. This Agreement, including its provisions related to statutory requirements, Early Actions, and Remedial Actions, record keeping, reporting and schedules of compliance, shall be enforceable under citizen suits pursuant to 42 U.S.C. Section 6972.

3. In the event of any action filed under section 7002 of RCRA, alleging any violation of this Agreement, it shall be presumed that this Agreement, including those provisions which address record keeping, reporting and schedules of compliance, are requirements, standards, and conditions, and are thus enforceable under Section 7002 of RCRA.

4. Nothing in this Agreement shall be deemed as authorizing any person(s) to seek judicial review of any action or work where such review is barred by CERCLA, including but not limited to Section 113 (h), 42 U.S.C. Section 9613(h).

XVII. FORCE MAJEURE AND EXCUSABLE DELAY

1. NASA shall perform the requirements of this Consent Agreement in the manner and within the time limits set forth herein, unless the performance is prevented or delayed by events which constitute a force majeure. NASA shall have the burden of proving such a force majeure. A force majeure is defined as any event arising from causes not reasonably foreseeable and beyond the control of NASA, which cannot be overcome by due diligence and which delays or prevents performance in the manner or by a date required by this Consent Agreement. Such events do not include increased costs of performance, changed economic circumstances, reasonably foreseeable weather conditions or weather conditions which could have been overcome by due diligence, or failure to obtain federal, state, or local permits.

2. NASA shall notify EPA, in writing, within seven (7) calendar days after it becomes or should have become aware of any event which NASA claims constitutes a force majeure. Such notice shall estimate the anticipated length of delay, including necessary demobilization and remobilization, its cause, measures taken or to be taken to prevent or minimize the delay, and an estimated timetable for implementation of these measures. Failure to comply with the notice provision of this Section XVII shall constitute a waiver of NASA's right to assert a force majeure claim with respect to such event. In addition to

the above notification requirements, NASA shall undertake all reasonable actions to prevent or to minimize any delay in achieving compliance with any requirement of this Consent Agreement after it becomes or should have become aware of any event which may delay such compliance.

3. If EPA determines that there is excusable delay because the failure to comply or delay has been or will be caused by a force majeure, the time for performance of that requirement of this Consent Agreement may be extended, upon EPA approval, for a period equal to the delay resulting from such force majeure. This shall be accomplished through an amendment to this Consent Agreement pursuant to Section XXIII, "SUBSEQUENT MODIFICATION." Such an extension shall not alter the schedule for performance or completion of any other tasks required by this Consent Agreement, unless these tasks are also specifically altered by amendment of the Consent Agreement. In the event that EPA and NASA cannot agree that any delay or failure has been or will be caused by a force majeure, or if there is no agreement on the length of the extension, NASA may invoke the dispute resolution procedures set forth in Section XV, "DISPUTE RESOLUTION."

XVIII. FUNDING

1. It is the expectation of the Parties to this Agreement that all obligations of NASA arising under this Agreement will be fully funded. NASA agrees to seek sufficient funding through its budgetary process to fulfill its obligations under this Agreement.

2. NASA shall include in its submission in its annual report to Congress the specific cost estimates and budgetary proposals associated with the implementation of this Agreement.

3. Any requirement for the payment or obligation of funds, including stipulated penalties, by NASA established by the terms of this Agreement shall be subject to the availability of appropriated funds. No provision herein shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act, 31 U.S.C. Section 1341.

4. If appropriated funds are not available to fulfill NASA's obligations under this Agreement, EPA reserves the right to initiate an action against any other person, or to take any response action, which would be appropriate. However, should the appropriated funds be inadequate in any year to meet the requirements of this Agreement, NASA will, in consultation with EPA, prioritize and allocate that year's appropriated funds, considering legal requirements pertaining to each site under this Consent Agreement, relative risks to human health and the environment, and other relevant factors.

XIX. RESERVATION OF RIGHTS

1. EPA expressly reserves all rights and defenses that it may have, including the right both to disapprove of work performed by NASA pursuant to this Consent Agreement, to require that NASA correct and/or reperform any work disapproved by EPA, and to request that NASA perform tasks in addition to those stated in the relevant EPA guidance documents, workplan(s), reports(s) and/or this Consent Agreement.

2. EPA hereby reserves all of its statutory and regulatory powers, authorities, rights and remedies, both legal and equitable, including any which may pertain to NASA's failure to comply with any of the requirements of this Consent Agreement. This Consent Agreement shall not be construed as a covenant not to sue, or as a release, waiver or limitation of any rights, remedies, powers and/or authorities, civil or criminal, which EPA has under RCRA, CERCLA, or any other statutory, regulatory or common law authority.

3. Compliance by NASA with the terms of this Consent Agreement shall not relieve NASA of its obligations to comply with RCRA or any other applicable local, state, or federal laws and regulations.

4. The signing of this Consent Agreement and NASA's consent to comply shall not limit or otherwise preclude EPA from taking additional enforcement action pursuant to Section 7003 of RCRA, 42 U.S.C. Section 6973, or any other authority, should EPA determine that such action is warranted.

5. This Consent Agreement is not intended to be, nor shall it be construed as, a permit. This Consent Agreement does not relieve NASA of any obligation to obtain and comply with any local, state, or federal permit or approval except as otherwise provided for in CERCLA Section 121(e)(1).

6. EPA reserves the right to perform any portion of the work consented to herein or any additional Site characterization, feasibility study, and response/remedial actions it deems necessary to protect public health or welfare or the environment. EPA may exercise its authority under RCRA, CERCLA or any other authority to undertake or require the performance of response actions at any time. EPA reserves the right to seek reimbursement from NASA for costs incurred by the EPA in connection with any such response actions. Notwithstanding compliance with the terms of this Consent Agreement, NASA is not released from liability, if any, for the costs of any response actions taken by EPA.

7. EPA reserves whatever rights it may have under CERCLA or any other law, or in equity, to recover from NASA any costs incurred by EPA in overseeing the implementation of

this Consent Agreement.

8.

XX. OTHER CLAIMS

Nothing in this Consent Agreement shall constitute or be construed as a release from any claim, cause of action or demand in law or equity against any person, firm, partnership, or corporation, or other entity for any liability it may have arising out of or relating in any way to the generation, storage, treatment, handling, transportation, release, or disposal of any solid waste, hazardous constituents, hazardous substances, hazardous wastes, pollutants, or contaminants found at, taken to, or taken from the Main Base and/or Wallops Island Parcels.

XXI. OTHER APPLICABLE LAWS

All actions required to be taken pursuant to this Consent Agreement shall be undertaken in accordance with the requirements of all applicable local, state, and federal laws and regulations. The Parties recognize that under Section 121(e)(1) of CERCLA and the NCP, portions of the response actions called for by this Agreement and conducted entirely on site, where such response actions are selected and carried out in accordance with CERCLA, are exempt from the requirement to obtain Federal, Commonwealth, or local permits. All activities must, however, comply with the applicable or relevant and appropriate Federal and Commonwealth standards, requirements, criteria, or limitations that would have been included in any such permit. Except as otherwise provided in CERCLA Section 121(e)(1), NASA shall obtain or require its authorized representatives to obtain all permits and approvals necessary under such laws and regulations.

XXII. NOTICE OF NON-LIABILITY OF EPA

EPA shall not be deemed a party to any contract involving NASA and relating to activities at the Main Base and/or Wallops Island Parcels and shall not be liable for any claim or cause of action arising from or on account of any act, or the omission of NASA, its officers, employees, contractors, receivers, trustees, agents or assigns, in carrying out the activities required by this Consent Agreement.

XXIII. SUBSEQUENT MODIFICATION

1. Except as provided in Paragraph 2 of this Section XXIII, below, this Consent Agreement

may be amended only by mutual agreement of EPA and NASA. Any such amendment shall be in writing, shall be signed by an authorized representative of each party, shall have as its effective date the date on which it is signed by EPA, and shall be incorporated into this Consent Agreement.

2. Minor modifications in the studies, techniques, procedures, designs or schedules utilized in carrying out this Consent Agreement and necessary for the completion of the project may be made by written agreement of the Project Coordinators. Such modifications shall have as an effective date the date on which the agreement is signed by the EPA Project Coordinator.

3. No informal advice, guidance, suggestions, or comments by EPA regarding reports, plans, specifications, schedules, and any other writing submitted by NASA shall be construed as relieving NASA of its obligation to obtain written approval, if and when required by this Consent Agreement.

XXIV. SEVERABILITY

If any provision or authority of this Consent Agreement or the application of this Consent Agreement to any party or circumstance is held by any judicial or administrative authority to be invalid, the application of such provision to other parties or circumstances and the remainder of this Consent Agreement shall not be affected thereby and shall remain in full force.

XXV. TERMINATION AND SATISFACTION

The provisions of this Consent Agreement shall be deemed satisfied upon NASA's receipt of written notice from EPA that NASA has demonstrated, to the satisfaction of EPA, that the terms of this Consent Agreement, including any additional tasks determined by EPA to be required pursuant to this Consent Agreement, have been satisfactorily completed. This notice shall not, however, terminate NASA's obligation to comply with any continuing obligations hereunder including, but not limited to, Sections XI ("RECORD PRESERVATION"), XIX ("RESERVATION OF RIGHTS"), XX ("OTHER CLAIMS") and XXI ("OTHER APPLICABLE LAWS").

XXVI. ATTORNEYS' FEES

NASA shall bear its own costs and attorneys' fees.

XXVII. EFFECTIVE DATE

The effective date of this Consent Agreement shall be the date on which NASA receives a true and correct copy of the fully executed Consent Agreement or a true and correct copy of the fully executed modified Consent Agreement as provided in Section VIII ("PUBLIC COMMENT AND REVIEW OF Agreement").

IT IS SO AGREED:

DATE: 9/28/04 BY: James J. Burke

JAMES J. BURKE
DIRECTOR OF THE WASTE AND CHEMICALS MANAGEMENT DIVISION
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, REGION III

DATE: 9-30-04 BY: E J Weiler

DR. EDWARD J. WEILER,
DIRECTOR
NASA GODDARD SPACE FLIGHT CENTER

Attachment 1
Index of Administrative Record

ADMINISTRATIVE RECORD - WALLOPS FLIGHT FACILITY

CD	ID No.	EPA AR Category and Document Tracking Number	Date	No. of pages	Description of Document/Correspondence	Doc. Type	Site	Author/Author's Affiliation	Recipient/Recipient's Affiliation
					1.0 Pre-Remedial				
					01.01 Pre-Remedial Investigation Correspondence				
1	0001	01.01.00.0001	3/1/1986	131	Vol. 1, Environmental Audit Goddard Space flight Center Wallops Flight Facility	Letter	WFF	Fred C. Hart Associates, Inc.	National Aeronautics and Space Administration (NASA)
1	0002	01.01.00.0002	9/18/1989	17	Review of Removal Actions, Waste Oil Site End of Runway 17-35	Letter	WOD	M. Green, NASA	James A. Asne/EBASCO Services, Inc.
1	0003	01.01.00.0003	3/3/1993	6	Locations and Maps for Coordination of Environmental Sites	Letter	WFF	Teresa Spagnuolo/NASA, Environmental Branch	NASA, Fac. Eng. Br.; Fac. Mgm. Sec; Plant O&M Br.
3	0004	01.01.00.0004	6/2/2003	9	Response to Comments on draft Site Screening Document M-15 Photographic Tank Site	Letter	M15	Tetra Tech NUS, Inc.	NASA, EPA, VADEQ
					01.02 Pre-Remedial Investigation Preliminary Assessment Documents				
2	0005	01.02.00.0001	1/1/1998	14	Preliminary Assessment Report for Wallops Flight Facility (WFF), National Aeronautics and Space Administration, Wallops Island, Virginia, undated	Report	WFF		
1	0006	01.02.00.0002	8/1/1994	371	Environmental Resources Document	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0007	01.02.00.0003	10/0/1999	381	Environmental Resource Document	Report	WFF	Occu-Health, Inc.	NASA
					01.03 Pre-Remedial Investigation Site Investigation Documents				
1	0008	01.03.00.0001	2/1/1989	51	NASA Site Inspection for Goddard Space Flight Center and WFF, Statement of Work for Soil Borings and Well Installations	WP	WFF	EBASCO Services, Inc.	NASA
1	0009	01.03.00.0002	3/1/1989	61	Site Inspection Goddard Space Flight Center Field Sampling Plan	WP	WFF	EBASCO Services, Inc.	NASA
1	0010	01.03.00.0003	1/1/1990	155	Final Site Inspection NASA, Volumes I and II	Report	WFF	EBASCO Services, Inc.	
1	0011	01.03.00.0004	9/1/1990	28	Final Report Soil Gas and PCB Screen; Waste Oil Dump; Scrapyard; PCB Transformer	Report	WFF	EBASCO Services, Inc.	NASA
1	0012	01.03.00.0005	9/26/1991	44	Detection Limits/Analytical Methods for All Analyses: TCL Volatiles, semi-Volatiles, Pesticides/PCB's and TAL Metals and Cyanide	Letter	WFF	Teresa Spagnuolo/NASA	Jane Pilllips/Medcalf & Eddy
1	0013	01.03.00.0006	5/1/1992	142	Quality Assurance/Quality Control Plan; Revision of Site Investigation	WP	WFF	Metcalf & Eddy, Inc.	NASA

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1	0014	01.03.00.0007	5/1/1992	98	Field Sampling and Analysis Plan, Revision of Site Investigation	WP	WFF	Metcalf & Eddy, Inc.	NASA
1	0015	01.03.00.0008	8/1/1992	227	Final Report; Revision of Site Investigation Vol. I	Report	WFF	Metcalf & Eddy, Inc.	NASA
1	0016	01.03.00.0009	8/1/1992	330	Final Report; Revision of Site Investigation Vol. II - References	Report	WFF	Metcalf & Eddy, Inc.	NASA
1	0017	01.03.00.0010	8/1/1992	474	Final Report; Revision of Site Investigation Vol. IV - References	Report	WFF	Metcalf & Eddy, inc.	NASA
1	0018	01.03.00.0011	8/22/1995	469	Final Site Inspection Work Plan	WP	WFF	Metcalf & Eddy, Inc.	NASA
2	0019	01.03.00.0012	5/1/1996	30	Aerial Photographic Analysis NASA - Wallops Flight Facility, Wallops Island, Virginia	Report	WFF	G. I. Martucci/Lockheed Environmental Systems & Technologies Co./EPA/ORD	EPA Hazardous Waste Mgm. Div. Reg. 3, Phila, PA/Office of Emergency and Remedial Response, Wash, DC
2	0020	01.03.00.0013	3/27/1996	512	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume I, Site Inspection Report	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0021	01.03.00.0014	3/27/1996	155	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume II, Preliminary Reports, Phases I-II, Field Surveys	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0022	01.03.00.0015	3/27/1996	407	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume III, Preliminary Reports, Phases III-IV, Field Sampling	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0023	01.03.00.0016	3/27/1996	180	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume IV, Preliminary Reports, HRS Scoring	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0024	01.03.00.0017	3/27/1996	435	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume V, Preliminary Reports, HRS PRECORE Output	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0025	01.03.00.0018	3/27/1996	1168	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume VI, Preliminary Report, HRS PRECORE Output	Report	WFF	Metcalf & Eddy, Inc.	NASA

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2	0026	01.03.00.0019	3/27/1996	92	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume VII, Preliminary Report, EPA HRS PRESCORE Software and Manual	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0027	01.03.00.0020	3/27/1996	425	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume VIII, Preliminary Reports, References	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0028	01.03.00.0021	3/27/1996	699	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume IX, Preliminary Report, References	Report	WFF	Metcalf & Eddy, Inc.	NASA
2	0029	01.03.00.0022	3/27/1996	847	Site Inspection for Miscellaneous Sites at Wallops Flight Facility, Volume X, Preliminary Report, References	Report	WFF	Metcalf & Eddy, Inc.	NASA
3	0030	01.03.00.0023	11/1/2000	36	Wallops Flight Facility - Main Base GIS Based Historical Photographic Analysis 1938-1980	Report	WFF	U.S. Army Corps of Engineers, Norfolk District	NASA
3	0031	01.03.00.0024	7/31/2001	95	Site Investigation Report ADAS Facility Site 10	Report	10	Versar, Inc.	NASA
3	0032	01.03.00.0025	1/14/2003	12	Letter Work Plan for Supplemental Investigations Advanced Data Acquisition Support Facility (ADAS) NASA WFF, Wallops Main Base, NASA, WFF, Wallops Island, Virginia	Letter Report	10	Sue Fields/NASA	Mark Leeper/VADEP and Todd M. Richardson/USEPA
3	0033	01.03.00.0026	2/20/2003	7	Final letter Work Plan, Potable Water Supply Well Sampling	WP	WFF	Tetra Tech NUS, Inc. (TtNUS)	NASA
3	0034	01.03.00.0027	4/8/2003	151	Final Letter Report, Potable Water Supply Well Sampling	Letter Report	WFF	TtNUS	NASA
1	0035	01.03.00.0028	9/0/1990	206	Final Summary Report, Scrapyard, PCB Transformer, Photographic Tank, Waste Oil Dump	Report	WFF	EBASCO Services, Inc.	NASA
01.04 Pre-Remedial Investigation Expanded Site Investigation									
3	0036	01.04.00.0001	1/14/2003	100	Final Letter Work Plan, Background Soil and GW Investigation for the Main Base, NASA, WFF, Wallops Island, Virginia	WP	WFF	Sue Fields/NASA	Mark Leeper/VADEP and Todd M. Richardson/USEPA
3	0037	01.04.00.0002	7/10/2003	66	Summary Site Characterization Report for Wallops Island Fueling Station VADEQ Case No. PC# 93-0913 (Site 6, Building X-5 and X-10)	Report	WFF	TtNUS	NASA

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					2.0 Removal Response				
					02.01 Removal Response Correspondence				
1	0038	02.01.00.0001	2/15/1995	2	Radiation Survey 'Walk-over' of Salvage Yard at Wallops Flight Facility (West Side of Building N-222)	Letter	N-222	Tad M. Blanchard, Senior Health Physics Technician, National Health Services, Inc.	Head, Safety and Health Branch, Terry Potterton/NASA
1	0039	02.01.00.0002	6/30/1995	1	Comments on Proposed Project Approach for Radiological Survey, Scrapyard, Wallops Flight Facility	Letter	N-222	Stacie M. Driscoll/EPA Region III	Ms. Teresa Spagnuolo/NASA
2	0040	02.01.00.0003	1/22/1996	5	Comments on NASA Goddard Space Flight Center Wallops Flight Facility, Scrapyard, Work Plan for Radiological Survey	Letter	N-222	Stacie M. Driscoll/EPA Region III	Ms. Teresa Spagnuolo/NASA
2	0041	02.01.00.0004	3/15/1996	14	Response to Comments on the Work Plan for Radiological Survey	Letter	N-222	Teresa Spagnuolo/NASA	Stacie Morekas-Driscoll/EPA, Region III
2	0042	02.01.00.0005	4/1/1996	1	Work Plan for Radiological Survey, Approval of Response to Comments	Letter	N-222	Stacie M. Driscoll/EPA, Region III	Ms. Teresa Spagnuolo/NASA
3	0043	02.01.00.0006	3/19/2003	2	Notification and Certification Requirements of 40 CFR Part 761.61	Letter	N-222	Sue Fields, NASA RPM	Donald S. Welsh, EPA/ R.G. Brumley DEQVA/K. Bull, Accomack County
					02.02 Removal Response Reports				
1	0044	02.02.00.0001	6/9/1995	11	Proposed Approach for Radiological Survey for Scrapyard located at Wallops Flight Facility (WFF)	Letter	N-222	Teresa Spagnuolo/NASA	Stacie Morekas-Driscoll/EPA, Region III
2	0045	02.02.00.0002	10/10/1997	72	Final Scrapyard Area Radiological Survey Report	Report	N-222	Metcalf & Eddy	NASA
3	0046	02.02.00.0003	10/1/2002	59	Final Sampling and Analysis Plan and Radiological Field Survey for the N-222 Scrapyard and Area	Report	N-222	Weiss Associates	NASA
3	0047	02.02.00.0004	1/1/2003	73	Final Work Plan For The Removal Action At Site 005 and Site 012 Wallops Flight Facility	Report	5/12	Foster Wheeler Environmental Corporation	NASA
3	[redacted]	02.02.00.0005	1/31/2003	162	Soil Sampling and Radiological Field Survey Data Ga[redacted]port	Report	N-222	Weiss Associates	NASA

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3	0049	02.02.00.0006	3/14/2003	101	Removal Action Work Plan for The N-222 Scrapyard Area	Report	N-222	Weiss Associates	NASA
02.03 Removal Response CERCLA Removal Site Record									
3	0050	02.03.00.0001	2/0/2003	7	Action Memorandum for the NASA Goddard Space Flight Center's Non-time-critical Removal Action at the Paint Stain (Site 5) and Former Wind Tunnel (Site 12) Wallops Island, VA	Action Memo	5/12	William B. Bott/NASA	
3.0 Remedial Investigation (RI)									
03.01 Remedial Investigation Correspondence									
1	0051	03.01.00.0001	10/6/1992	14	Review of the draft Work Plan, Fire Training Area, Remedial Investigation/Feasibility Study for Wallops Flight Facility and the draft Field Operations Plan, Fire Training Area, Remedial Investigation/Feasibility Study for Wallops Flight Facility	Letter	FFTA	Stacie Morekas/USEPA	Mr. Terry M. Potterton/NASA
2	0052	03.01.00.0002	2/5/1997	13	Ecological Risk Assessment, Revisions to Work Plan for Sites 5, 12, 14, and 15	Letter	5/12 14/15	Mr. William H. Burton/Versar, Inc.	Coastal Resource Coordinator/National Oceanic and Atmospheric Administration
3	0053	03.01.00.0003	1/1/2002	2	VADEQ Comments on the December 2001 RI/FS for Sites 5 and 12, undated	Letter	5/12	VADEQ	NASA
3	0054	03.01.00.0004	2/25/2002	6	VADEQ Comments on the March 2001 RI/FS for Site 16	Letter	WOD	VADEQ	NASA
03.02 Remedial Investigation Sampling and Analysis Data - validated data and chain of custody forms are included in the AR by indicating their location and									
1	0055	03.02.00.0001	9/16/1993	586	Data Validation Narratives - Volume I	Report	WFF	Versar, Inc./Roy F. Weston, Inc.	NASA
2	0056	03.02.00.0002	5/14/1997	551	Data Validation Narratives - Volume II	Report	WFF	Versar, Inc.(Metcalf & Eddy/Roy F. Weston, Inc.)	NASA
03.03 Remedial Investigation Study Management Plan									

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03.04 Remedial Investigation Work Plan (Including FSAP and QAPP) Progress Report									
1	0057	03.04.00.0001	3/29/1993	225	Fire Training Area RI/Feasibility Final Work Plan	WP	FFTA	Metcalf & Eddy, Inc.	NASA
1	0058	03.04.00.000	3/0/1993	609	Fire Training Area RI/Feasibility Final Field Operations Plan	WP	FFTA	Metcalf & Eddy, Inc.	NASA
1	0059	03.04.00.0003	1/16/1995	373	Limited RI/Feasibility Study Final Work Plan Scrapyard	WP	N-222	Metcalf & Eddy, Inc.	NASA
2	0060	03.04.00.0004	5/2/1997	84	NASA Wallops island RI/FS Work Plan Sites 5, 12, 14, and 15	WP	5/12 14/15	Versar, Inc.	NASA
3	0061	03.04.00.0005	1/0/2003	800	Work Plan for Supplemental RI Activities at the Former Fire Fighting Training Area and Waste Oil Dump	WP	FFTA WOD	Tetra Tech NUS, Inc.	NASA
3	0094	03.04.00.0006	8/1/2003	123	Final Work Plan for the Supplemental RI at WFF Sites 005 and 012 (CD)	WP	WFF	Tetra Tech NUS, Inc.	NASA
03.05 Remedial Investigation Interagency or Federal Facility Agreements									
03.06 Remedial Investigation ARARs - if applicable									
03.07 Remedial Investigation (RI) Report									
1	0062	03.07.00.0001	8/28/1995	203	Limited RI Report for the Scrapyard Area	Report	N-222	Metcalf & Eddy	NASA
2	0063	03.07.00.0002	2/28/1996	370	Former Fire Training Area RI Final Report	Report	FFTA	Metcalf & Eddy	NASA
2	0064	03.07.00.0003	6/14/1999	757	RI/Feasibility Study Sites 14 and 15	Report	14/15	Versar, Inc.	NASA
3	0065	03.07.00.0004	12/6/2001	484	RI/Feasibility Study Sites 5 and 12, Volume I	Report	5/12	Versar, Inc.	NASA
3	0066	03.07.00.0005	12/6/2001	445	RI/Feasibility Study Sites 5 and 12, Volume II	Report	5/12	Versar, Inc.	NASA
3	0067	03.07.00.0006	3/13/2001	477	RI/Feasibility Study Site 16 Waste Oil Dump	Report	WOD	Versar, Inc.	NASA
3	0068	03.07.00.0007	10/6/2003	51	Final Site Screening Document M-15 Photographic Tank (Photo Tank) Site	Report	M15	Tetra Tech NUS, Inc.	NASA

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03.08 Remedial Investigation Health Assessment - produced by ATSDR									
03.09 Remedial Investigation Endangerment/Risk Assessments									
3	0069	03.09.00.0001	12/8/2000	194	Risk Assessment Update Former Fire Fighting Training Area	Report	FFTA	Versar, Inc.	NASA
4.0 Feasibility Study (FS)									
04.01 Feasibility Study (FS) Co									
04.02 FS Sampling and Analysis Da									
04.03 FS Scopes of Work - If applicable									
04.04 FS Work Plans - If applicable									
04.05 FS ARARs - Initial Screening									
04.06 FS Treatability Studies/Site Characterizations - If applicable									
04.07 Feasibility Study (FS) Report									
04.08 FS Proposed Plans for Selected Remedial Action									
5.0 Record of Decision									
05.01 Correspondence									
05.02 Responsiveness Summaries - Administrative Record									

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05.03 Scope of Work									
3	0070	05.03.00.0001	2/7/2002	4	Preliminary Identification, Commonwealth of Virginia, Applicable, Relevant & Appropriate Requirements (ARARs)	Letter	WFF	VADEQ	NASA
05.04 Work Plans									
05.05 Interagency or Federal Facility Agreements									
05.06 ARARs									
05.07 Records of Decision									
3	0071	05.07.00.0001	2/24/2003	69	Final Decision Document for Building N-161C PCB Transformer Pad Site NASA Wallops Flight Facility	Report	N-161	Tetra Tech NUS, Inc.	NASA
3	0095	05.07.00.0002	8/1/2002	156	Final Decision Document for Advance Data Acquisition Support Facility (ADAS) Site NASA Wallops Flight Facility	Report	N-161	Tetra Tech NUS, Inc.	NASA
6.0 Remedial Design									
06.01 Correspondence									
06.02 Sampling and Analytical Data									
06.03 Scope of Work									
06.04 Work Plans and Technical Memorandum									
06.05 Cost Estimates									

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06.06 Interagency and Cooperative Agreements									
06.07 Applicable or Relevant and Appropriate Requirements (ARARs)									
06.08 Remedial Design Documents									
7.0 Remedial Action									
07.01 Correspondence									
07.02 Sampling and Analytical Data									
07.03 Scopes of Work									
07.04 Work Plans and Progressive Reports									
3	0072	07.04.00.0001	6/1/2003	38	Final Work Plan Addendum for the OE Removal Action at the N-222 Scrapyard Area WFF 2/03	Report	N-222	NASA	NASA
3	0073	07.04.00.0002	6/1/2003	59	Final Site Health and Safety Plan Addendum for the OE Removal Action at the N-222 Scrapyard Area, June 2003	Report	N-222	NASA	NASA
07.05 Cost Reports and Invoices									
07.06 Interagency and Cooperative Agreements									
07.07 ARAR									
07.08 Remedial Action Documents									

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					8.0 Site Closeout (BRAC Documents)				
					08.01 Correspondence				
					08.02 Deletion from National Priorities List				
					08.03 Operation and Maintenance				
					08.04 Contractor Work Plans and Reports				
					08.05 Cost Reports and Invoices				
					08.06 Long Term Responses				
					9.0 State Coordination				
					09.01 Correspondence - documents of state involvement				
					09.02 Federal Facility/State Contract/State Lead Permit - if applicable				
					09.03 State Memorandum of Agreement/SMOA - if applicable				
					10.0 Enforcement				
					10.01 Correspondence				
					10.02 Unilateral Orders				

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					10.04 State Negotiations				
					10.05 Federal Facility Negotiation				
					10.06 EPA Administrative Order				
					10.07 EPA Consent Order				
					13.0 Community Relations				
					13.01 Correspondence - all written comments from the public including factual data and Federal Agency responses				
					13.02 Mailing List				
3	0074	13.02.00.0001	3/1/2003	6	Community Involvement Mailing List, Appendix A	List	WFF	Tetra Tech NUS, Inc.	NASA
					13.03 Technical Review Committee				
					13.04 Community Involvement Plan				
3	0075	13.04.00.0001	3/1/2003	47	Community Involvement Plan for NASA Wallops Flight Facility, Wallops Island, Virginia	Plan	WFF	Tetra Tech NUS, Inc.	NASA
					13.05 Public Meetings - transcripts with public comments, responsiveness summaries, and EPA responses				
3	0076	13.05.00.0001	12/28/2002	2	Public Notice for Sites 5/12 RI, Removal Work Plan, Action Memo, and Removal Action	PN	5/12	Gannett Publications	
					13.06 Fact Sheets				
1	0077	13.06.00.0001	4/1/1991	1	Environmental Fact Sheet, Old Aviation Fuel Tank Farm	FSh	WFF	NASA, Public Affairs	
1	0078	13.06.00.0002	9/1/1991	2	Environmental Insight Fact Sheet, Old Aviation Fuel Tank Farm	FSh	WFF	NASA, Public Affairs	
1	0079	13.06.00.0003	9/1/1992	1	Environmental Insight Fact Sheet, Old Aviation Fuel Tank Farm	FSh	WFF	NASA, Public Affairs	

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1	0080	13.06.00.0004	10/1/1993	1	Environmental Insight Fact Sheet, Old Aviation Fuel Tank Farm	FSh	WFF	NASA, Public Affairs	
1	0081	13.06.00.0005	10/1/1994	2	Environmental Insight Fact Sheet, Old Aviation Fuel Tank Farm	FSh	WFF	NASA, Public Affairs	
3	0082	13.06.00.0006	12/1/2002	2	NASA Fact Sheet, NASA's Environmental Restoration Program at Wallops Flight Facility	FSh	WFF	NASA, Public Affairs	
3	0083	13.06.00.0007	6/0/2002	2	Former Wind Tunnel (Site 12) Contaminated Soil, Fact Sheet	FSh	5/12	NASA, Env. Program	
					14.0 Congressional Relations				
					14.01 Correspondence – If applicable				
					14.02 Transcripts – If applicable				
					14.03 Testimonies – If applicable				
					14.04 Published Hearing Records – If applicable				
					16.0 Natural Resource Trustee				
					16.01 Correspondence				
3	0084	16.01.00.0001	1/14/2003	5	Natural Resource Trustee Notification	Letter	WFF	Sue Fields/NASA	Robert M. Burr/US DOI
3	0085	16.01.00.0002	1/14/2003	5	Natural Resource Trustee Notification	Letter	WFF	Sue Fields/NASA	Russell Bellmar/NOAA
3	0086	16.01.00.0003	1/14/2003	5	Natural Resource Trustee Notification	Letter	WFF	Sue Fields/NASA	Honorable W. Tayloe Murphy,Jr./Secretary Natural Resources, Commonwealth of VA
					16.02 Natural Resource Trustee Reports				
					16.03 Environmental Assessment/Evaluation				
					16.04 Technical Issue Paper				

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					18.0 Initial Remedial Measures (IRM)				
					18.01 Correspondence				
					18.02 IRM Response				
					19.0 Resource Conservation and Recovery Act (RCRA) Records				
					19.01 Correspondence				
					19.02 Notification Part A/Part B				
					19.03 RCRA Facility Assessment (RFA) Report				
1	0087	19.03.00.0001	11/1/1992	147	Draft RFA Report	Report	WFF	Versar, Inc.	
					19.04 RCRA Facility Inspection (RFI) Report				
					19.05 RCRA Enforcement Action				
					19.06 Quarterly Enforcement Action				
					19.07 RCRA Corrective Measures Study (CMS)				
					19.08 RCRA Statistical Data				
					19.09 RCRA Corrective Measures Implementation				

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[illegible]									
19 / 1 Correspondence									
19 / 2 Sampling and Analysis Data									
19 / 3 Corrective Action MGMT [illegible]									
19 / 4 Work Plans									
19 / 5 Interagency/Federal Facility Agreements									
19 / 6 ARARs									
19 / 7 RCRA Facility Investigation (RFI) Reports									
19 / 8 Health/Endangerment/Risk Assessments									
19 / 9 Interim Measures									
19 / 10 RCRA Corrective Measures Study (CMS)									
19 / 11 Correspondence									

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19.72 Sampling and Analysis Data									
19.73 Scopes of Work									
19.74 Work Plan									
19.75 ARARs - Initial Screening									
19.76 Treatability Studies/Site Characterization									
19.77 Corrective Measure Study (CMS) Report									
19.78 Proposed Plan for Selected Remedial Action									
19.79 RCRA Statement of Basis									
19.84 Correspondence									
[illegible] Responsiveness Summaries									
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[illegible]									
19.86 ARARs									
19.87 Statement of Basis									
19.90 RCRA Corrective Measures [illegible]									
19.91 Correspondence									
19.92 Sampling and Analysis Data									
19.93 Scopes of Work									
19.94 Work Plans/Progress Reports									
19.95 Cost Reports and Invoices									
19.96 Interagency and Cooperative Agreements									
19.97 ARARs									
19.98 Corrective Measures Design/Construction Implementation									

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21.0 Non-Specific/Oversight Activities									
21.01 Correspondence - If applicable									
21.02 RPM Meeting Minutes - Handouts - If Material									
3	0088	21.02.00.0001	10/23/2001	3	Remedial Project Managers Meeting Summary	Minutes	WFF	Sue Fields/NASA	Project Team
3	0089	21.02.00.0002	1/23/2002	2	Remedial Project Managers Meeting Summary	Minutes	WFF	Sue Fields/NASA	Project Team
3	0090	21.02.00.0003	4/30/2002	1	Remedial Project Managers Meeting Summary	Minutes	WFF	Sue Fields/NASA	Project Team
3	0091	21.02.00.0004	8/19/2002	1	Remedial Project Managers Meeting Summary	Minutes	WFF	Sue Fields/NASA	Project Team
3	0092	21.02.00.0005	12/4/2002	84	Remedial Project Managers Meeting Summary	Minutes	WFF	Sue Fields/Donna Sutherland/NASA	Project Team
3	0093	21.02.00.0006	3/6/2003	23	Final Remedial Project Managers Meeting Summary	Minutes	WFF	Donna Sutherland/NASA	Project Team
3	0096	21.02.00.0007	6/18/2003	7	Remedial Project Managers Meeting Summary	Minutes	WFF	Brenda Harris/Carolyn Turner	Project Team
50.0 Administrative Record Oversight Activities									
50.01 Internal Requests for AR Inclusion									
50.02 Repository Correspondence									

MODULE V
DETECTION MONITORING

V.A. HIGHLIGHTS

The Open Burn/Open Detonation (OB/OD) Facility at the NASA Wallops Flight Facility (WFF) is located on the southwest end of Wallops Island and consists of three cylinders embedded in the ground and a single open burn pad assembly. Groundwater monitoring at the OB/OD site is to be conducted under a Detection Monitoring Program until such time that hazardous constituents related to the site are detected at statistically significant concentrations above background concentrations. At that time a permit modification is necessary that requires WFF to enter into a Compliance Monitoring Program.

V.B. DETECTION MONITORING REQUIREMENTS

V.B.1. The Detection Monitoring Program requires semiannual monitoring of a background well and at downgradient point of compliance wells. Static groundwater elevation will be measured at all wells specified in **Permit Section V.B.1.a**.during each sampling event.

a. Groundwater beneath the OB/OD shall be monitored with one background groundwater monitoring well and at least three downgradient point of compliance wells located as specified on the map presented in **Permit Figure II.AA-4**.

As a result of the major storm event of November 11 -13, 2009, the original background monitoring well MW-3 was damaged and was deemed inoperable. The Permittee submitted a *Open Burn Area Proposed Background Well (MW-4) Analysis Report*, dated February 9, 2010. The above Report proposed an original point-of-compliance well, MW-4, to serve as the new background monitoring well, replacing the damaged background well MW-3. In a letter dated April 5, 2010, the DEQ determined that MW-4 was a suitable replacement background well. On May 6, 2010, the Permittee requested a Class 2 permit modification to replace MW-3 with MW-4 as the facility background well. MW-4 was approved as the OB/OD unit background well on August 3, 2010.

Monitoring well MW-4 is the background well for the OB/OD unit and monitoring wells MW-1, MW-2, MW-5, MW-6, and MW-7 are the point of compliance wells.

V.B.2. The compliance point wells and background well will be sampled in accordance with the Sampling and Analysis Plan (**Permit Attachment V.AA**) and the following schedule:

a. The background well and downgradient point of compliance wells specified in **Permit Section V.B.1.** will be sampled at least semi-annually for the constituents listed in **Permit Attachment V.BB.**. Samples for each constituent will be collected using the methods specified in **Permit Attachment V.AA** and analyses shall be obtained using the EPA SW-846 Methods specified in **Permit Attachment V.BB.**.

b. Alternate SW-846 methods may be approved by the Director, provided the request is in writing and submitted 30 days prior to the sampling event. Proposed alternate methods must achieve the same Limit of Quanititation (or lower) as the specified method and meet the requirement of **Permit Attachment V.AA. SectionIII.C**

V.C. **WELL LOCATION, INSTALLATION AND CONSTRUCTION**

The Permittee shall maintain the groundwater monitoring system as specified below:

V.C.1. The Permittee shall maintain groundwater monitoring wells MW-1, MW-2, MW-4, MW-5, MW-6, and MW-7 at the locations specified on the map presented in **Figure II.AA-4**. If additional monitoring wells are required they shall be installed and sampled in accordance with the requirements of 40 CFR 264.97.

a. Boring logs for monitoring wells MW-1, MW-2, MW-4, MW-5, MW-6, and MW-7 are included as **Exhibit V.AA-8**.

b. Monitoring well design and construction details for monitoring wells MW-1, MW-2, MW-4, MW-5, MW-6, and MW-7 are included as **Exhibit V.AA-8**.

V.C.2. All groundwater monitoring wells required by this permit shall be maintained in conformance with the following:

a. The groundwater monitoring system must yield samples in the background well that represent the quality of the background groundwater unaffected by leakage from any regulated unit, and from downgradient wells that yield samples representative of the quality of groundwater passing the compliance point.

b. The number and location of monitoring wells must be sufficient to identify and define all logical release pathways from the regulated unit to the

uppermost aquifer based on site specific hydrogeologic characterization.

V.C.3. The Permittee shall maintain the monitoring wells identified in **Permit Section V.C.1.** of the Permit in accordance with the plans and specifications presented in **Exhibit V.AA-8**.

V.C.4. The Director must approve the addition or removal of all monitoring wells prior to installation or decommissioning.

a. All wells deleted from the monitoring program shall be plugged and abandoned in accordance with **Exhibit V.AA-7**. Well plugging methods and abandonment certification shall be submitted to the Director within thirty (30) days from the date the wells are removed from the monitoring program.

b. All monitoring wells added to the existing groundwater monitoring system described in **Permit Section V.C.1.** must be constructed in accordance with the requirements of EPA's *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (TEGD) and approved by the Department **(Exhibit V.AA-5)**.

V.D. INDICATOR PARAMETERS AND MONITORING CONSTITUENTS

V.D.1. The Permittee shall monitor all wells as described in **Permit Section V.C.1** for all parameters and constituents specified in **Attachment V.BB.**

V.D.2. Background groundwater concentrations shall be established the first year subsequent to Permit issuance. Existing data may be used to establish background concentrations provided it is of sufficient quality. Established background values for parameters and constituents will be listed in **Attachment V.CC.**

V.D.3. For those parameters and constituents in **Attachment V.BB** for which no accurate background values are established at the time the Permit is issued (or for constituents added to the monitoring program during the life of the Permit), the Permittee shall establish accurate background values in accordance with the procedures in **Exhibit V.AA-6**.

a. Background groundwater quality for a monitoring parameter or constituent shall be based on data from quarterly sampling of MW-3 for one year.

V.E. SAMPLING AND ANALYSIS PROCEDURES

The Permittee shall use the following techniques and procedures when obtaining and analyzing samples from the groundwater monitoring wells described in

Permit Sections V.C.:

V.E.1. Groundwater monitoring samples shall be collected using the techniques described in **Attachment V.AA.**

V.E.2. Samples shall be preserved, packed, and shipped off-site for analysis in accordance with the procedures specified in **Permit Attachment V.AA.**

V.E.3. Samples shall be analyzed in accordance with the procedures specified in **Permit Attachment V.AA.** using the methods prescribed in **Attachment V.BB.**

V.E.4. Samples shall be tracked and controlled using the chain-of-custody procedures specified in **Attachment V.AA.**

V.E.5. The Permittee must determine the concentration of hazardous constituents and parameters listed in **Attachment V.AA** in the groundwater at the compliance point at least semi-annually.

V.F. ELEVATION OF THE GROUNDWATER SURFACE

V.F.1. The Permittee shall determine the groundwater surface elevation at each monitoring well (MW-1, MW-2, MW-4, MW-5, MW-6, and MW-7) each time groundwater is sampled in accordance with **Attachment V.AA**.

V.F.2. The Permittee shall report the surveyed elevation of any additional or replacement monitoring well(s) when installed with as-built drawings. The total depth of wells and the elevation of the following shall be recorded: top of the casing, ground surface and/or apron elevation, and the top of the protective casing.

V.G. STATISTICAL PROCEDURES

V.G.1. When evaluating the monitoring results in accordance with **Permit Section V.H.**, the Permittee shall use the procedures in **Exhibit V.AA-6.**

a. If the appropriate statistical test (specified in **Exhibit V.AA-6** and/or approved by the Director) indicates that the difference between the established background (or upgradient well concentration) and the downgradient well concentration is significant, the Permittee may repeat the procedure with a fresh sample from the monitoring well collected within thirty (30) days of the original sample.

b. If the second round of analyses specified in **Permit Section V.G.1.a.** indicates that the difference is significant, the Permittee shall conclude that a

statistically significant change has occurred and the Permittee shall follow the procedures of Permit Section **V.H.5.**

V.H. MONITORING PROGRAM AND DATA EVALUATION

The Permittee shall determine groundwater quality as follows:

V.H.1. The Permittee shall collect, preserve, and analyze groundwater samples pursuant to **Permit Section V.E.**

V.H.2. For each hazardous constituent identified in **Permit Section V.D.**, the Permittee shall determine whether there is statistically significant evidence of increased contamination for any parameter or chemical constituent each time the concentration of hazardous constituents is monitored in groundwater at the compliance point. In determining whether such an increase has occurred, the Permittee shall compare the groundwater quality at each monitoring well specified in **Permit Section V.B.** of the Permit, to the background concentration for that constituent, in accordance with the procedures specified in **Attachment V.AA** if appropriate. These determinations shall be made each time groundwater monitoring occurs.

V.H.3. The Permittee shall determine the groundwater flow rate and direction in the uppermost aquifer at least annually.

V.H.4. The Permittee shall perform the statistical evaluation required by **Permit Section V. G.** within 30 days from the date the analytical results are available from the laboratory performing the analyses.

V.H.5. Pursuant to **Permit Section V.G.**, if the Permittee determines there is a statistically significant evidence of increased contamination above the concentration limits specified in **Attachment V.BB** for the constituents specified in **Permit Section V.D.** (indicating that the background concentration is being exceeded), at any monitoring well at the point of compliance, the Permittee shall:

a. Notify the Department in writing within seven (7) days of the determination. The notification must include what parameters or constituents have shown statistically significant evidence of contamination;

b. Immediately sample the groundwater in all monitoring wells for the constituents listed in Appendix IX of CFR 40 Part 264.

c. For any Appendix IX constituents detected, the Permittee may resample within thirty (30) days and repeat the analysis for those constituents detected.

If the results of the second analysis confirm the initial results, the detected Appendix IX constituents will form the basis for Compliance Monitoring.

d. If the second analysis (**Permit Section V.H.5.c.**) confirms the presence of constituents not included in the Detection Monitoring program or if the Permittee chooses not to resample, the Permittee shall establish the background values for each additional Appendix IX to 40 CFR Part 264 constituent found in the groundwater pursuant to **Permit Sections V.D.2 and V.D.3.**

e. Within ninety (90) days, submit to the Director a Permit modification request to establish a Compliance Monitoring Program [Module VI and 40 CFR 264.98(h)]. The application must include the following:

i. An identification of the concentration of each Appendix IX to CFR 40 Part 264 constituent found in the groundwater at each monitoring well at the compliance point.

ii. Proposed changes to the groundwater monitoring system necessary to meet the requirements of compliance monitoring as described in 40 CFR 264.99.

iii. Proposed changes to the monitoring frequency, sampling and analysis procedures, or methods or statistical procedures used at the facility necessary to meet the requirements of compliance monitoring as described in 40 CFR 264.99.

iv. For each hazardous constituent found at the compliance point, a proposed concentration limit, or a notice of intent to seek an alternate concentration limit for a hazardous constituent.

V.H.6. If the Permittee determines, pursuant to **Permit Condition V.H.5.**, that there is a statistically significant increase above the background concentration for the constituents specified in **Attachment V.BB,** the Permittee may make a demonstration that the exceedence was due to sources other than a regulated unit or errors in sampling, analysis, evaluation, or natural variation in the groundwater.

a. The Permittee must notify the Director in writing, within seven (7) days, that a demonstration will be made.

b. The Permittee must submit a report to the Director within ninety (90) days that demonstrates that a source other than a regulated unit caused the exceedence or that the exceedence was a result of an error in sampling,

analysis, or evaluation.

c. The Permittee must submit to the Director within 90 days an application for a permit modification to make any appropriate changes in the Detection Monitoring Program at the facility.

d. The Permittee must continue to monitor in accordance with the Detection Monitoring Program established under 40 CFR 264.98.

V.I. REPORTING AND RECORDKEEPING

V.I.1. The Permittee shall enter all monitoring, testing, and analytical data obtained pursuant to **Permit Section V.H.** in the operating record. The data must include all computations, calculated means, variances, and results of statistical tests and must be submitted to the Director, at least annually, no later than March 1 of each year.

V.I.2. The Permittee shall submit the analytical results (**Permit Section V.H.**), whenever there is a change in flow rate or direction, or statistically significant evidence of increased contamination in one or more of the hazardous constituents being monitored, or at least annually with the annual groundwater report.

V.I.3. The Permittee shall annually submit potentiometric contour maps depicting groundwater flow paths and the supporting groundwater elevation data to determine whether the requirements for locating the monitoring network continue to be satisfied. If the evaluation determines the existing monitoring wells no longer satisfy the requirements of 40 CFR 264.97(a), the Permittee shall immediately submit a permit modification request to the Director to bring the monitoring system back into compliance.

V.J. ASSURANCE OF DETECTION

The Permittee shall demonstrate to the Director that groundwater monitoring and corrective action measures necessary to achieve compliance with the groundwater protection standard under 40 CFR 264.92 are taken during the term of the Permit.

V.K. REQUESTS FOR PERMIT MODIFICATION

V.K.1. If the Permittee or the Director determines the Groundwater Detection Monitoring Program no longer satisfies the requirements of 40 CFR 264.98, then the Permittee shall submit to the Director an application for a permit modification to make any appropriate changes to the program in accordance with 40 CFR 264.98(h).

ATTACHMENT V.AA

GROUNDWATER MONITORING PROGRAM SAMPLING AND ANALYSIS PLAN

ATTACHMENT V.AA

GROUNDWATER MONITORING PROGRAM
SAMPLING AND ANALYSIS PLAN

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WALLOPS ISLAND OB/OD, SAMPLING AND ANALYSIS PLAN

I.A. INTRODUCTION

Federal regulations at 40 CFR§270.14(c)(5), 270.14(c)(6)(iv), and 270.14(c)(7)(vi) require a description of the sampling, analysis, and statistical comparison procedures proposed for evaluating groundwater monitoring data. In addition, §§264.97(d) and 264.97(e) outline minimum procedures and techniques for groundwater monitoring programs implemented pursuant to 40 CFR Part 264 Subpart F. These regulations require that groundwater monitoring programs include measurement, sampling, and analytical methods that accurately assess groundwater quality, and that provide early detection of hazardous constituents released to groundwater.

Groundwater beneath the OB/OD unit will be monitored with one background monitoring well and six downgradient compliance point monitoring wells located as specified on the map presented in **Figure II.AA-4.** Monitoring well MW-4 is the background well. Monitoring wells MW-1, MW-2, MW-5, MW-6, and MW-7 are the point of compliance wells for the unit.

The Wallops Island Sampling and Analysis Plan (S&AP) is an essential part of the Detection Monitoring Program in that it stipulates the field sampling, laboratory analysis and annual reporting methods to be utilized throughout the post-closure period. The S&AP addresses the Detection Monitoring Program requirements prescribed in the VHWMR, 9 VAC 20-60 § 264.98 and as described in the Operating Permit.

I.B. SAMPLING FREQUENCY

Groundwater samples will be collected and analyzed semi-annually at each point of compliance well for all the constituents listed in **Attachment V.BB. Permit Attachment V.BB** lists the parameters, constituents, and test methods required for the Detection Monitoring Program. The Permittee may resample for any statistically significant detection within 30 days to confirm or refute the detection.

I.C. FIELD METHODS

The following activities should be performed prior to collecting ground-water samples for analysis:

- Measurement of static water level elevation;
- Detection and sampling of immiscible layers; and
- Well purging.

I.C.1. Measurement of Static Water Level Elevations:

Prior to purging each well, both the static water level (SWL) and the depth to the bottom of the well shall be measured to ±0.01 foot. Well measurements will be made using an electronic water level probe, referenced to a predetermined mark at the top of the well casing. The elevation of the top of the well casing (with locking cap removed) will be established to an elevation ±0.01 foot, in relation to the existing landfill datum, which will be established from a National Geodetic Vertical Datum.

The static ground water surface elevations obtained prior to each sampling event shall be used to create potentiometric maps to determine whether the requirements for locating the monitoring wells continues to be satisfied. If the potentiometric maps reveal that the depths, location, or number of wells is insufficient to monitor hazardous waste constituents migrating from the waste management area, new well locations and depths will be submitted to the Department for their approval and subsequent installation and monitoring. Any new wells will be installed prior to the next regularly scheduled groundwater sampling event.

Background wells and wells where constituents have not historically been noted will be measured first, followed by wells where constituents have been noted. All measurements for each well will be recorded in the Groundwater Log. Measurements that do not correlate with the previous trends will be verified in the field with different measurement technology, if necessary.

I.C.2. Calculation of Static Water Volume:

The static water level and total depth will be used to calculate the volume of stagnant water in the well and provide a check on the integrity of the well (e.g., identify siltation problems), as well as characterize changes in hydraulic conditions that may occur over time. The static water level measuring device used will be constructed of inert materials and thoroughly decontaminated prior to each use to prevent cross contamination from one well to another. The meter will be decontaminated by washing with non-phosphate detergent and rinsing three times with deionized water prior to air-drying. Decontamination fluid will be containerized and disposed of in an on-site wastewater treatment system if available or a publicly owned treatment facility with approval. Sampling members will wear clean gloves during sampling and shall change gloves between sampling each well at a minimum.

I.C.3. (Reserved)

I.C.4. Well Purging

The volume of stagnant water in each well will be determined prior to well evacuation based on the static water level, well depth, well diameter, filter pack length, and borehole diameter. Three volumes of the pore space of the screen filter pack and three volumes of the well casing will be purged prior to sampling if

possible. The volume of stagnant water to be purged shall be calculated according to the formulae presented in Exhibit V.AA-2 of this Attachment. Purge volume calculations will be recorded in the Groundwater Log shown in Exhibit V.AA-1, or volume purged shall be sufficient when pH, temperature, and conductivity have stabilized.

a. If the wells prove to be low yield, wells will be evacuated to dryness once and will be purged at a rate which will not cause recharge water to be excessively agitated. Dry and low recharge rates will be noted in the field observations.

b. All purge water will be containerized and disposed of in an on-site wastewater treatment system if available or a publicly owned treatment facility with approval.

Stabilization parameters pH, temperature, and conductivity will be measured at the start and end of sampling as a check on the stability of the water samples over time. Four (4) replicate measurements of pH and specific conductivity will be recorded in the Groundwater Log shown in Exhibit V.AA-1 for each groundwater sample. In addition to the start and end measurements, additional measurements will be taken for each well volume. All purging equipment that has been or will be in contact with ground water should be decontaminated prior to use (See Section I.C.6.). Decontamination water should be stored in appropriate containers and disposed of per I.C.4.b and Exhibit V.AA-9.

I.C.5. Groundwater Sampling Equipment:

The Department prefers that all sampling equipment be dedicated to a particular well. The following recommendations apply to the selection of sampling equipment:

- Sampling equipment should be chosen based on the analytes of interest and the characteristics and depth of the saturated zone from which the sample is withdrawn. For example, the choice of sampling equipment should reflect consideration of the potential for Light Non Aqueous Phase Liquids and Dense Non Aqueous Phase Liquids.

- Sampling equipment should be constructed of inert material. Sample collection equipment should not alter analyte concentrations, cause loss of analytes via sorption, or cause gain of analytes via desorption, degradation, or corrosion.

- Sampling equipment should be designed such that Viton®, Tygon®, silicone, or neoprene components do not come into contact with the ground-water sample.

- Sampling equipment should cause minimal sample agitation and should be selected to reduce/eliminate sample contact with the atmosphere during sample transfer. Sampling equipment should not allow volatilization or aeration of samples to the extent that analyte concentrations are altered.

I.C.6. Decontamination:

When dedicated equipment is not used for sampling (or well purging) or when dedicated equipment is stored outside of the well, it will be thoroughly decontaminated between wells by disassembling and washing with (non-phosphate) detergent, thoroughly rinsed with de-ionized water, and air dryed. All equipment coming in contact with media suspected of being contaminated will be decontaminated before it contacts a media which is likely to be less contaminated or uncontaminated.

All non-dedicated ground water sampling equipment will be cleaned over a decontamination pad after each use in the following manner:

- Rinse with tap water.
- Wash with a non-phosphate laboratory detergent and tap water.
- Rinse with distilled water
- Wash with laboratory-grade methanol or isopropanol
- Triple rinse with de-ionized, distilled water
- Allow to air dry.

If the equipment is not to be used again immediately, it should be packaged and properly stored to protect it from dust and dirt. Equipment may be wrapped in aluminum foil (shiny side on the outside) and placed in a plastic bag. A label should be affixed to the outside wrapping summarizing the decontamination procedure and stating the date of decontamination. Decontaminated sampling equipment should not be placed on the ground or on other contaminated surfaces prior to insertion in the well.

The decontamination pad will be lined with polyethylene sheeting and sloped to promote drainage towards one corner into an in-ground container. This will facilitate removal of any potentially contaminated decontamination fluids. The fluids will be collected, contained, labeled, and stored in U.S. Department of Transportation (DOT)-approved 55 gal drums. All decontamination fluids will be managed and disposed of in accordance with the DEQ Investigation-Derived Waste Policy (Appendix 9). Disposable items will be disposed of as solid waste in an approved, permitted landfill.

I.C.7. Groundwater Sample Collection

Monitoring well sampling should always progress from a well that is the least contaminated to the well that is the most contaminated, to minimize the potential for cross-contamination of samples that may result from inadequate

decontamination of sampling equipment. Samples should be collected and containerized according to the volatility of the target analytes. The preferred collection order for some of the more common groundwater analytes is as follows:

- Volatile organics and total organic halogens
- Dissolved gases and total organic carbon
- Semi-Volatile Organics
- Pesticides/herbicides
- PCBs
- Metals and cyanide
- Total Phenols
- Major water quality cations and anions (sulfate, chloride, etc.)
- Nitrate

A sample collecting bottle kit should be prepared from the sample parameter list in accordance with approved sample analysis methods (see Appendix 4). The sample kit should be stored in clean coolers for transport to the site. To preserve sample intergrity, all samples should be collected in precleaned containers, preserved when required, and stored at the appropriate temperature. The containers shall be shipped with caps that are securely fastened. Samples shall be transferred directly from the sampling device to the sample containers.

The following recommendations apply to the use and operation of groundwater sampling equipment:

- Check valves should be designed and inspected to ensure that fouling problems do not reduce delivery capabilities or result in aeration of samples.

- Sampling equipment should never be dropped into the well, as this will cause degassing of the water upon impact.

- Contents of the sampling device should be transferred to sample containers in a controlled manner that will minimize sample agitation and aeration.

- Decontaminated sampling equipment should not be allowed to come into contact with the ground or other contaminated surfaces prior to insertion into the well.

- Ground-water samples should be collected as soon as possible after the well is purged. Water that has remained in the well casing for more than about 2 hours has had the opportunity to exchange gases with the atmosphere and to interact with the well casing material.

- The rate at which a well is sampled should not exceed the rate at which the

well was purged. Low sampling rates, approximately 0.1 L/min, are suggested. Pumps should be operated at rates less than 0.1 L/min when collecting samples for volatile organics analysis.

- Pump lines should be cleared at a rate of 0.1 L/min or less before collecting samples for volatiles analysis so that the samples collected will not be from the period of time when the pump was operating more rapidly.

- Pumps should be operated in a continuous, non-pulsating manner so that they do not produce samples that are aerated in the return tube or upon discharge.

- When sampling wells that contain LNAPLs, a stilling tube should be inserted in the well. Groundwater samples should be collected from the screened interval of the well below the base of the tube.

- Groundwater samples collected for analysis for organic constituents or parameters should not be filtered in the field.

I.D. FIELD AND LABORATORY QA/QC PROGRAM

Field Quality Assurance/Quality Control (QA/QC) requires the routine collection and analysis of blanks to verify that the sample collection and handling process has not affected the quality of the samples. Both field and laboratory QC samples should be prepared during the sampling event. It is recommended that the following samples be analyzed with each batch of samples (a batch may not exceed 20 samples):

- One field duplicate;
- One equipment rinsate (required only when non-disposable equipment is being used);
- One matrix spike (when appropriate for the method); and
- One duplicate sample (either a matrix duplicate or a matrix spike duplicate).

A trip blank should be prepared and analyzed when samples are being analyzed for volatile organic analytes. A trip blank should be submitted with samples each day that samples are collected.

I.D.1. All field QC samples should be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The concentrations of any contaminants found in blank samples should not be used to correct the groundwater data. The contaminant concentrations in blanks should be documented, and if the concentrations are more than an order of magnitude greater than the field sample results, the Permittee should resample the ground water. Other QA/QC practices such as sampling equipment calibration,

equipment decontamination procedures, and chain-of-custody procedures are discussed in other sections of this Attachment.

I.D.2. Laboratory QA/QC Program

The permitte's laboratory should provide for the use of control samples. The Permittee should use appropriate statistical procedures to monitor and document performance and to implement an effective program to resolve testing problems (e.g., instrument maintenance, operator training). Data from control samples (e.g., spiked samples, duplicates, and blanks) should be used as a measure of performance or as an indicator of potential sources of cross-contamination. All QC data should be submitted to the Department with the groundwater monitoring sample results.

I.D.3. At a minimum, all field instruments should be calibrated at the beginning of each use and in accordance with the frequency suggested by the manufacturer. Field instruments should be calibrated using at least two calibration standards spanning the range of results anticipated during the sampling event. For example, if groundwater pH is expected to be near pH 7, the two standards used to calibrate the pH meter should be pH 4 and pH 10, respectively.

I.E. SAMPLE HANDLING AND CHAIN-OF-CUSTODY

Sample handling will be strictly controlled to prevent sample contamination. Chain-of-Custody control for all samples will consist of the following:

1. Labels will be placed on individual sample containers while sampling indicating the sampler's name, date and time of sample collection, place of collection, and preservation method used for the sample.

2. A custody seal should be placed on the shipping container or on the individual sample bottles. Custody seals provide prevention or easy detection of sample tampering. The custody seal should bear the signature of the collector and the date signed. The custody seal can be placed on the front and back of a cooler, around the opening of a polyethylene overpack bag or on the lid of each sample container.

3. No sample should be brought back to the laboratory for preservation. It is recommended that two polyethylene overpack bags be used in shipping. The first will contain the sample bottles, the second the ice needed to keep the samples at 4°C. A temperature history of the samples should be maintained as a quality control measure. Upon receipt of the shipment, the laboratory should record the temperature on the chain-of-custody record. Holding time refers to the period that begins when the sample is collected from the well and ends with its extraction or analysis.

4. A chain-of-custody record should be completed and should accompany every

sample shipment. The chain-of-custody record should contain enough copies so that each person possessing the shipment receives his/her own and should be designed to allow the Permittee to reconstruct how and under what circumstances a sample was collected, including any problems encountered. An example of a chain-of-custody form that includes the necessary information is included as Appendix 3.

4. Samples will be packaged and labeled for shipment in compliance with current U.S. Department of Transportation regulations. All samples will be shipped priority/overnight via commercial carrier or hand delivered to the lab.

5. Samples will arrive at the laboratory via the overnight delivery service or hand delivery. Upon delivery to the laboratory, the ice chests will be checked for intact custody seals and the samples will be unpacked and the information on the accompanying chain of custody records will be examined. If the samples shipped match those described on the chain-of-custody form, the laboratory sample coordinator will sign the form and assume responsibility for the samples. If problems are found with the sample shipment, the laboratory sample custodian will sign the form and record the problems in the "remarks" section.

6. Any missing samples, missing sample tags, broken sample bottles, or unpreserved samples will be noted on the chain-of-custody record. If there are problems with individual samples, the sample custodian will inform the laboratory coordinator of such problems. The laboratory custodian will then contact the Permittee to determine a viable solution to the problem.

7. All information relevant to the sample will be secured at the end of each business day. All samples will be stored in a designated sample storage refrigerator, access to which will be limited to laboratory employees.

I.F. FIELD LOGBOOK

Field technician(s) will keep an up-to-date field logbook documenting information pertaining to field activities. Appendix 1 of this Attachment provides an example of a Groundwater Log that includes the necessary information that must be completed for each monitoring well sampled.

II. LABORATORY ANALYSIS

II.A. INTRODUCTION

The groundwater parameters and constituents to be analyzed include organic and inorganic constituents which have been used at the facility or have been detected in the facility's waste, sludge, and/or groundwater (**Attachment V.BB**). **Attachment V.BB** also lists analytical methods that must be used in the analysis

of groundwater samples.

II.B. LABORATORY QA/QC

QA/QC procedures will be used at all times. The laboratory shall assure the accuracy and precision of all analytical determinations.

II.B.1. Internal quality control:

Internal quality control checks shall be undertaken regularly to assess the precision and accuracy of analytical procedures. Internal quality control checks shall include use of calibration standards, standard references, duplicates and spiked/fortified samples.

II.B.2. Calibration:

Calibration standards shall be verified against standard reference from an outside source. Calibration curves shall be comprised of a minimum of one blank and three standards. Samples shall be diluted if necessary to ensure analytical measurements fall on the linear portion of the calibration curve.

II.B.3. Duplicate samples:

Duplicate samples shall be processed at an average frequency of ten percent to assess the precision of testing methods, and standard references shall be processed monthly to assess accuracy of analytical procedures. Spiked/fortified samples shall be carried through all stages of sample preparation and measurement to validate the accuracy of analysis. During the course of analysis, quality control data and sample data shall be reviewed to identify questionable data.

III. DATA EVALUATION

III.A. ANALYTICAL DATA REVIEW

The Permittee and/or its representative will review and validate the analytical data to ensure that the laboratory followed proper analytical protocols. The data review will be performed in general accordance with the following United States EPA guidance documents:

- *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses*, April 1993, and
- *Region III Modifications to National Functional Guidelines for Organic Data Review Multi-Media, Multi-Concentration*, September 1994.

III.B. STATISTICAL EVALUATION

Statistical evaluations will be performed in general accordance with Exhibit V.AA-6.

III.C. DATA QUALITY OBJECTIVE

High-quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for in the permit) to meet the program objectives. It is the Permittee's responsibility to report sufficient valid analytical results for each monitoring event. Reported data will, at a minimum, be of such quality to immediately detect a release from the regulated unit. Laboratory methods will be selected to yield reporting limits (Limit of quantitation, or LOQ) values that are equal to or below human health-based standards for the target analytes. The human health-based standards are established as: Maximum Contaminant Levels (MCLs) under the Safe Drinking Water Act; Alternate Concentration Limits (ACLs) whenever MCLs are not available; or as EPA Region III Tap Water Risk Based Concentrations when MCLs or ACLs are not available. ACLs are calculated by the Risk Exposure and Analysis Modeling System (REAMS) using a residential ground water ingestion-modeling scenario by VADEQ.

IV. RECORD KEEPING AND REPORTING

IV.A. INTRODUCTION

Copies of all groundwater analytical results, groundwater semiannual reports, groundwater annual reports, groundwater level elevations, Groundwater Sampling and Analysis Plan, Facility Operating Permit, etc. shall be maintained at the Wallops Island site throughout the active life of the facility and post-closure care period. The Permittee shall report the groundwater monitoring information to the Director described in Sections IV.B and IV.C below.

IV.B. GROUNDWATER MONITORING RESULTS

The Permittee shall report concentrations or values of the parameters and constituents listed in **Attachment V.BB** for each required groundwater monitoring well within 30 days after completing each analysis.

IV.C. ANNUAL REPORT

The Permittee shall submit an Annual Groundwater Monitoring Report to the Virginia Department of Environmental Quality by March 1st of the following year for the year beginning January 1st and ending December 31st containing:

1. Static groundwater level elevations;

2. Potentiometric surface maps reflecting each sampling event;

3. Groundwater flow rate and direction in the uppermost aquifer calculated after each sampling event;

4. Statistical evaluations of the concentrations or values of the parameters and constituents listed in **Attachment V.BB**;

5. The calculated or measured rate of migration of hazardous waste or hazardous waste constituents in the groundwater; and

6. Results of the evaluations of groundwater surface evaluations to determine whether the requirements for locating the monitoring wells continue to meet the criteria set forth in 40 CFR § 264.97.

EXHIBIT V.AA-1

GROUNDWATER LOG EXAMPLE

SAMPLING EVENT _____
LOCATION _____
WELL NO. _____ DATE: _____
WEATHER _____ TEMPERATURE: _____

MEASUREMENT TEAM _____
TIME WELL CASING UNLOCKED _____
DEPTH TO WATER FROM TOP OF OUTER CASING _____FT
DEPTH OF WELL FROM TOP OUTER CASING _____FT
STATIC WASTER LEVEL _____FT

MEASUREMENT TECHNIQUE: [ ] WATER LEVEL INDICATOR
[ ] OTHER/EXPLAIN _____

FORMULAS FOR DETERMINING PURGE VOLUME **TWD =**

Water Level above Sand Pack: [ ]

$3 \times [(\pi r_b^2 h_s - \pi r_c^2 h_s) \times 0.3 + (\pi r_c^2 h_w)]$

Water Level below Sand Pack: [ ]

$3 \times [\pi r_b^2 h_w - \pi r_c^2 h_w) \times 0.3 + (\pi r_c^2 h_w)]$

where:
r_b = radius of boring =
r_c = radius of casing =
h_s = height of sand =
h_w = height of water =

IMMISCIBLE LAYERS: [ ] YES [ ]NO
DETECTION METHOD: [ ] VISUAL [ ] OTHER_____
COLLECTION METHOD: [ ] BEAKER [ ]OTHER_____

SAMPLE IDENTIFICATION _____

PURGE TEAM _____

PURGE PROCEDURE/EQUIPMENT: [ ]TEFLON BAILER
[ ]WELL PUMP

PURGE TIME _____ PURGE VOLUME _____

PURGE APPEARANCE _____
COMMENTS _____
_____
_____

EXHIBIT V.AA-1 (cont'd)

SAMPLING EVENT: _____
LOCATION: _____
WELL: _____ DATE _____

SAMPLING PROCEDURE/EQUIPMENT: [ ]TEFLON BAILER
[ ]WELL PUMP

SAMPLING TIME: _____

pH METER CALIBRATED WITH BUFFERS: [ ]4 [ ]7 [ ]10
pH METER CALIBRATED BY: _____
CONDUCTIVITY METER CALIBRATED WITH STANDARD SOLUTION OF _____
CONDUCTIVITY METER CALIBRATED BY: _____

pH(S.U.) _____, _____, _____,

TEMP (°C) _____, _____, _____,

COND (µS) _____, _____, _____,

SAMPLE COLLECTION TIME: CONTAINER*/PRESERVATIVE

(1)_____	VOC(G/NONE)	(2)_____	TOX(A/HNO_3)
(3)_____	TOC(A/H_2SO_4)	(4)_____	COD(A/H_2SO_4)
(5)_____	O&G/TPH(A/HCL)	(6)_____	PHEN(A/H_2SO_4)
(7)_____	N(/)	(8)_____	PHOS(A/H_2SO_2)
(9)_____	SO(/)	(10)_____	TMET(P/HNO_3)
(11)_____	DMET(P/NONE)	(12)_____	pH,COND(P/NONE)
(13)_____	CHLORIDE(P/NONE)	(14)_____	SMLL TST(P/NONE)
(15)_____	CN^- (P/NONE)	(16)_____	(P/NONE)

FINAL pH (S.U.) _____ FINAL TEMPERATURE (°C)_____
FINAL CONDUCTIVITY (µS) _____

LOCKED WELL AT _____

COMMENTS _____
_____
_____
_____
_____

NOTES:

1. G = GLASS, A=AMBER GLASS BOTTLE, P=PLASTIC(POLYETHYLENE)

2. Shipping containers (cooling chest with ice or ice pack) should be certified as to the 4° C temperature at time of sample placement into these containers. Preservation of samples requires that the temperature of collected samples be adjusted to the 4° C immediately after collection. Shipping coolers must be at 4° C and maintained at 4° C upon placement of sample and during shipment. Chain-of-custody forms will have Shipping/Receiving (max/min) temperature boxes for recording data and verification.

3. IDW: Collect all used decontamination solutions and rinses; store in a labeled 55 gallon drum for no more than 90 days in accordance with DEQ's IDW Policy.

4. SILTATION: If the level of siltation is higher than 1 foot above the base of the screen, the well will need to be redeveloped. Note whether the level of siltation is greater than 1 foot in the comments section.

5. DEDICATED TEFLON TUBING: replace if older than one year; note in comments the date the tubing was installed.

EXHIBIT V.AA-2

CALCULATIONS OF PURGE VOLUME

Determine purge volume as follows:

Water Level above sand pack:

$$3 \times [(\Pi r_b^2 h_s - \Pi r_c^2 h_s) \times 0.3 + (\Pi r_c^2 h_w)]$$

Water Level below sand pack

$$3 \times [(\Pi r_b^2 h_w - \Pi r_c^2 h_w) \times 0.3 + (\Pi r_c^2 h_w)]$$

where:

r_b = radius of boring
r_c = radius of casing
h_s = height of sand
h_w = height of water

This calculation must be based upon 30% filter pack volume. Once the volume to be purged is known, purging can begin. The purge water will be collected, containerized and disposed of in accordance with local, state and federal regulations and laws.

EXHIBIT V.AA-3

EXAMPLE CHAIN OF CUSTODY RECORD

Phone:
Fax:

Chain of Custody Record

Date: _____ Page: _____ of _____

Contact Name	Phone Number	Fax Number
Company Name		
Street Address		
City, State, Zip		
Project Name	Site Location	

Sample ID	Date Collected	Time	Matrix	Lab ID	Preservation Code	Number of Containers	Rush	Container Size	Analysis Request							Comments

Preservation Code
1 = 4°C
2 = HNO_3
3 = HCl
4 = H_2SO_4
5 = NaOH
6 = Other

Special Instructions / Comments	(1) Relinquished By	(2) Relinquished By	Sampler Initials:
	(1) Date / Time	(2) Date / Time	Method of Shipment
	(1) Company	(2) Company	HAND CARRY USPS FEDX UPS
	(1) Received By	(2) Received By	CoC
Route Results Through: Circle: Fax Email	(1) Date / Time	(2) Date / Time	Seal Intact?
Email address:	(1) Company	(2) Company	Yes No

EXHIBIT V.AA-4

SAMPLE CONTAINERS AND PRESERVATIVES

Analyte	SW-846 Analysis Numbers	Container	Preservative	Holding Time (days)
TOC	9060	Amber glass Teflon cap	H_2SO_4 4° C	28
TOX	9020	Amber glass Teflon cap	H_2SO_4 4° C	28
Phenols	8040	Amber glass, Teflon cap	H_2SO_4 4° C	28
Organic Nitrogen		HDPE	H_2SO_4 4° C	28
Ammonia	EPA 350.2	HDPE	H_2SO_4 4° C	28
Total Lead	7421	HDPE	HNO_3 to pH<2	6 months
Total Cyanide	9010	HDPE	NaOH	14 days
pH	9040	HDPE	None	Analyze immediately
Specific Conductance	9050	HDPE or glass	4 degrees C	Analyze immediately

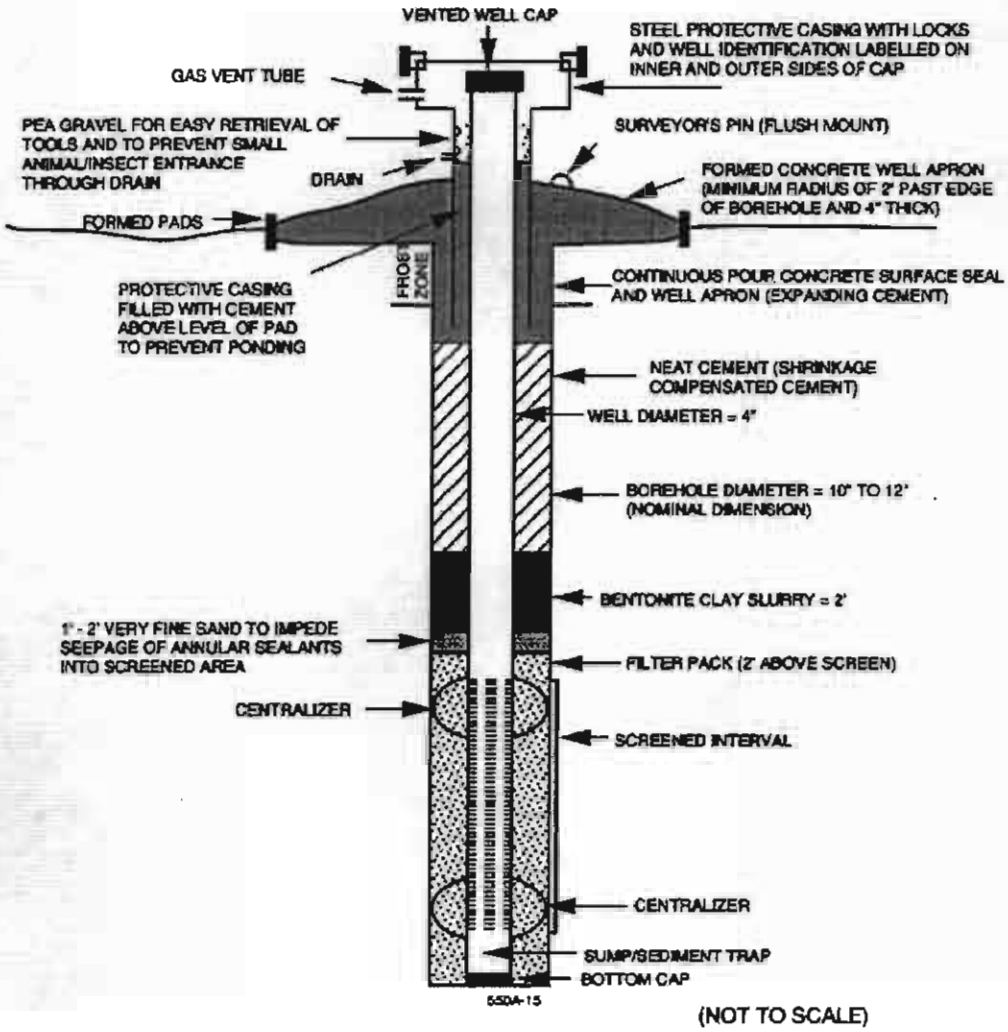
NOTES:

1. References:
   Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846 (2nd edition, 1982).
   Methods for Chemical analysis of Water and Wastes, EPA-600/4-79-020.
   Standard Methods for the Examination of Water and Wastewater, 16th edition (1985).

2. Container Types:
   HDPE = Plastic (polyethylene)
   T = Fluorocarbon resins (PTFE, Teflon8. FEP, PFA, etc.)

EXHIBIT V.AA-5

MONITORING WELL CONSTRUCTION DIAGRAM
(from *EPA Technical Enforcement Guidance Document, 1986*)



CROSS-SECTION OF TYPICAL MONITORING WELL

EXHIBIT V.AA-6

STATISTICAL PROCEDURES

A. HIGHLIGHTS

In accordance with 40 CFR 264.97(g), the permittee will collect an appropriate number of samples from upgradient well(s) and an appropriate number of samples from each of the point of compliance wells specified in Permit Section IV.C.1. Appropriate background sample sizes for the preferred method of statistical analysis will be collected prior to the scheduled date of the statistical analysis.

Statistical analysis of the groundwater data will include the following:

1. Outliers
2. Testing of normality
3. Missing data
4. Evaluation of data below detection limits or quantitation limits
5. Selection of statistical method
6. Verification sampling strategy (optional)

B. OUTLIERS

An outlier refers to a data point which is an inconsistently large or small value. An outlier can be observed due to sampling, laboratory, transportation, or transcription errors. To remove the possibility of including data with this type of error, the historical data should be screened for each well and constituent for the existence of outliers (USEPA 1992 section 6.2) using the method described by Dixon (1953) or another method approved by the VADEQ. Background observations, which are considered to be outliers, should not be included in the statistical analysis. If an extreme value occurs in a point-of-compliance well or during a Detection sampling event, the facility should collect a re-sample during the Detection period of the initial sample. Any elimination of an outlier must be approved by the Department.

C. TESTING NORMALITY OF DATA DISTRIBUTION

The Permittee shall verify that the distribution of monitoring data for the Hazardous Constituents is consistent with the assumptions of the selected statistical test method. A multiple group version of the Shapiro-Wilk test shall be applied to determine if the distribution of the data is normal or lognormal. To test for log normality, the natural

logarithms of original data are taken and if the distribution of the transformed concentrations is normal then the data are considered to be log-normally distributed. The permittee may use any other appropriate method for testing the distributional assumptions (see Gibbons 1994a for a review, also see USEPA 1992). However, the permittee shall demonstrate that the alternative method can detect deviations from normality with similar power as the Shapiro-Wilk and Shapiro-Francia methods. No testing of normality is required when the percentage of non-detects or non-quantified values is greater than 50%. Once the distribution of the data is determined, the permittee should apply statistical tests as follows:

When the detection frequency is less than 50% and/or transformation fails to bring about normality, a non-parametric method should be used.

When the detection frequency is between 50%-75%, a parametric test can be performed with an adjustment for non-detects. Aitcheson's or Cohen's adjustments are recommended. Determination of the appropriate adjustment to be applied should be based on the properties of the data set (USEPA, 1992, section 2.2).

When the detection frequency is 75% or greater, an appropriate parametric test may be applied without adjusting for non-detects. Non-detects should be analyzed using one half the laboratory limit of detection or quantitation.

D. MISSING DATA

If a sampling event results in a missing data value, an attempt to resample for the missing value shall be made within two weeks.

E. DATA BELOW DETECTION LIMITS

For data where the non-detects or non-quantified values are less than 25 percent, the Permittee shall replace the non-detects or non-quantified values with one half the laboratory limit of detection or quantitation. However, when the percentage of non-detects or non-quantified values is greater than 25 percent and less than 50 percent the mean and standard deviation should be adjusted using Atchison's method (USEPA 1992 section 2.2.2 and Aitchison, 1955). An acceptable alternative to Aitchison's method is Cohen's maximum likelihood estimator (Cohen, 1961). Extensive tables and computational details are also provided in Gibbons, 1994a. The approach for selection between the two methods is described in USEPA (1992) section 2.2.1.

F. SELECTION OF STATISTICAL METHOD

The Permittee shall use an appropriate statistical method consistent with the Virginia Hazardous Waste Management Regulations. As specified in these regulations, the level of significance for individual well comparison shall be no less than 0.01 and no less than 0.05 for multiple comparisons. However, these performance standards do not apply for

prediction intervals, tolerance intervals and control charts. The false positive rate for these interval methods or control charts can depend on the number of data points available from the background wells at the time of statistical comparison. A larger number of background data points can decrease the false positive rate for these tests. In the event the Permittee has decided to use an interval or other statistical method, and if the selected method requires additional samples, the Permittee shall collect the additional samples prior to the date specified in this permit for conducting appropriate statistical analysis. The statistical comparison shall not be delayed due to collection of an inadequate number of samples. The false positive rate for a single constituent/well comparison shall not be lower than .01 unless the Permittee can demonstrate that an alternative false positive rate will provide at least 50% power to detect a 3 standard deviation increase above background levels and 80% power to detect a 4 standard deviation increase above background levels.

1. Interval Method

If the Permittee uses an interval method and the percentage of detects is greater than 50%, the Permittee shall test the data from the background wells for normality. If the background well data are normally or log-normally distributed the permittee shall use a parametric interval method. Table 1 provides the suggested minimum number of samples for calculation of parametric interval methods that are acceptable to VADEQ. In the event the background data are not normally or log-normally distributed the permittee shall use a non-parametric interval method . Suggested test methods and recommended minimum sample size requirements are provided in Table 1. However, a statistical analysis can be conducted with a smaller data set than the suggested size at any time. Please note that these methods can lead to higher false positive or false negative rates with smaller samples sizes. For each sampling event, the permittee shall calculate the appropriate interval for the background data set based on the method selected, and compare each data point from the point of compliance well to the upper limit. If the point of compliance well data exceeds the upper limit, the permittee shall report that there has been a statistical increase of contaminants in the groundwater.

2. Other Methods

In the event the Permittee has selected any other method listed in the Virginia Hazardous Waste Management Regulations, the Permittee shall collect the appropriate number of samples and shall maintain the appropriate level of significance specified above.

G. VERIFICATION SAMPLING (OPTIONAL)

Verification resampling can be an integral part of the statistical methodology (USEPA, 1992 section 5); however, it should be considered as a part of the statistical test and based

on the site-specific condition. Since the probability of an initial exceedance is very high for the site as a whole (considering only test wise false positive rates), the verification sample is considered as a part of the evaluation to conclude a statistically significant exceedance. A pre-planned verification sample can be incorporated into the calculation of the statistical limits to calculate an upper limit using a smaller false positive rate. Without verification resampling, an attempt to minimize the false positive rates will lead to very large prediction limits. This will increase the false negative rates and decrease the power of the test to detect a release from the facility. All verification samples must be collected at the earliest time possible (prior to next scheduled sampling event) or as approved by the DEQ or as specified in this permit. Note that the Department must be informed of any planned verification resampling in advance.

Verification resampling can involve one or two samples. DEQ's preferred strategy includes passing one verification resample or passing one of two verification resamples. Statistical analyses which incorporate verification samples must provide at least 50% power to detect a 3 standard deviation increase above background levels and 80% power to detect a 4 standard deviation increase above background levels.

H. COMPARISON OF POINT OF COMPLIANCE WELL DATA TO A STANDARD DURING COMPLIANCE OR CORRECTIVE ACTION MONITORING

In accordance with the Virginia Hazardous Waste Management Regulations the point of compliance data shall be compared to the GWPS. If a maximum contaminant level (MCL) is promulgated or alternate concentration limit (ACL) is established for a constituent, and the ACL or MCL is greater than the background limit (or statistically determined background level), the ACL or MCL is the groundwater protection standard. All new concentrations in the point of compliance wells should be compared to the standard (i.e., ACL or MCL) using the lower 95% confidence limit computed from the last four sampling values (collected during the last 12 months).

If an upper limit based on a tolerance or prediction limit calculated from naturally occurring background data exceeds the MCL or ACL, then the background limit will be the groundwater protection standard. If the groundwater protection standard is based on a tolerance or prediction limit, the point of compliance samples shall be compared to the GWPS using a point comparison. If the point of compliance sample exceeds the background based GWPS, a statistical exceedence above the GWPS shall be reported to the Department.

However, for all constituents analyzed, if the established groundwater protection standard is less than the Department accepted Limit of Quantitation (LOQ) then the LOQ becomes the standard, and the new point of compliance well data will be compared to the LOQ.

Comparisons of point of compliance well data to a groundwater protection standard based on a MCL or ACL should be performed by a parametric or non-parametric confidence interval. If data are normally or log-normally distributed a 95% lower confidence limit on

the last four samples (collected during the last 12 months) can be calculated for comparison to the MCL or ACL. If data are not normally or log-normally distributed the minimum concentration from the last four samples (collected during the last 12 months) should be compared to the groundwater protection standard (based on a MCL or ACL). Alternative statistical methods for comparing lower limits of Compliance well data to a groundwater protection standard based on a MCL or ACL should be approved by the Department prior to implementation. If the lower confidence limit or minimum concentration exceeds the groundwater protection standard based on a MCL or ACL then the permittee has shown a statistical exceedence above the ground water protection standard.

Please note that a point comparison (non-statistical) to the GWPS (based on a MCL or ACL) may be performed if only one data point exists for a sampling event. If the point comparison indicates that the given data point is above the groundwater protection standard, and the GWPS is based on a MCL or ACL, and the facility chooses not to use data from the previous three sampling events, then additional samples (at least three additional samples will be required to calculate a confidence interval) may be collected within the next 3 months and a statistical comparison to the GWPS (based on a MCL or ACL) may be performed.

I. REFERENCES

1. Aitchison, J. On the distribution of a positive random variable having discrete probability mass at the origin, Journal of American Statistical Association, 50(272), 901-908 (1955).

2. Cohen, A.C. Tables for maximum likelihood estimates: Singly truncated and singly censored samples, Technometrics, 3, 535-541 (1961).

3. Gibbons, R.D. Statistical Methods for Groundwater Monitoring, John Wiley and Sons, Inc., 1994.

4. Gibbons, R.D. Some conceptual and statistical issues in analysis of groundwater monitoring data, Environmetrics, 7, 185-199 (1996).

5. USEPA, Statistical analysis of groundwater monitoring data at RCRA facilities. Addendum to Interim Final Guidance. Office of Solid Waste, July 1992.

6. USEPA, Statistical analysis of groundwater monitoring data at RCRA facilities - Interim Final guidance (April 1989).

Suggested Minimum Samples*			
	Parametric	Non-Parametric	Non-Parametric Interval %Confidence
CABF T-test	4	NA	NA
Wilcoxon Rank Sum	NA	5	NA
Confidence Interval	4	NA	NA
Tolerance Interval	8	19	95%
Prediction Interval	8	13	99%#
Shewhart CUSUM Chart+	8	NA	NA

* The above tests can be used with fewer samples; however it will increase the false positive rate.

Includes one verification re-sample, use 19 samples for a 95% Prediction Interval with no verification re-samples.

+ For Intra-well testing only.

NA Not Applicable.

EXHIBIT V.AA-7

MONITORING WELL ABANDONMENT PROCEDURES

NOTE: Approval from the Director must be granted before any monitoring well may be abandoned.

A. Monitoring wells and/or piezometers will be abandoned by pressure grouting methods. Surface installations (protective covers or manholes) will be removed and an attempt to pull the casing string with the rig will be made. Once this has either been accomplished or has failed, grouting operations will commence as described below.

A.1. Monitoring well abandonment will be accomplished by lowering a tremie pipe to the bottom of the borehole.

A.2. Portland cement/bentonite grout will then be pumped down the tremie pipe until an even flow of consistent grout returns at the surface.

A.3. The tremie pipe will be removed from the borehole on completion of grouting operations and a minimum four inch thick and six foot diameter concrete cap will be constructed over the grouted borehole.

B. Removed casings will be steam cleaned, cut up into manageable sections, and disposed of as refuse.

C. All tremie rods and other downhole equipment will be steam cleaned prior to introduction into the hole or well.

D. All decontamination fluid will be containerized and handled pursuant to decontamination fluid handling procedures contained in **Exhibit V.AA-9**.

Exhibit V.AA-8

BORING LOGS AND WELL CONSTRUCTION DIAGRAMS

Boring logs and well construction diagrams for groundwater monitoring wells are included as appendices to this Attachment.

Well MW-1
Well MW-2
Well MW-4
Well MW-5
Well MW-6
Well MW-7

BORING LOG AND WELL CONSTRUCTION DIAGRAM FOR MW-1

CLIENT	JOB #	BORING #	SHEET
NASA – WALLOPS ISLAND	N2844A	MW–1	1 OF 1

PROJECT NAME	ARCHITECT–ENGINEER
WFF HYDROLOGIC STUDY	OCCU–HEALTH INC.

ECS LTD

SITE LOCATION: WALLOPS ISLAND, VIRGINIA

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)

PLASTIC LIMIT % X — WATER CONTENT % ⊕ — LIQUID LIMIT % Δ (10 20 30 40 50+)

STANDARD PENETRATION BLOWS/FT. ⊗ (10 20 30 40 50+)

DEPTH (FT)	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS / SURFACE ELEVATION)	PID READINGS (ppm)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	36	0	Topsoil Soil was hand dug to avoid fiberoptic line.		
	2	SS	24	24	Tan and Orange Fine to Medium SAND, Trace Silt	8.3	5
5	3	SS	24	24		9.4	12
	4	SS	24	24		22.0	12
	5	SS	24	24	Tan and Brown Fine to Medium SAND, With Shell Fragments, Trace Silt	8.6	12
10	6	SS	24	24	Tan and Brown Fine to Coarse SAND With Fine Gravel, and Shell Fragments	8.1	6
	7	SS	24	24		10.9	8
15	8	SS	24	24		9.0	4
	9	SS	24	24		6.7	5
20					END OF BORING @ 19.0'		
25							
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

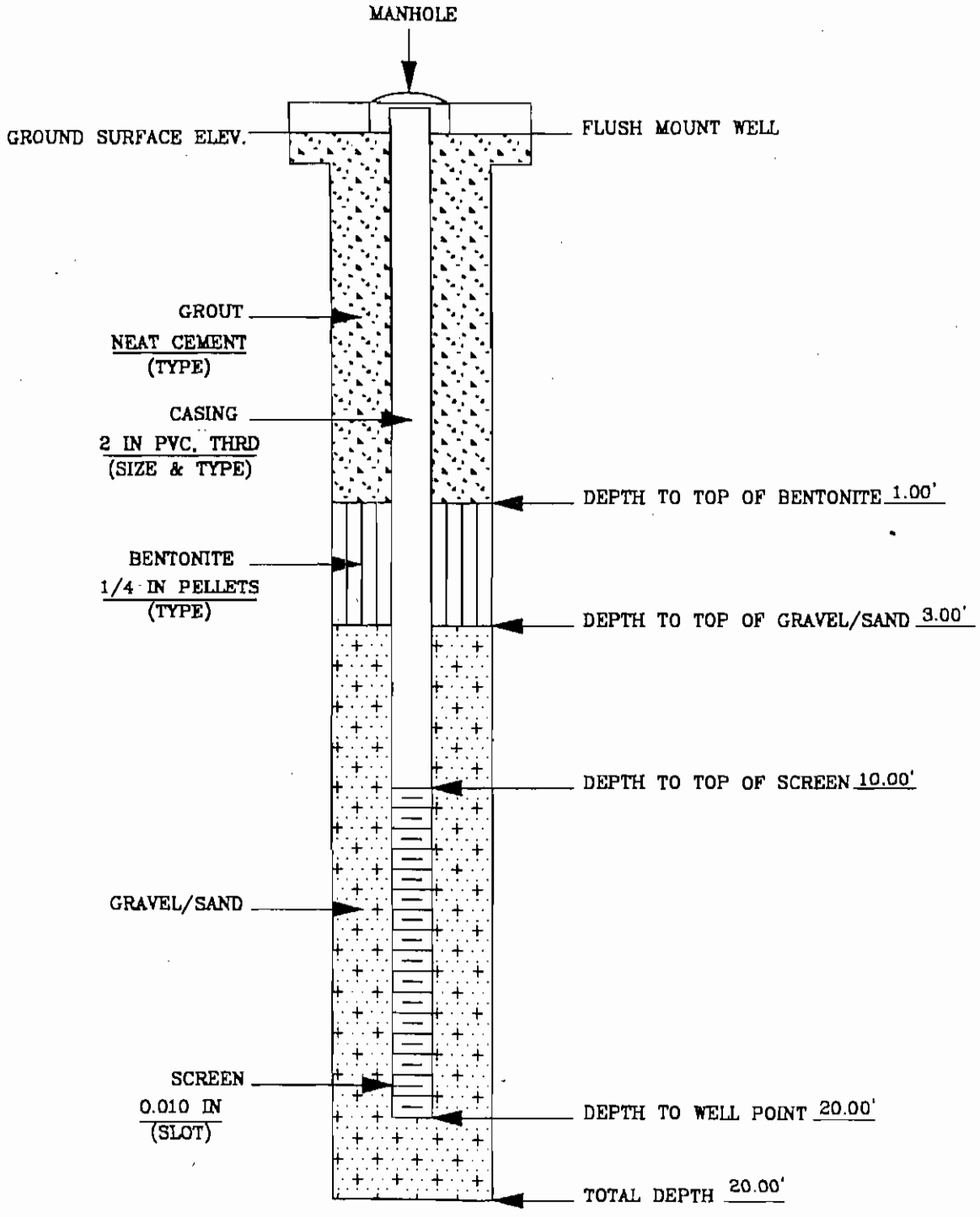
8.00' WS OR WD	BORING STARTED 9/17/98	TOPSOIL DEPTH: 6"
WL HCR ACR	BORING COMPLETED 9/17/98	CAVE IN DEPTH @
WL	RIG FOREMAN FISHBURNE	DRILLING METHOD HOLLOW STEM AUGER

814 GREENBRIER CIRCLE
SUITE A
CHESAPEAKE, VA. 23320
PHONE (757) 366-6100
FAX (757) 366-5203

MONITORING WELL SCHEMATIC

WELL NO. MW-1
DATE COMPLETED 9/17/98
PROJECT NO. N2844A

O.D. OF CASING 4.50"
LENGTH OF SCREEN 10.0'
SCREEN OPENING SIZE 0.010"



NOTE: ALL DEPTHS REFERENCED FROM GROUND SURFACE

BORING LOG AND WELL CONSTRUCTION DIAGRAM FOR MW-2

CLIENT	JOB #	BORING #	SHEET
NASA – WALLOPS ISLAND	N2844A	MW-2	1 OF 1

PROJECT NAME: WFF HYDROLOGIC STUDY

ARCHITECT-ENGINEER: OCCU-HEALTH INC.

ECS LTD

SITE LOCATION: WALLOPS ISLAND, VIRGINIA

CALIBRATED PENETROMETER TONS/FT.^{2} (1 2 3 4 5+)

PLASTIC LIMIT % (X) — WATER CONTENT % (⊕) — LIQUID LIMIT % (Δ)

STANDARD PENETRATION BLOWS/FT. (⊗) (10 20 30 40 50+)

DEPTH (FT)	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	PID READINGS (ppm)	STANDARD PENETRATION BLOWS/FT.
					ENGLISH UNITS		
					SURFACE ELEVATION		
0	1	SS	36	0	Topsoil Hand dug to avoid fiberaptic line		
5	2	SS	24	24	Tan Fine to Medium SAND, Trace Silt	12.9	12
	3	SS	24	24		16.7	20
	4	SS	24	24		10.9	7
10	5	SS	24	24	Tan Fine to Medium SAND, Trace Silt, With Shell Fragments	8.9	8
					END OF BORING @ 11.0'		
15							
20							
25							
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

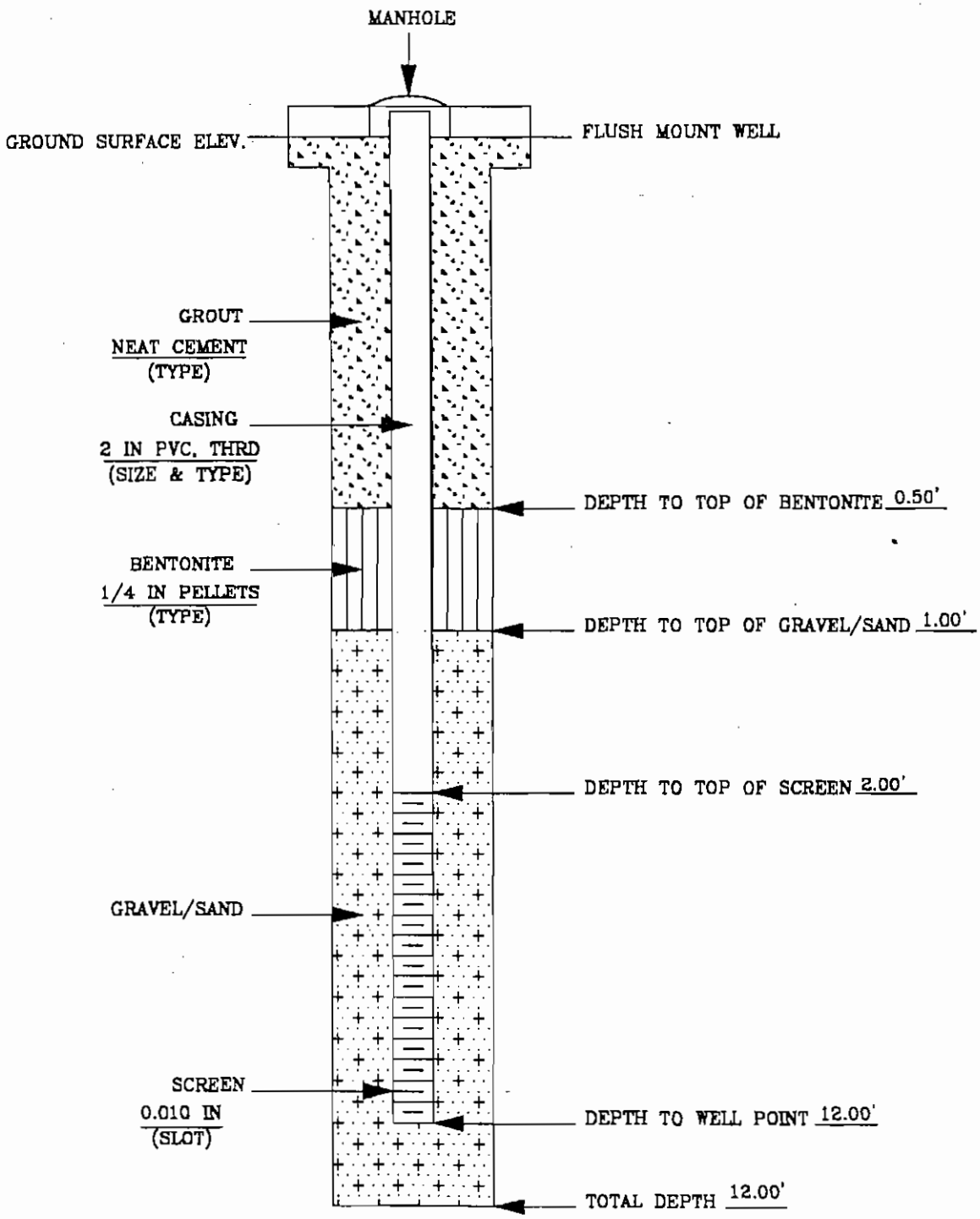
8 WS OR WD	BORING STARTED 9/17/98	TOPSOIL DEPTH: 6"
WL BCR ACR	BORING COMPLETED 9/17/98	CAVE IN DEPTH @
WL	RIG FOREMAN FISHBURNE	DRILLING METHOD HOLLOW STEM AUGER

814 GREENBRIER CIRCLE
SUITE A
CHESAPEAKE, VA. 23320
PHONE (757) 366-5100
FAX (757) 366-5203

MONITORING WELL SCHEMATIC

WELL NO. MW-2
DATE COMPLETED 9/17/98
PROJECT NO. N2844A

O.D. OF CASING 2.375"
LENGTH OF SCREEN 10.0'
SCREEN OPENING SIZE 0.010"



NOTE: ALL DEPTHS REFERENCED FROM GROUND SURFACE

BORING LOG AND WELL CONSTRUCTION DIAGRAM FOR MW-3

(The boring log and well construction diagram for MW-3 was removed from the Permit by permit modification, dated August 3, 2010. As a result of the major storm event of November 11 -13, 2009, the original background monitoring well MW-3 was damaged and was deemed inoperable. The Permittee submitted a *Open Burn Area Proposed Background Well (MW-4) Analysis Report*, dated February 9, 2010. The above Report proposed an original point-of-compliance well, MW-4, to serve as the new background monitoring well, replacing the damaged background well MW-3. In a letter dated April 5, 2010, the DEQ determined that MW-4 was a suitable replacement background well. On May 6, 2010, the Permittee requested a Class 2 permit modification to replace MW-3 with MW-4 as the OB/OD unit background well. Monitoring well MW-3 was subsequently abandoned in accordance with procedures approved by the DEQ in correspondence, dated July 27, 2010.)

BORING LOG AND WELL CONSTRUCTION DIAGRAM FOR MW-4

CLIENT	JOB #	BORING #	SHEET
NASA – WALLOPS ISLAND	N2844A	MW–4	1 OF 1
PROJECT NAME	ARCHITECT–ENGINEER.		
WFF HYDROLOGIC STUDY	OCCU–HEALTH INC.		

SITE LOCATION
WALLOPS ISLAND, VIRGINIA

CALIBRATED PENETROMETER TONS/FT.^{2} (1, 2, 3, 4, 5+)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DEPTH (FT)	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	PID READINGS (ppm)	STANDARD PENETRATION BLOWS/FT.
					ENGLISH UNITS		
					SURFACE ELEVATION		
0	1	SS	24	24	Brown and Orange Clayey SAND, Trace Silt	12.1	7
	2	SS	24	24		16.4	7
5	3	SS	24	24		7.7	13
	4	SS	24	24		6.6	5
	5	SS	24	24	Brown and Gray Fine to Medium SAND With Shell Fragments	7.0	9
10	6	SS	24	24	Gray Fine to Medium SAND With Shell Fragments	3.9	14
					END OF BORING @ 12.0'		
15							
20							
25							
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

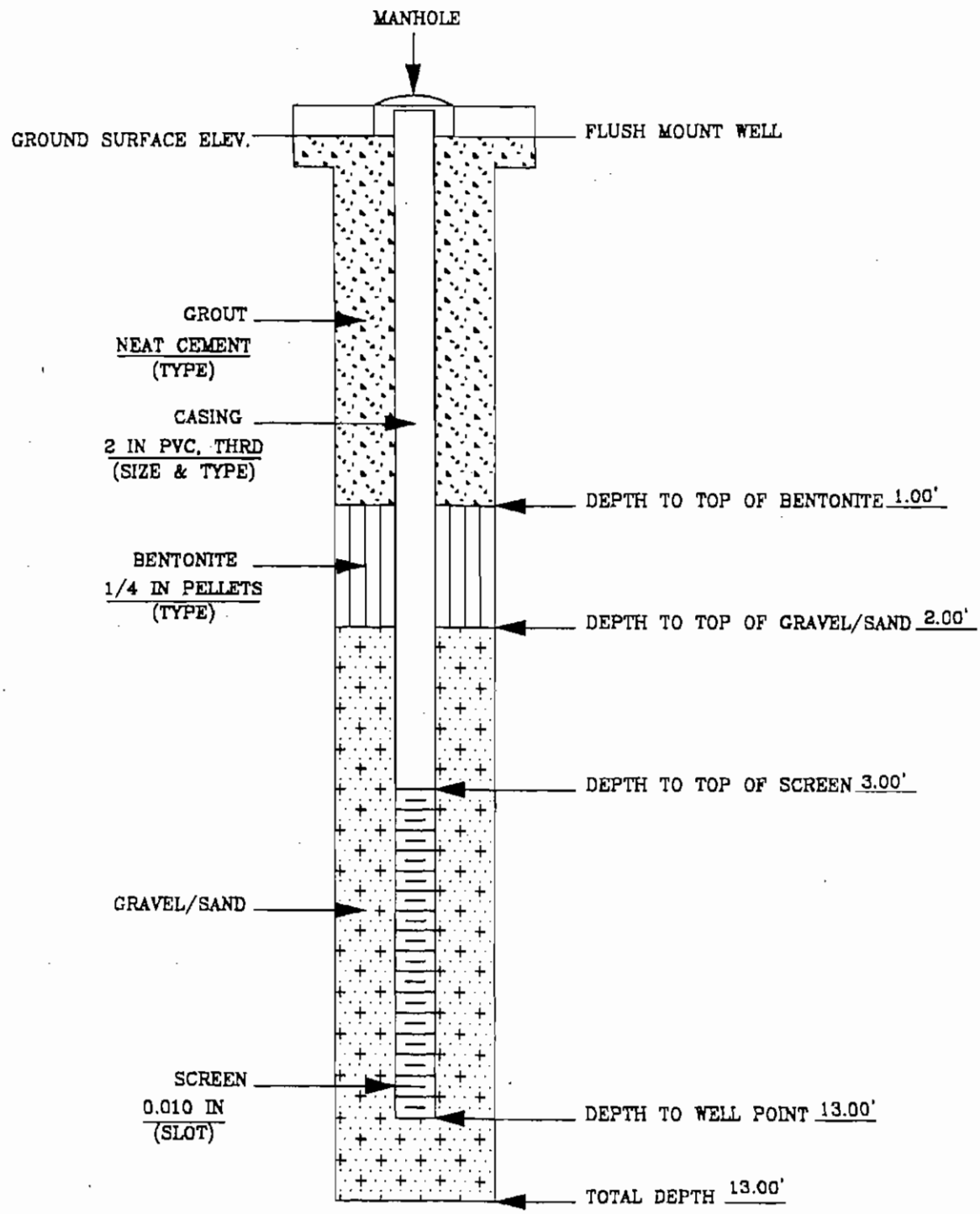
WL 6.00' WS OR WD	BORING STARTED 9/17/98	TOPSOIL DEPTH:
WL BCR ACR	BORING COMPLETED 9/17/98	CAVE IN DEPTH @
WL	RIG FOREMAN FISHBURNE	DRILLING METHOD HOLLOW STEM AUGER

814 GREENBRIER CIRCLE
SUITE A
CHESAPEAKE, VA. 23320
PHONE (757) 366-6100
FAX (757) 366-5203

MONITORING WELL SCHEMATIC

WELL NO. MW-4
DATE COMPLETED 9/17/98
PROJECT NO. N2844A

O.D. OF CASING 2.375"
LENGTH OF SCREEN 10.0'
SCREEN OPENING SIZE 0.010"



NOTE: ALL DEPTHS REFERENCED FROM GROUND SURFACE

BORING LOG AND WELL CONSTRUCTION DIAGRAM FOR MW-5

CLIENT	JOB #	BORING #	SHEET
NASA – WALLOPS ISLAND	N2844A	MW-5	1 OF 1

ECS LTD

PROJECT NAME: WFF HYDROLOGIC STUDY

ARCHITECT-ENGINEER: OCCU-HEALTH INC.

SITE LOCATION: WALLOPS ISLAND, VIRGINIA

ENGLISH UNITS

SURFACE ELEVATION

CALIBRATED PENETROMETER TONS/FT²: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % Δ

STANDARD PENETRATION BLOWS/FT. ⊗: 10 20 30 40 50+

DEPTH (FT)	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	PID READINGS (ppm)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	24	24	Tan and Brown Fine to Medium SAND, Trace Silt	9.1	8
	2	SS	24	24		10.4	7
5	3	SS	24	24		10.1	16
	4	SS	24	24		8.5	8
	5	SS	24	24	Orange and Tan Fine to Coarse SAND, Trace Silt	5.9	10
10	6	SS	24	24	Gray Fine to Medium SAND, Trace Silt With Shell Fragments	6.8	19
					END OF BORING @ 12.0'		
15							
20							
25							
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

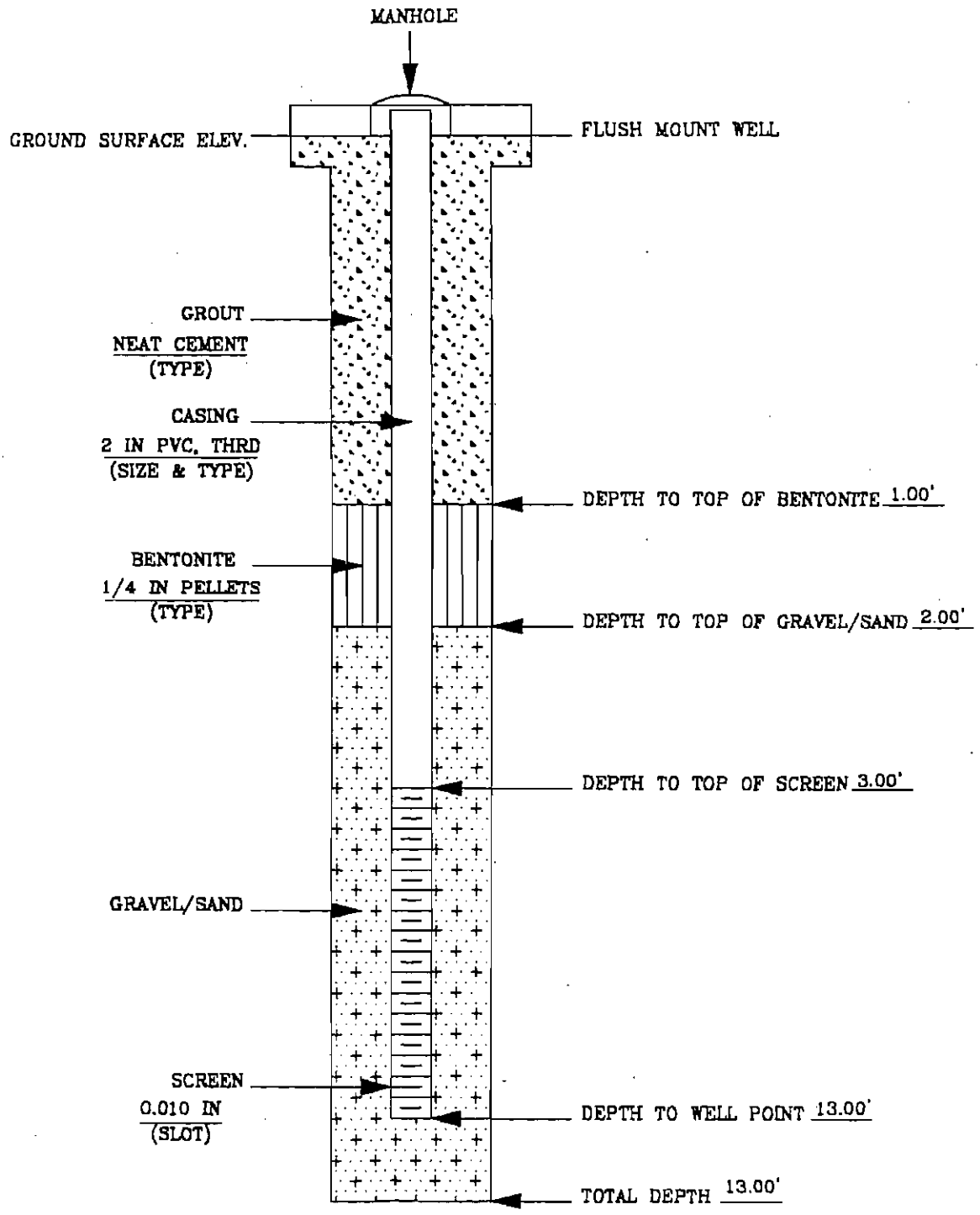
WL 5.00' WS OR WD	BORING STARTED 9/17/98	TOPSOIL DEPTH:
WL BCR ACR	BORING COMPLETED 9/17/98	CAVE IN DEPTH @
WL	RIG FOREMAN FISHBURNE	DRILLING METHOD HOLLOW STEM AUGER

814 GREENBRIER CIRCLE
SUITE A
CHESAPEAKE, VA. 23320
PHONE (757) 366-5100
FAX (757) 366-5203

MONITORING WELL SCHEMATIC

WELL NO. MW-5
DATE COMPLETED 9/17/98
PROJECT NO. N2844A

O.D. OF CASING 2.375"
LENGTH OF SCREEN 10.0'
SCREEN OPENING SIZE 0.010"



NOTE: ALL DEPTHS REFERENCED FROM GROUND SURFACE

BORING LOG AND WELL CONSTRUCTION DIAGRAM FOR MW-6

CLIENT	JOB #	BORING #	SHEET
NASA – WALLOPS ISLAND	N2844A	MW-6	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
WFF HYDROLOGIC STUDY	OCCU-HEALTH INC.

ECS LTD

SITE LOCATION: WALLOPS ISLAND, VIRGINIA

DEPTH (FT)	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	PID READINGS (ppm)
0	1	SS	24	24	Tan Fine to Medium SAND, Trace Silt	16.1
	2	SS	24	24		8.7
5	3	SS	24	24	Tan Fine to Coarse SAND, Trace Silt	4.3
	4	SS	24	24		12.8
	5	SS	24	24	Grey Fine to Coarse SAND, Trace Silt	11.6
10	6	SS	24	24		10.9
					END OF BORING @ 12.0'	
15						
20						
25						
30						

ENGLISH UNITS

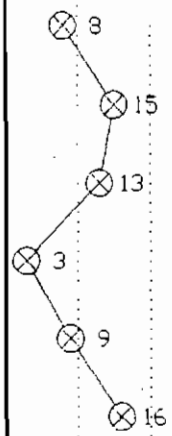
SURFACE ELEVATION

CALIBRATED PENETROMETER TONS/FT.^{2}: 1 2 3 4 5+

PLASTIC LIMIT % X — WATER CONTENT % ● — LIQUID LIMIT % △

10 20 30 40 50+

STANDARD PENETRATION BLOWS/FT. ⊗: 10 20 30 40 50+



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

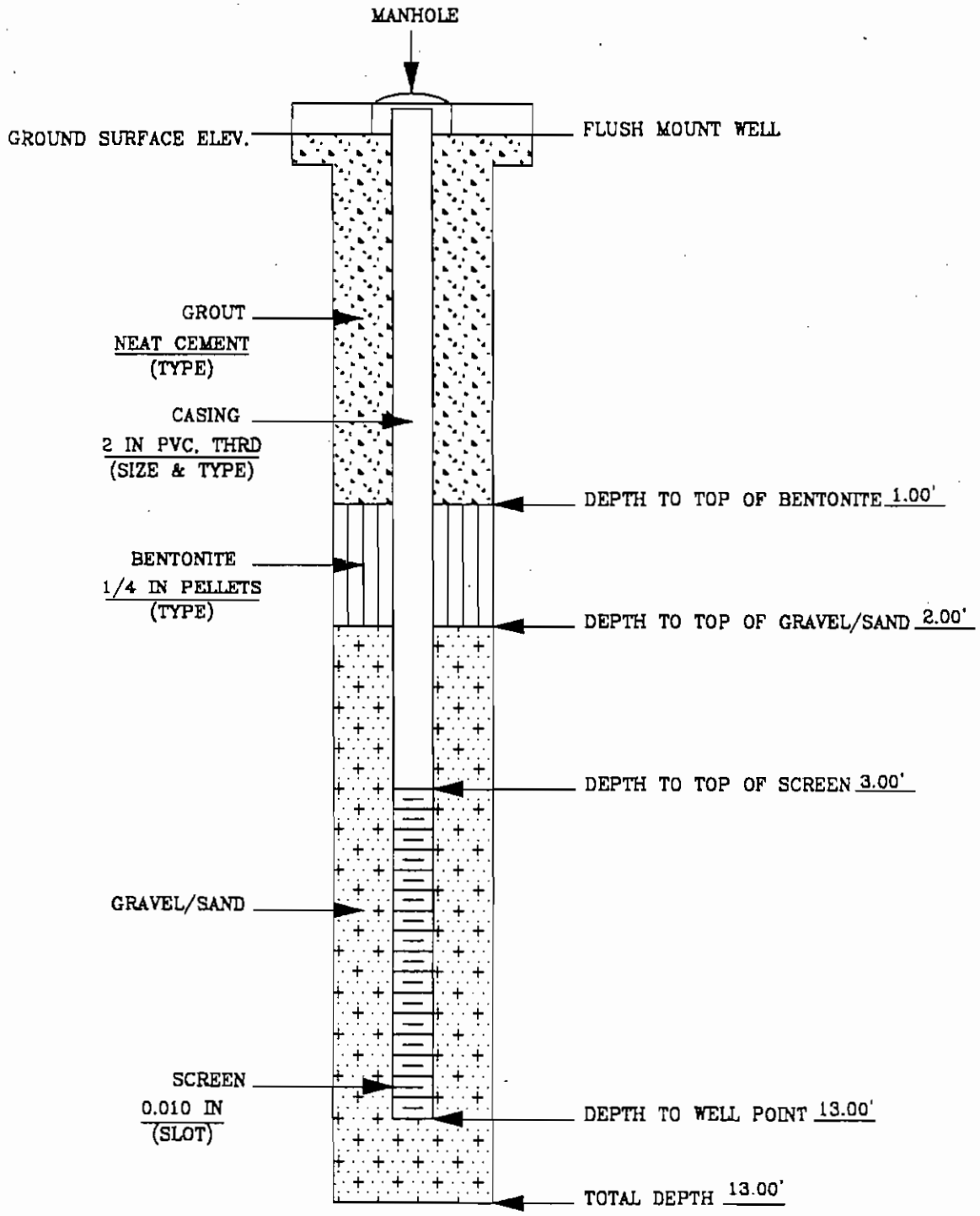
5.00'	WS OR (WD)	BORING STARTED	9/17/98	TOPSOIL DEPTH:
	BCR ACR	BORING COMPLETED	9/17/98	CAVE IN DEPTH @
WL		RIG	FOREMAN FISHBURNE	DRILLING METHOD HOLLOW STEM AUGER

814 GREENBRIER CIRCLE
SUITE A
CHESAPEAKE, VA. 23320
PHONE (767) 366-6100
FAX (757) 366-5203

MONITORING WELL SCHEMATIC

WELL NO. MW-6
DATE COMPLETED 9/17/98
PROJECT NO. N2844A

O.D. OF CASING 2.375"
LENGTH OF SCREEN 10.0'
SCREEN OPENING SIZE 0.010"



NOTE: ALL DEPTHS REFERENCED FROM GROUND SURFACE

BORING LOG AND WELL CONSTRUCTION DIAGRAM FOR MW-7

CLIENT	JOB #	BORING #	SHEET
NASA – WALLOPS ISLAND	N2844A	MW-7	1 OF 1
PROJECT NAME	ARCHITECT-ENGINEER		
WFF HYDROLOGIC STUDY	OCCU-HEALTH INC.		

ECS LTD

SITE LOCATION
WALLOPS ISLAND, VIRGINIA

CALIBRATED PENETROMETER TONS/FT.² (1, 2, 3, 4, 5+)

PLASTIC LIMIT % (X) — WATER CONTENT % (●) — LIQUID LIMIT % (Δ)

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50+)

DEPTH (FT)	SAMPLE NO	SAMPLE TYPE	SAMPLE DISTANCE (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL ENGLISH UNITS SURFACE ELEVATION	PID READINGS (ppm)	STANDARD PENETRATION BLOWS/FT.
0	1	SS	24	24	Ton and Brown Fine to Medium SAND, Trace Silt	17.0	4
	2	SS	24	24		10.3	3
5	3	SS	24	24		14.3	WOH
	4	SS	24	24		11.4	7
	5	SS	24	24	Brown and Tan Fine to Coarse SAND, Trace Silt	17.6	9
10	6	SS	24	24		9.3	10
					END OF BORING @ 12.0'		
15							
20							
25							
30							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES IN-SITU THE TRANSITION MAY BE GRADUAL

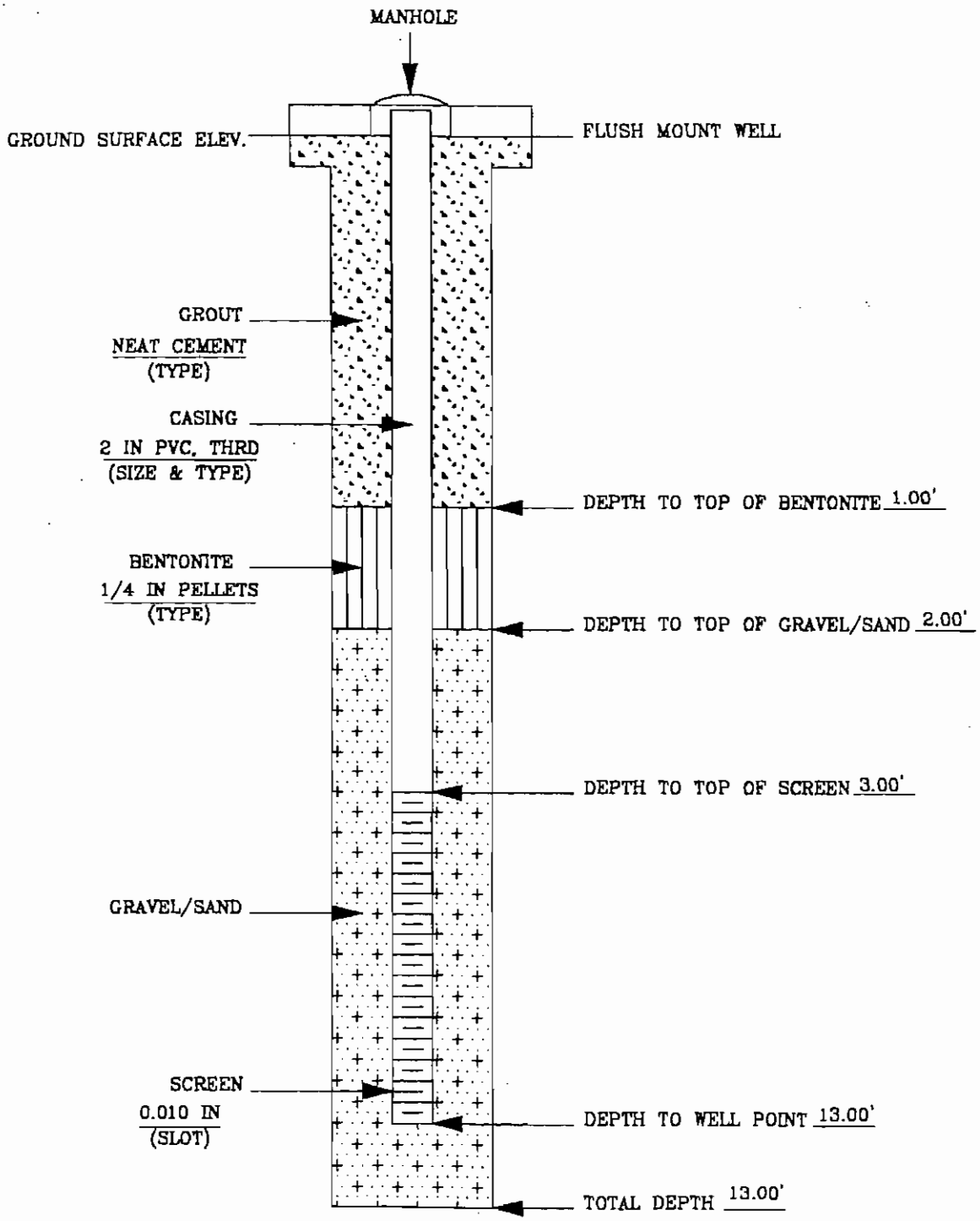
5.00' WS OR WD	BORING STARTED 9/17/98		TOPSOIL DEPTH:
BCR ACR	BORING COMPLETED 9/17/98		CAVE IN DEPTH @
WL	RIG	FOREMAN FISHBURNE	DRILLING METHOD HOLLOW STEM AUGER

ECS LTD
614 GREENBRIER CIRCLE
SUITE A
CHESAPEAKE, VA. 23320
PHONE (757) 366-5100
FAX (757) 366-5203

MONITORING WELL SCHEMATIC

WELL NO. MW-7
DATE COMPLETED 9/17/98
PROJECT NO. N2844A

O.D. OF CASING 2.375"
LENGTH OF SCREEN 10.0'
SCREEN OPENING SIZE 0.010"



NOTE: ALL DEPTHS REFERENCED FROM GROUND SURFACE

EXHIBIT V.AA-9

INVESTIGATIVE DERIVED WASTE POLICY

Department of Environmental Quality
Waste Operations
Policy for the Handling of
Investigation Derived Waste (IDW)

The Department of Environmental Quality (DEQ), Waste Operations has received a request for guidance from the regulated community concerning the Commonwealth of Virginia's requirements regarding the management and disposal of investigation derived waste (IDW). Because Virginia administers an authorized state RCRA program, the Virginia Solid Waste Management Regulations (VSWMR) and the Virginia Hazardous Waste Management Regulations (VHWMR) will serve as the governing requirements in lieu of Federal RCRA regulations contained in the Code of Federal Regulations (40 CFR 260 - 270) except for the Land Disposal Restrictions of 40 CFR 268. For reference, please see the Virginia Waste Management Act, Code of Virginia §10.1-1400 et seq.; the Virginia Hazardous Waste Management Regulations (VHWMR) (VR 672-10-1); the Virginia Solid Waste Management Regulations (VSWMR) (VR 672-20-10); Federal: the Resource Conservation and Recovery Act (RCRA), 42 USC 6901; and the U. S. Department of Transportation Rules for the Transportation of Hazardous Materials, 49 CFR Part 107, 171.1 - 172.558.

With regard to IDW, it is the site manager's responsibility to determine whether the wastes generated during an investigation meet the definition of a solid or hazardous waste. The site manager will be either the on-scene coordinator (i.e., either the federal official predesignated by the Environmental Protection Agency (EPA) or the U.S. Coast Guard to coordinate and direct federal responses under subpart D or the official designated by the lead agency to coordinate and direct removal actions under subpart E of the National Contingency Plan (NCP)), or the remedial project manager (i.e., the official designated by the lead agency to coordinate, monitor, or direct remedial or other response actions under subpart E of the NCP).

If there is a possibility that either the ground water or the soil at the location where a monitoring well is installed is contaminated, the site manager must determine whether or not the well cuttings, purge water, and/or other IDW are contaminated (i.e., whether they are solid or hazardous wastes). In these cases, the site manager may use knowledge of the contaminated media to declare that the IDW is solid or hazardous waste. If analysis shows that no contamination is present in the soil or the ground water at the location where the monitoring well is installed, neither the well cuttings, nor the purge water would be regulated as a solid waste. An example of a situation where the site manager might use knowledge to determine proper disposition (i.e., testing would not be required) would involve materials generated at locations where wells are installed for the purpose of ascertaining naturally occurring levels of

inorganic constituents and there is no basis to expect contamination, i.e., there is no past history of hazardous waste management activities or releases in these areas. If this is the case, the soils, cuttings, purge water, etc. would not be regulated as solid wastes. Test results or knowledge of the waste should be used to screen the well cuttings, purge water and other IDW to demonstrate that concentrations of contaminants are below or equal to background levels.

Purge water, well cuttings from monitoring wells, and other IDW, if tested, must be done so in accordance with EPA SW-846, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, 3rd edition, 1986, as updated. If contaminant levels are found to be above background levels, the IDW would be considered a solid waste. Should test results further indicate that the IDW contains a listed hazardous waste, or if the IDW exhibits a characteristic of hazardous waste, the IDW is a hazardous waste and must be managed and disposed in accordance with the VHWMR. Alternatively, contaminated IDW that contains a listed hazardous waste must be managed as a hazardous waste until it no longer "contains" the hazardous waste, i.e., until the constituent levels are below site specific risk based levels. This is consistent with EPA's Contained In Policy. The DEQ should be contacted directly to determine the site specific risk based levels that would apply to IDW that contains listed hazardous waste.

If the IDW is not a hazardous waste, but contains levels of contaminants above background levels, the IDW must be managed in accordance with the VSWMR. Solid waste generated from cleanup or investigation activities is considered a special waste under Part VIII of the VSWMR. Prior to acceptance of a special waste for disposal at a solid waste management facility, the operator must obtain prior authorization from the Department. Purge water, on the other hand, must be disposed at a publicly owned treatment works (POTW) or other wastewater treatment system operating in accordance with its Virginia Pollutant Discharge Elimination System (VPDES) permit, provided that all other pertinent criteria are satisfied.

The on-site treatment, storage, or disposal of IDW must be authorized by a permit from the DEQ. A generator of hazardous IDW may accumulate such wastes in tanks or containers in accordance with VHWMR §6.4.E. Treatment of hazardous waste in tanks or containers within the 90 day accumulation period may only occur upon prior written approval from the appropriate DEQ Regional Office.

This policy may be revised or rescinded at any time as Federal and/or State regulations change.

Signed:

Hassan Vakili

Hassan Vakili, Director
Waste Operations

6-28-95
Date

ADDENDUM

Department of Environmental Quality
Waste Operations
Policy for the Handling of
Investigation Derived Waste (IDW)

This Addendum is being provided to clarify the distinction between the disposal requirements for Investigation Derived Waste (IDW) that is generated from an undefined area, and the requirements for soil and sediment IDW when soil and sediment is generated from an area of known contamination subject to further response measures with oversight from DEQ and/or EPA.

"DEQ Policy for the Handling of Investigation Derived Waste" dated July 5, 1995, specifies that IDW contaminated above background levels is considered a solid waste and must be managed in accordance with the Virginia Solid Waste Management Regulations. If the IDW contains a listed hazardous waste or exhibits a characteristic of hazardous waste, it must be managed as hazardous waste in accordance with the Virginia Hazardous Waste Management Regulations. Under this policy, returning contaminated IDW to the location from which it is generated is prohibited.

However, this policy was not intended to address the requirements associated with soil and sediment IDW generated from an area of known contamination when this area is subject to future response activities with oversight from DEQ or EPA. In such a case, the management and disposal of the IDW should be in accordance with the pertinent EPA guidance governing the applicability of RCRA land disposal restrictions. ("Management of IDW During SI's", EPA/540/G-91/009).

Under the EPA guidance, replacement of soil and sediment IDW into the area of contamination from which it is generated is permissible provided that the waste is not treated prior to placement. Therefore, the above-referenced DEQ IDW policy now recognizes that if soil and sediment IDW is generated from an area of known contamination, and this area is subject to further response measures with oversight from DEQ and/or EPA, the IDW may be placed back into the area from which it is taken provided there is no treatment of this waste prior to placement.

Signed Hassan Vakil Date 7/24/96

Hassan Vakili, Director
Division of Waste Operations

ATTACHMENT V.BB

GROUND WATER MONITORING LIST

ATTACHMENT V.BB

GROUND WATER MONITORING LIST

Constituents	Analytical Method
Indicator Parameters	
pH	field
Specific Conductivity	field
Analyte	
Total Organic Carbon (TOC)	9060
Total Organic Halogen (TOX)	9020
Nitrate/Nitrite	9056
Ammonia	SM4500-NH_3-C
Total Lead	6020
Phenols	9065
Total Cyanide	9010/9014

Note:

1. Alternate SW-846 Methods may be approved by the Department if the request is in writing and submitted at least 30 days prior to the sample collection event. Proposed alternative methods must achieve the appropriate Data Quality Objective (i.e. at least a Department approved health-based concentration limit).

PERMIT ATTACHMENT V.CC

INITIAL BACKGROUND CONCENTRATIONS

ATTACHMENT V.CC

INITIAL BACKGROUND CONCENTRATIONS (mg/l)
For Replacement Background Well - MW-4

Constituents	Concentration (mg/L)	Statistical Method
Total Organic Carbon (TOC)	4.0	95 % UTL*
Total Organic Halogen (TOX)	8.6	95 % UTL
Nitrate - N	2.2	95 % UTL
Nitrite - N	0.046	95 % UTL
Ammonia - N	0.3	95 % UTL
Total Lead	0.0089	95 % UTL
Total Phenols	0.092	95 % UTL
Total Cyanide	0.064	95 % UTL

* The 95 % Upper Tolerance Limit (UTL) Background Values for all constituents of concern (COCs) were calculated by the DEQ using the data from MW-4 from November 2005, through December 2011. See DEQ correspondence to Permittee, dated May 25, 2012.

MODULE VI
GROUNDWATER COMPLIANCE MONITORING

VI.A. HIGHLIGHTS

Groundwater monitoring at the OB/OD site is to be conducted under a Detection Monitoring Program. If the Permittee determines that the Detection Monitoring Program no longer satisfies the requirements of Module V, the Permittee must submit an application for a permit modification to make appropriate changes to the program. If the program changes are the result of hazardous constituents, related to the site, detected at statistically significant concentrations above background concentrations, then the Permit will be modified for a Compliance Monitoring Program.