DEMILITARIZATION ALTERNATIVES TO OPEN BURNING/OPEN DETONATION (OB/OD)

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(VG-2) There is growing concern within the U.S. Army that the Department of Defense (DOD), federal, or state environmental protection agencies may in the future, restrict or limit the practice of OB/OD of munitions and explosives. As the Single Manager for Conventional Ammunition (SMCA) field operating element, the U.S. Army Armament, Munitions and Chemical Command (AMCCOM) has the responsibility to oversee the demilitarization of the services excess and obsolete ammunition. This responsibility includes developing technology, equipment, and processes, as well as management of the demilitarization inventory. Technology funding constraints, however, have severely limited these efforts. Several independent studies over the past decade, as well as new demilitarization technology efforts, have been explored to determine if more efficient methods are available for the demilitarization of ammunition. The U.S. Army Defense Ammunition Center and School (USADACS) located in Savanna, IL was tasked to accomplish a study that identifies alternative methods or technologies to OB/OD.

The Demilitarization Technology Office, AMSMC-DSM-D, of AMCCOM has a parallel study in process at Dugway Proving Ground (DPG) that is to be used in petitioning the federal and various state environmental protection agencies (EPA) to continue OB/OD as a demilitarization method. In addition, USADACS has completed a parallel study covering large rocket motor (LRM) demilitarization. These studies will not be covered in this paper.

(VG-3) The demilitarization account, also known as the B5A account, consists of 4,476 separate national stock numbered (NSN) items. These items have been divided into 80 separate families and 14 consolidated families to assist in the comparison of technologies. The U.S. Army Defense Ammunition Center and School has developed the capability to provide detailed analysis of the inventory by various methods. Some of these methods are a direct result of the conversion of the Joint Ordnance Commanders Group (JOCG) Demilitarization/Disposal Handbook, Volume I, Demilitarization/Disposal Inventory (Orange Book) and JOCG Volume III, Reclamation of Materiels and Weights, to dBase files. This conversion provides quantifiable inventory information to perspective technology developers that was previously impossible, due to the matrix of variables such as the 16 distinct material types and 78 major fillers.

(VG-4) A historical review of the demilitarization inventory reveals that there was over 220,000 short tons of materiel in 1981. The quantity dipped to a low of 155,000 short tons during 1985. This drop was achieved through an aggressive Department of the Army (DA) funding effort. The inventory has since grown to over 200,000 short tons today. Current trends indicate that there is an annual generation of approximately 20,000 short tons.

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(VG-5) Comparing the 1986 inventory with the 1989 inventory, there is an obvious drop in the quantity of smokes and dyes. This is attributed to the successful development and implementation of the white phosphorus - phosphoric acid conversion (WP-PAC) plant. There has been an increase in the quantity of munitions in the bombs, torpedoes, CBUs, depth charges, rockets and missiles, and HE-loaded projectiles.

(VG-6) The 31 December 1989 demilitarization inventory may be shown by the relationship between the explosive or reactive filler and the inert material. This type of information is necessary because the composition of filler normally drives the technology development. The quantity and type of filler often drive the technology development and could determine the possible return on investment through reclamation.

(VG-7) This same analysis may be performed not only on the entire demilitarization inventory, but may also be used to understand the material types and quantities or filler types and quantities in the individual consolidated families. An example of this is the consolidated family of HE-loaded projectiles. In this example, the materials that are most prevalent in this consolidated family are: heavy steel - projectile body, wood - packing material, light steel - cartridge case or tracer, fiber - inner container, mixed metal - fuze with booster, and brass - primer.

(VG-8) The fillers of the consolidated family of HE-loaded projectiles are more complex. They consist of single base propellant, Comp B, Comp A-3, double base propellant, triple base propellant, TNT, explosive D, tetryl, black powder, and HC smoke among others. As can be seen from the chart, the single base propellant is by far the most extensive filler in the HE-loaded projectile consolidated family at 3,400 short tons followed by Comp B at 1,576 short tons.

(VG-9) There are several factors that influence the technical solutions to the disposal of munitions in the demilitarization account. These include the planned base closures of several locations that store munitions and the retrograde of stocks from the Federal Republic of Germany (FRG). These actions may create a shortage of available storage space and will mandate an increase in demilitarization. Demilitarization by OB/OD, even if fully funded, could not dispose of all the items. There are some munitions that cannot be safely destroyed by OB/OD and must be demilitarized using other technology. These items include hand grenades, improved conventional munitions (ICMs), smokes, dyes, and pyrotechnics. Newer ammunition or ammunition that is under development by the Services may require new technology such as the copperhead or ammunition containing depleted uranium. Other factors that will influence the demilitarization of ammunition is the increased emphasis on the environment by the DOD, other governmental agencies, and various other organizations.

(VG-10) This report was accomplished in three phases. The approach to phase I was to review, compile, and maintain a database of existing studies and reports. This includes 11 previous demilitarization or disposal studies, 28 reports from the Defense Technical Information Center (DTIC) that were applicable to this study, and 60 technical reports from various sources.

Phase II consisted of on-site visits to DOD/industry/academia. Included in these on-site visits were 16 to Government facilities and 12 to industrial or academia locations. Phase III consists of analyzing the emerging technologies against the demilitarization stockpile and the needs of the technology.

(VG-11) The technologies identified have been divided into 11 categories in order to compile, evaluate, and prioritize them. These categories are: washout, meltout, reclamation, controlled incineration, disassembly, electrochemical reduction, chemical conversion, detonation chamber, super/subcritical fluid extraction, oxidation, and biodegradation. A description of each of the families and their members follows:

(VG-12) The washout family has been divided into four distinct technology groups. They are hot water, high pressure, solvent, and cryogenic dry wash. The hot water technology is comprised of two existing processes. These processes are the ammunition peculiar equipment (APE) 1300 washout plant designed by the Ammunition Equipment Directorate (AED), Tooele Army Depot (TEAD) and used for hot water washout of TNT and RDX fillers. The hydraulic cleaning system which is located at the Western Area Demilitarization Facility (WADF) is used for removing explosive D from Navy munitions. The high pressure technology group consists of two existing "hogout" processes that are used for removing ammonium perchlorate (AP) propellant from LRMs. These processes are located at the Thiokol Corporation, Brigham City, UT and Aerojet Solid Propulsion Company, Sacramento, CA. These hogout processes use a combination of solvation of the AP and high pressure waterjet erosion of the binder material to remove the propellant. A third existing hogout process is located at WADF and is designed for removal of explosive A-3 from projectiles.

An emerging high pressure washout process is the Waterjet Ordnance and Munitions Blastcleaner with Automated Tellurometry (WOMBAT). This system was developed by the University of Missouri at Rolla for the Naval Weapons Support Center (NWSC), Crane, IN. This system is designed for the removal of PBX (plastic bonded RDX) from projectiles. The process consists of an automated state-of-the-art system for maneuvering the waterjet lance through a variety of different geometries encountered inside munitions that have internal plumbing. Before this system can be put into production usage, computerized waterjet operational procedures must be developed for each type of munition and the sensitivity of the various explosive fillers to the high pressure waterjet must be determined.

(VG-13) Solvent washout is another group in the washout family. These processes are related by the fact that they all dissolve a component of the filler in order to perform removal. The toluene process was a feasibility study conducted by AED. This process used toluene to remove Comp B from projectiles. The chemical hazards and flammability of toluene has been deemed inappropriate for further studies of this solvent for this process.

The methylene chloride and methanol system was designed and tested by NWSC, Crane for use in recovering ingredients from aircraft parachute flares. The pilot plant proved successful, but has never been scaled up to an operational facility due to economic considerations. The Naval Weapons Support Center, Crane developed a similar system using water as the solvent to reclaim aluminum from photoflash cartridges; it too was never scaled up to an operational facility. A similar process has been tested using a high flash point solvent to remove and reclaim ingredients from infrared flares.

The Naval Weapons Support Center, Crane has under development two similar processes for removal of PBX fillers using a solvent. The first is a 60 percent methanol and 40 percent methylene chloride solvent blend for dissolution of the binders that are used in the PBX series of fillers. These solvents exhibit low toxicity, are reasonably priced, and have a flash point in excess of 100 degrees Fahrenheit. Bench scale testing has been completed on different PBX compositions. Bench scale and pilot plant testing, economic analysis of solvent extraction/ingredient recovery methods has yet to be accomplished.

The other effort currently underway by NWSC, Crane in conjunction with El Dorado Engineering is the solvent extraction of PBX materiels. This automated system will feature mutli-solvent storage, solvent distillation and recycling, and process water disposal. Lab scale testing has been completed on different PBXs with bench scale testing extended through Fiscal Year 1991 (FY 91).

(VG-14) A conceptual method to remove energetic materiel from projectiles and rocket motors has been proposed by General Atomics, San Diego, CA. This conceptual method involves applying a cryogenic liquid to the surface of the filler. This liquid causes the surface to cool rapidly, thus causing thermal stress in the materiel. The thermal stress will cause the material to develop fractures. Preliminary tests indicate that a mechanical method in combination with the cryogenic liquid may be necessary to remove AP propellant from the motor case.

(VG-15) The meltout family is comprised of methods that remove the energetic materiel by applying heat to the filler causing it to melt and flow out. This family consists of three discrete technologies; they are autoclave, steamout, and heating. These technologies are described further in the following text.

The autoclave process transfers heat to the meltable explosive filler by applying steam to the metal casing. In the ideal situation, the steam condensate would be kept separate from the melting explosive so that a hazardous waste is not created and the condensate could be reused. There is a full scale production autoclave facility at WADF that is in layaway. This facility was intended to be used to meltout TNT or TNT Comp B. The WADF process was initially developed by the AED at TEAD. An operating autoclave is located at Ravenna Army Ammunition Plant (RVAAP). This autoclave is older and allows commingling of the melted explosive and the condensate. The contaminated water that is produced because of this is treated on-site in a charcoal filter system prior to discharge.

Another type of meltout technology is steamout. Steamout is similar to the autoclave process, except in steamout the steam is applied directly to the explosive. This direct application of steam to the explosive is a more efficient heat transfer system than the autoclave, and thus reduces the time necessary for meltout. The direct application of steam to the explosive produces contaminated water that must be processed through a charcoal filter prior to discharge. Although this method does produce some explosive contaminated water, it produces less than the hot water washout technology.

Several steamout facilities exist in the continental United States. Two facilities where on-site visits were conducted are located at Crane Army Ammunition Activity (CAAA) and WADF. The facility at CAAA is prepared to operate, while the facility at WADF is in layaway.

Two other heating methods have been tested and produced limited success. They are induction heating and microwave meltout. Induction heating is a technique that operates on the principle of friction and eddy currents induced by an electric current. Although this method obtains the most rapid heating, it also has a high potential for creating hot spots. Microwave meltout was tested on 500- and 750-pound bombs. This technique was not considered successful due to uncontrollable heating which created hot spots within the tritonal filler.

(VG-16) The technologies grouped in the reclamation family all provide a product that may be recovered. A solvation process has been tested by Thiokol Corporation on AP propellant extracted from LRMs. The propellant is placed in a hydraulic macerator where high pressure waterjets cut the propellant into small parts and extract the AP into solution. The AP may be recovered from solution and the binder destroyed by other means. A pilot plant developed by Aerojet Solid Propulsion Company, Sacramento, CA has demonstrated that some of the components may be recovered from AP solid rocket propellant. In the process, the AP is extracted from the propellant after it is removed from the motor casing. The remaining material which consists of binder, aluminum, and a small percent of AP are incinerated in the propellant thermal processor (PTP). The initial incineration produces an aluminum ash which may be recycled. The second stage incineration is done on the gaseous effluents from the initial incineration. This combustion destroys any organics that remain from the first stage incineration. The effluent is further scrubbed to meet existing EPA regulations. The brine produced from this scrubbing is deep well injected.

The conversion technologies manufacture a marketable product from a munition filler that is considered a raw material. This process was demonstrated by NWSC-Crane using red phosphorus as the raw material and converting it to phosphoric acid. There is a production facility at CAAA which converts white phosphorus (WP) to phosphoric acid. The WP to phosphoric acid conversion (WP-PAC) plant incinerates the raw material WP in a modified APE 1236 to form phosphorus pentoxide. The phosphorus pentoxide is drawn through a hydration system where it is combined with water to form phosphoric acid. This process has been vary successful in reducing the amount of WP in the demilitarization inventory.

There are two emerging recovery technologies in the reclamation family. These technologies are both under development by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). The first process involves reuse/reblending of single-, double-, or triple-based propellants as an alternative to thermal destruction. This technique processes the propellant for reintroducing into the production process. The process involves grinding the waste propellant under water and drying it for reintroducing into an existing propellant production line. Laboratory scale and preliminary cost analysis have been conducted with pilot scale demonstration to be conducted during FY 91-92.

The other emerging recovery technology that USATHAMA has demonstrated on a pilot scale is the use of explosives as a supplemental fuel. This process involves dissolving TNT or Comp B in toluene and combining this solution with No. 2 fuel oil so that the concentration of explosive is from 5 to 15 percent by weight. This solution is then used as a fuel to fire an industrial type boiler for production of steam.

(VG-17) The controlled incineration family is comprised of processes that destroy the propellant, explosive and pyrotechnic (PEP) filler or contamination by incineration. Some of the processes are similar and may differ only in the ancillary equipment that feeds the incinerator or treats the effluent. Other processes may be limited to treatment of PEP contaminated material.

The flashing chamber system located at WADF, was designed to decontaminate large items. This system has since been converted to the hot gas decontamination test facility.

The APE 1236 deactivation furnace was designed by AED. The furnace consists of a 4-section rotary kiln and is used for incineration/destruction of small arms, primers, and items with minimal explosive content. The APE 1236 furnace is undergoing an upgrade to bring it into compliance with applicable environmental regulations. This upgrade includes a modified feed system with automatic feed cutoff, afterburner, high/low temperature heat exchangers, centrifugal dust collector (cyclone) baghouse, draft fan, and exhaust stack. The rotary kiln will be completely shrouded to capture any fugitive emissions and process them through the afterburner. When the upgrade is completed, there will be 14 locations that will operate this incinerator. The other locations that did not receive the upgrade on their APE 1236 furnaces may continue to operate, but will not be allowed to process ammunition that is designated as hazardous waste.

The deactivation furnace located at Pine Bluff Arsenal (PBA) is a modified APE 1236. The modification done in-house consists of a feed system with automatic feed cutoff and shrouded rotary kiln. The exhaust gases are directed to a central afterburner and air pollution control system. There are plans to add a hydrosonic scrubbing system to the central air pollution control system.

The APE 2210 deactivation furnace located at WADF is a two rotary kiln system. The rotary furnace lead item system is intended for deactivation of small caliber ammunition equipped with lead projectiles. The rotary furnace detonating items system is intended for deactivation of larger detonating items equipped with non-lead projectiles. These systems are currently undergoing modification to comply with environmental regulations.

The explosive waste incinerator (EWI) was developed by AED and is a rotary kiln system designed to incinerate quantities of up to 5 pounds of bulk explosives or propellant. The EWI has a positive feed system and a pollution abatement system which consists of an indirect, low temperature heat exchanger; a cyclone dust collector; baghouse; draft fan; and, exhaust stack. There are plans to upgrade the EWIs with an afterburner, high temperature heat exchanger, and a new control system. The retort will be shrouded to contain fugitive emissions similar to the APE 1236 deactivation furnace system.

The contaminated waste processor (CWP) was developed by AED for incineration of explosive contaminated packing material or decontamination of metal parts. The CWP is a 'car bottom' type incinerator which has a movable hearth. There are two sizes of CWPs; the small unit is batch fed using a 4-foot by 8-foot basket. The large unit can be operated in a continuous mode by processing the material through a shredder system and then feeding it into the fire chamber through a series of doors. Both systems are equipped with air pollution abatement equipment that consists of a dilution air damper, low temperature heat exchanger, dust collector, bag house, draft fan, and exhaust stack.

The car bottom furnace located at PBA is a commercial incinerator that is used for the incineration of PEP contaminated material or decontamination of metal parts. This incinerator may be batch feed or operated in a continuous mode by addition of material through a door on the side of the furnace.

(VG-18) The flashing furnace at WADF is designed to heat moderate sized ammunition components to a temperature where any residual energetic materiel is decomposed or burned. The furnace is large enough to accommodate four skids at a time. The skids are moved through the furnace by means of a walking beam conveyer.

A rotary kiln type incinerator located at WADF can be used to incinerate explosive slurries and Otto fuel. This incinerator differs from the standard APE 1236 in that it has a refractory liner which is unsuitable for use with items that detonate. Another refractory lined rotary kiln incinerator is located at ENESCO, El Dorado, AR. This incinerator is used to destroy EPA classified hazardous wastes, including PCBs.

The chain grate incinerator at PBA is used for incinerating contaminated packing materials, munitions hardware, and decontaminating scrap metal. The material to be treated is pulled into the fire chamber by means of a movable chain grate assembly. The emissions from the incinerator are processed through the facilities central afterburner.

The fluidized bed incinerator (FBI) at PBA has a thermal capacity of 26 million BTU/hr. The FBI uses high velocity air to entrain solids in a highly turbulent combustion chamber. The bed media is 8 feet expanded height of silica sand. This thermal mass stabilizes the combustion temperature and allows for efficient heat transfer to the material being incinerated. The process material must not be explosives, but can be smokes, dyes, riot control agents, or other material in liquid, slurry, or solid form.

Another closed incinerator that was examined was the circulating bed combustor (CBC) operated by Ogden Environmental Services, Inc. This system is similar to the FBI and is used mainly for decontamination of soil contaminated with hazardous wastes. This system differs from the FBI in that it has provisions for continuous removal of incinerated soils.

The air curtain incinerator located at PBA is a commercially available unit that is used for size reduction of non-PCP treated wood, paper, and scrap material. It consists of a burning chamber and a blower system that generates a 'curtain of air' across the top of the pit. This air curtain entrains the effluent from the combustion process and circulates it back into the flame.

The air control incinerator is under development by Los Alamos National Laboratory (LANL) under contract with NWSC, Crane. The incinerator is designed to incinerate toxic/carcinogenic materials such as organic dyes that are contained in some colored smoke compositions. The incinerator will be a scaled-down model of the LANL incinerator that was used to incinerate samples of Army and Navy smokes. A new feed module system has been constructed and tested using a slurry made from Navy flare composition.

(VG-19) Plasma heating systems convert electricity into heat by ionizing gases and can operate with almost any gas including air, argon, helium, hydrogen, carbon dioxide, or methane. Plasma arc torches are available in many configurations from low power convertible torches, to high power systems suitable for large volume raw municipal waste treatment plants. These torches may routinely create temperatures that range from 7,000 to 12,000 degrees Fahrenheit. They have been proposed by Mason & Hanger National Inc. as an incineration method for use in demilitarization operations. This incineration method may be usable when developed for destruction of smokes, dyes, pyrotechnics, and riot control agents.

Static firing of LRMs may be considered another form of controlled incineration. The Thiokol Corporation has been contracted by MICOM to dispose of Pershing 1A and II rocket motors at Longhorn Army Ammunition Plant (LHAAP). This process is accomplished by using two test stands to restrain the motors for subsequent functioning. This method has no provisions for capturing the effluent for treatment prior to release to the environment; therefore, it may not be a viable alternative in the future.

As an alternative to static firing the LRMs, Lockheed Missiles & Space Company has proposed a technique for capturing and treating the effluent that is dispersed into the atmosphere. This process consists of removing the nozzle assembly of the LRMs and burning the motor at ambient pressure. The effluent gases would be bubbled up through a 40-foot tank of water that contains a series of perforated steel plates into an enclosed chamber. The gases from this chamber would be passed through a duct to air emissions control equipment that has not been identified.

(VG-20) The disassembly family contains processes that will reduce the size of the munition or will expose the PEP filler for further processing. A process of this nature must be accomplished prior to most other processing and generally does not destroy any of the hazardous characteristic of the filler. For instance the TNT explosive filler must be exposed before a meltout operation may be performed. The following processes are examples of disassembly technology:

Laser grooving is a technology that has been proposed by the AED at TEAD. This process would involve using a laser to score the projectile case at its major diameter. This would create a circular weakened groove which in combination with a tearing/breaking process would bisect the case to expose the filler. This filler would then be exposed for further processing such as washout or meltout.

Waterjet cutting or waterjet abrasive cutting has been demonstrated by Program Manager for Ammunition Logistics (PM-AMMOLOG). They demonstrated that a 105mm fuzed projectile may be rendered safe by remotely severing the fuze using an abrasive waterjet. Equipment similar to that used by PM-AMMOLOG is manufactured by Flow International. Their ultra-high-pressure intensifier pump pressurizes water up to 55,000 psig and forces it through a nozzle as small as 0.004 inches in diameter which generates a high velocity waterjet with speeds of up to 3,000 feet per second. This waterjet can cut a variety of non-metallic materials. To cut metallic or hard materials such as metal plates, ceramics, or glass, an abrasive is entrained into the waterjet to enhance the cutting capability.

An emerging disassembly technology is cryofracturing that is under development by General Atomics, San Diego, CA. This technology may prove capable of exposing the filler in difficult or dangerous to disassemble munitions. The cryofracture process involves cooling a munition in a bath of liquid nitrogen at cryogenic temperatures. At this temperature, the heavy steel projectile body becomes brittle, and if subject to pressure of a 1,000-ton press, it will shatter, thus exposing the contents. The shattered munitions can subsequently be treated by another technology to complete the demilitarization process. The process has been successfully demonstrated on simulated filled chemical munitions.

(VG-21) Electrochemical reduction is a very selective process in its application. This process has been demonstrated in the demilitarization of lead azide. In this process, a quantity of bulk lead azide is dissolved in a 20 percent sodium hydroxide solution. The solution is then circulated into a larger tank where two electrodes have been positioned. Application of an electric current to the electrodes causes the lead to plate out where it may be removed. This process does produce a sludge material which also must be disposed of.

The neutralization process in the chemical conversion family is limited in use to acidic or basic fillers. This process has been demonstrated for disposal of bulk FS smoke. The FS material is slowly added to a rapid flow of water. The diluted solution is then allowed to mix with lime slurry in a water cooled four million gallon tank to dissipate the heat that is generated.

S-cubed, San Diego, CA constructed a six-foot diameter steel sphere for total containment of explosives detonation experiments. This sphere will fully contain a detonation of up to 100 pounds of C-4 explosive. For charges of 20 pounds or more, the steel sphere is filled with coke which acts as a heat-sink material.

A promising process that is emerging is the use of super/sub-critical fluids that is under development at MICOM for the removal of propellants from LRMs. This process takes advantage of the enhanced solubility characteristics of super/sub-critical fluids and the liquid-to-gas phase transitions which occur during the compression or expansion of all gases. This process may be used for other fillers; however, further study is needed to determine the appropriate super/sub-critical fluids. The fundamental operation principle of this system is similar to that which occurs in a refrigeration system. Soluble propellant ingredients are extracted into the fluidized solvent and separated by filtration from all undissolved materials. The dissolved propellant ingredients are recovered down stream in a separation vessel during the liquid-to-gas pressure reduction cycle. The expanded gas now devoid of all dissolved propellant ingredients is filtered and re-compressed to the fluid state to complete the solvent regeneration cycle.

(VG-22) The oxidation family consists of an emerging high/low temperature oxidation process for red/pink water. This process is under development by Combustion Engineering, Bloomfield, NJ. The scale model will treat less than 10 gallons per minute of red/pink water at an operation temperature of approximately 400 degrees Celsius with a 10-minute retention time. Laboratory work is in process.

The biodegradation family consists of two processes: Degradation of explosive waste by micro-organisms and white rot fungus. Lawrence Livermore National Laboratory, Livermore, CA is examining the feasibility of using micro-organisms to degrade HE contaminated water and soils. Preliminary results indicate that micro-organisms are capable of degrading RDX under aerobic conditions. Work is in process to determine the optimum conditions for HE degradation.

Lummus Crest Inc., a subsidiary of Combustion Engineering, Bloomfield, NJ, has done laboratory work on a process to biodegrade pink water. The active portion of the system consists of a packed column unit or rotating biological contractor upon which a white rot fungus culture has been grown. In the laboratory work, the pink water is continually circulated through the system. Combustion Engineering has successfully reduced, using a batch test method, the TNT concentration in pink water to 2 ppm in 24 hours and the RDX concentration in pink water to less than 10 ppm in 48 hours. This process may have an application in treating waste water effluent from washout or steamout operations.

(VG-23) Volume II is titled "Demilitarization Alternatives to Open Burning/Open Detonation - Technology Compilations Project Number DEV 12-88" and contains a compilation of all the technologies investigated thru April 1990. There are no doubt technologies being pursued which have not been brought to our attention. To remain informed of new developments in this area, we would like to be made aware of any efforts that are being undertaken. If there is a written report, they may be sent to the following address:

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Volume III is titled "Appendixes" and include the following:

a. Bibliography of 99 separate reports
b. Points of contact at 28 locations/agencies visited
c. Applicable demil/disposal regulations

d. Listing of current demilitarization Depot Maintenance Work Requirements (DMWRs) cross-referenced to DODIC

e. Brief description of currently available ammunition peculiar equipment (APE) and new APE programed for FY 90-92

f. Listing of current demilitarization/disposal capabilities at DOD installations worldwide

Volume I containing recommendations for technology funding is "For Official Uses Only." Volumes II and III will be available through the DTIC when released.

DEMILITARIZATION ALTERNATIVES TO OPEN BURNING/OPEN DETONATION (OB/OD)

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BACKGROUND

- ARMY AND SINGLE MANAGER CONTINUE TO RELY UPON OB/OD AS PRINCIPAL DEMIL METHOD

- USADACS FUNDED BY AMCCOM OCT 88 TO ACCOMPLISH STUDY THAT IDENTIFIES ALTERNATIVE METHODS (TECHNOLOGY)

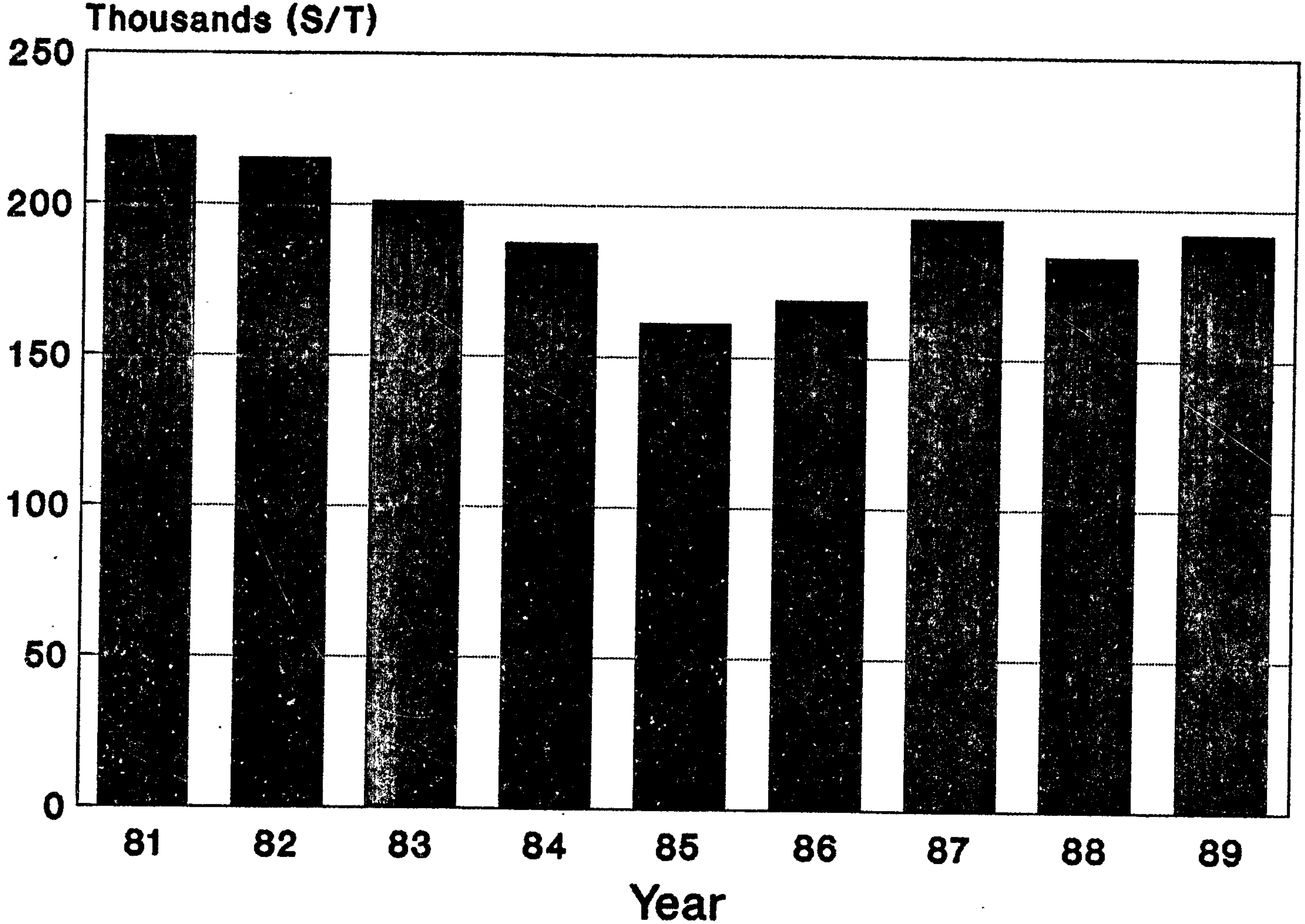
- AMCCOM HAS A PARALLEL STUDY IN PROCESS AT DUGWAY TO QUANTIFY ENVIRONMENTAL IMPACT OF OB/OD

- USADACS HAS A PARALLEL STUDY IN PROCESS COVERING LARGE ROCKET MOTOR (LRM) DEMIL THAT HAS BEEN BRIEFED AT THE JOINT LOGISTICS COMMANDERS (JLC) LEVEL

CURRENT DEMIL STOCKPILE (PROBLEM)

- 4,476 SEPARATE NSNs IN "ORANGE BOOK"
- 80 SEPARATE "FAMILIES" OF AMMUNITION
- 16 DISTINCT MATERIEL TYPES
- 78 MAJOR FILLERS

9 YEAR TREND



Source-JOCG Demilitarization / Disposal
Handbooks

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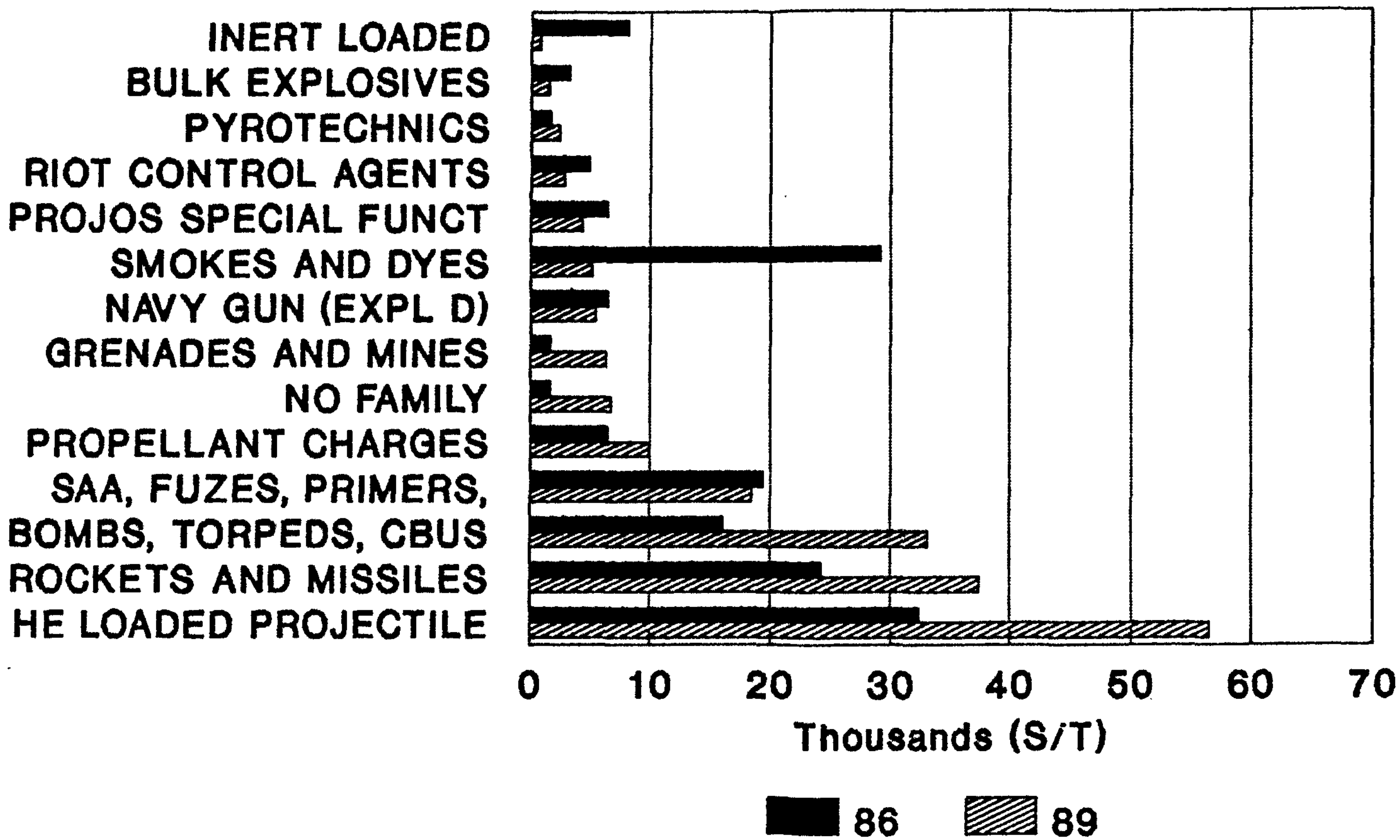
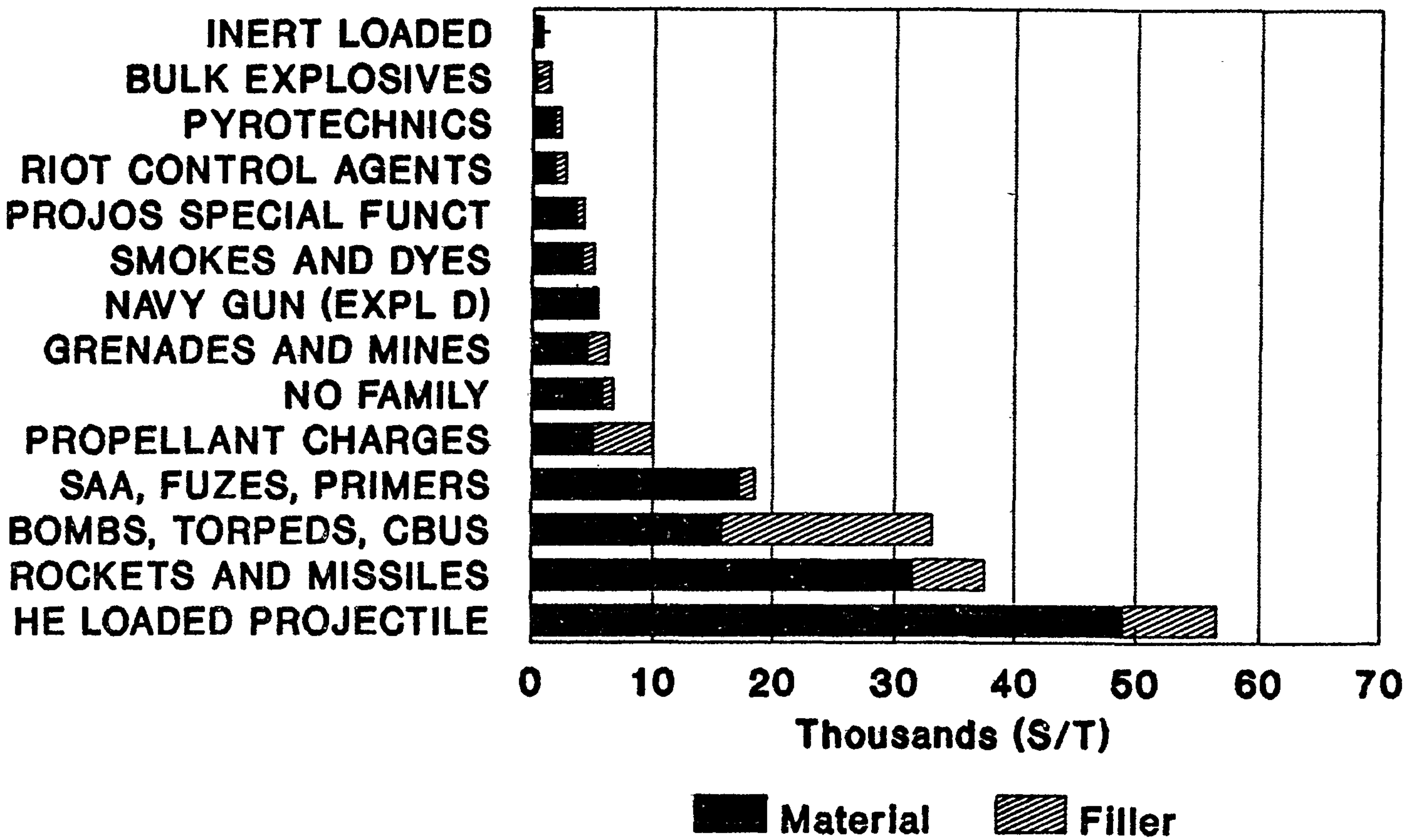
DEMIL INVENTORY BY CONSOLIDATED FAMILY 1986 VS 1989



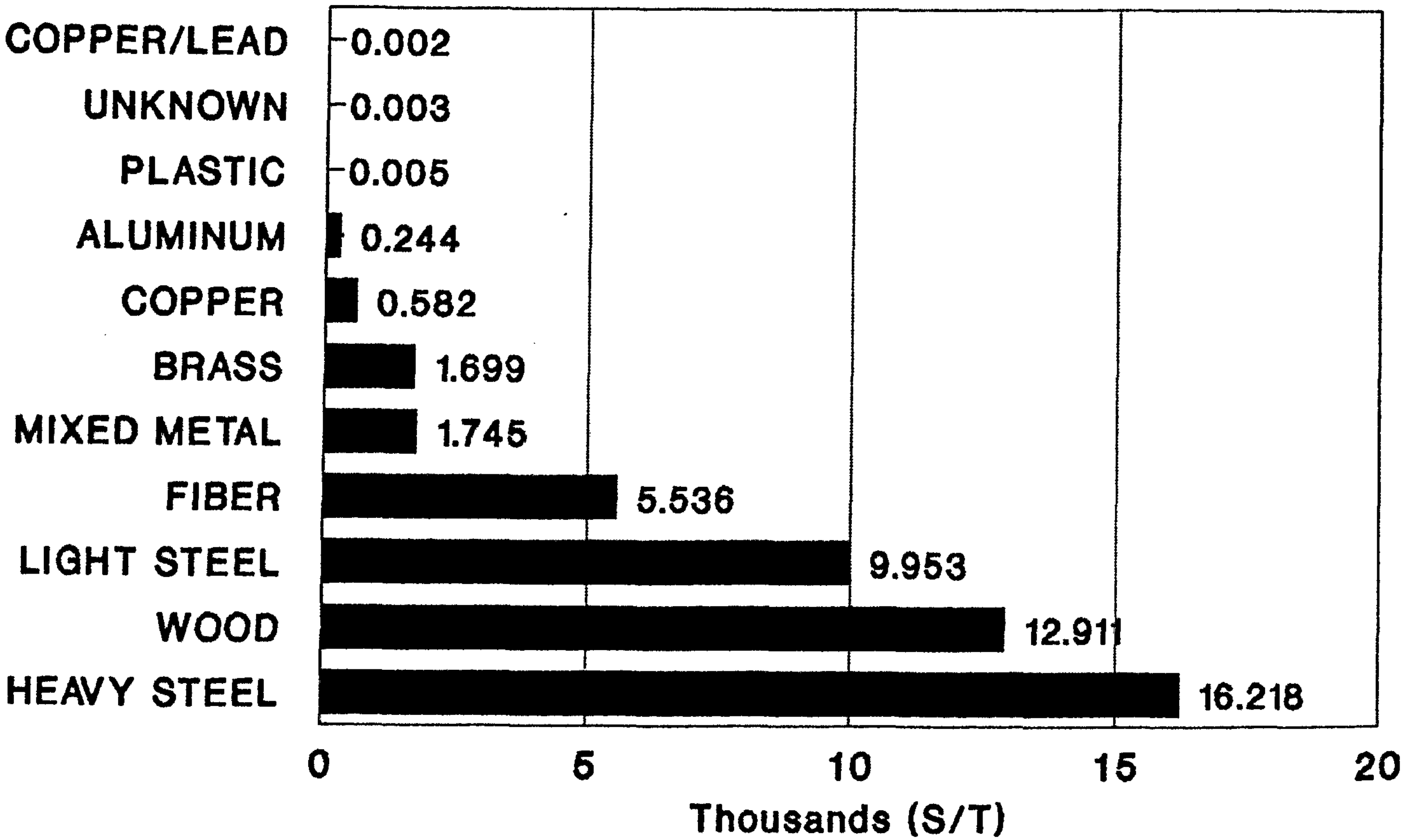
Source-JOCG Demilitarization / Disposal Handbook 31 Dec 86 & 31 Dec 89

31 DEC 89 DEMIL INVENTORY
(By Consolidated Family)



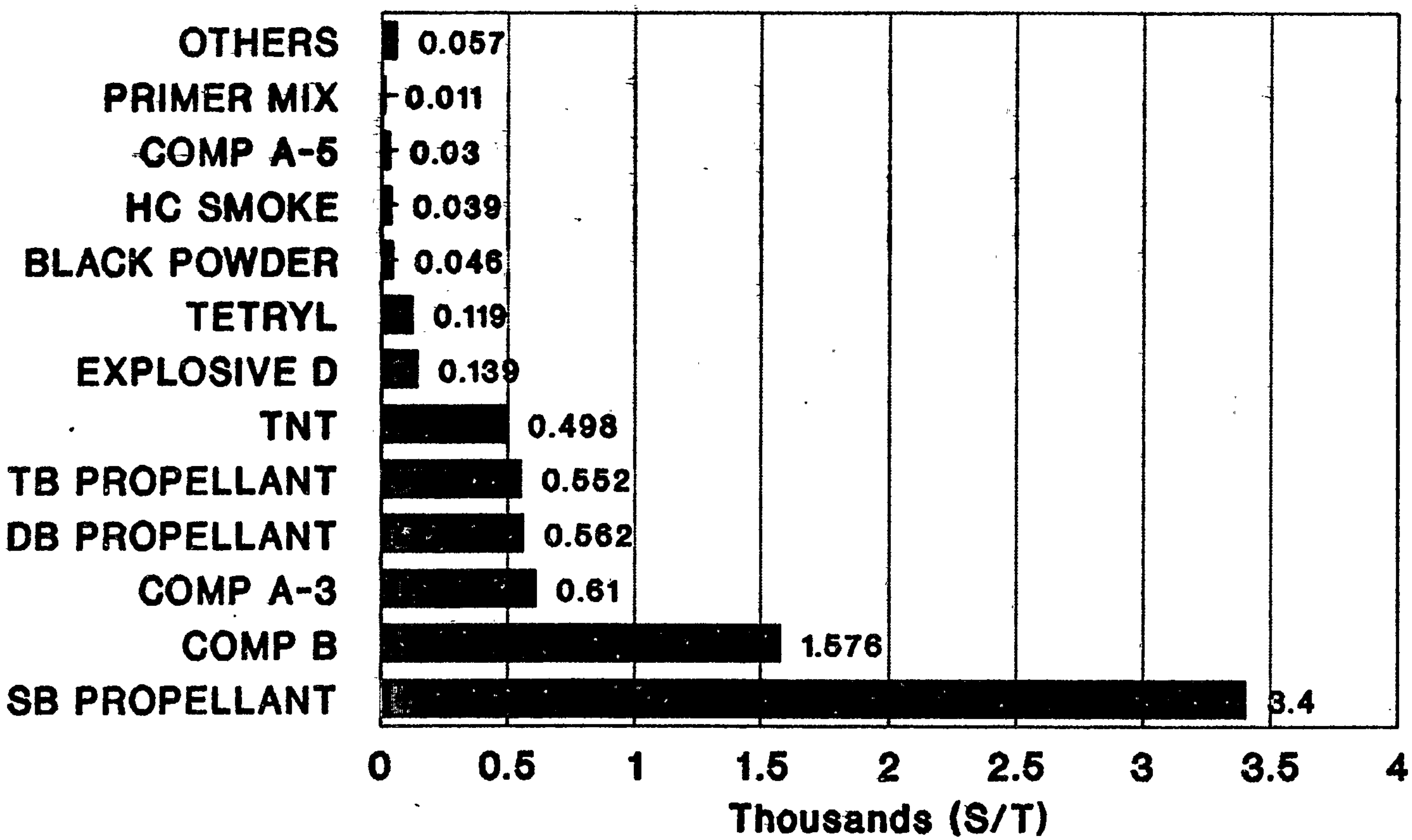
Source-JOCG Demilitarization / Disposal
Handbooks Volume I and Volume III

31 DEC 89 DEMIL INVENTORY FOR THE FAMILY OF HE LOADED PROJECTICLES
(By Material)



Source-JOCG Demilitarization / Disposal Handbooks Volume I and Volume III

31 DEC 89 DEMIL INVENTORY FOR THE FAMILY OF HE LOADED PROJECTILES (By Filler)



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EMERGING IMPACTS THAT REQUIRE IMMEDIATE TECHNICAL SOLUTIONS

- BASE CLOSURES AND RETROGRADE OF STOCKS FROM FRG WILL MANDATE INCREASED DEMIL
  - OB/OD (IF FUNDED) CANNOT DEMIL ALL ITEMS
  - HAND GRENADES/ICMs/SMOKES/DYES/PYROTECHNICS REQUIRE NEW TECHNOLOGY
- NEWER AMMUNITION (COPPERHEAD/DU ROUNDS) WILL ALSO REQUIRE NEW TECHNOLOGY
- DOD HAS INCREASED EMPHASIS ON ENVIRONMENT
  - INCLUDING OB OF SINGLE/DOUBLE BASE PROPELLANT

STUDY APPROACH

- REVIEW, COMPILE, AND MAINTAIN DATABASE OF EXISTING STUDIES/REPORTS INCLUDING:
  - 11 PREVIOUS DEMIL DISPOSAL STUDIES
  - 28 DTIC REPORTS APPLICABLE TO THIS STUDY
  - 60 TECHNICAL REPORTS FROM VARIOUS SOURCES

- ON-SITE VISITS TO DOD/INDUSTRY/ACADEMIA INCLUDING:
  - 16 GOVERNMENT
  - 12 INDUSTRY AND ACADEMIA

- RATE/RANK 28 TECHNOLOGIES (53 SEPARATE DESCRIPTIONS) AGAINST NEED/RISK/COST (RETURN ON INVESTMENT)

ALTERNATIVE FAMILIES TO OB/OD

- WASHOUT
- MELTOUT
- RECLAMATION
- CONTROLLED INCINERATION
- DISASSEMBLY
- ELECTROCHEMICAL REDUCTION
- CHEMICAL CONVERSION
- DETONATION CHAMBER
- SUPER/SUBCRITICAL FLUID EXTRACTION
- OXIDATION
- BIODEGRADATION

WASHOUT FAMILY

HOT WATER:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
WASHOUT PLANT (APE 1300)	LBAD	AED	TNT/RDX FILLERS	EXISTS
HYDRAULIC CLEANING SYS	WADF	AMCCOM	EXPLOSIVE D	EXISTS

HIGH PRESSURE:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
"HOGOUT"	THIOKOL	THIOKOL	LRM PROPELLANT	EXISTS
"HOGOUT"	AEROJET	AEROJET	LRM PROPELLANT	EXISTS
"HOGOUT"	WADF	AMCCOM	EXPLOSIVE A3	EXISTS
WOMBAT	UNIV OF MO-ROLLA	UNIV OF MO-ROLLA	PBX FILLERS	EMERGING

WASHOUT FAMILY (CON'T)

SOLVENT:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
TOLUENE	AED	AED	COMP B EXPLS	TRIED
METHYLENE CHLORIDE METHANOL	NWSC, CRANE	NWSC, CRANE	A/C PARACHUTE FLARES	TRIED
WATER	NWSC, CRANE	NWSC, CRANE	PHOTOFLASH CTG	TRIED
BLEND	NWSC, CRANE	NWSC, CRANE	IR FLARES	TRIED
BLEND	NWSC, CRANE	NWSC, CRANE	PBXN-3,4,5 & 6	EMERG ING
BLEND	NWSC	NWSC, CRANE & EL DORADO ENG, INC.	PBX FILLERS	EMERG ING

WASHOUT FAMILY (CON'T)

CRYOGENIC DRY WASH:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
CRYOGENIC FLUID	GENERAL ATOMICS	EL DORADO ENGR, INC.	EXPLOSIVES & PROPELLANTS	CONCEPT

MELTOUT FAMILY

AUTOCLAVE:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
STEAM	AED	AED	TNT OR TNT COMP	TRIED
STEAM	WADF	AMCCOM	MELTABLE EXPLS	EXISTS
STEAM	RVAAP	RVAAP	MELTABLE EXPLS	EXISTS

STEAMOUT:

STEAM	CAAA	CAAA	MELTABLE EXPLS	EXISTS
STEAM	WADF	AMCCOM	MELTABLE EXPLS	EXISTS

HEATING:

INDUCTION	AED	AED	MELTABLE EXPLS	TRIED
MICROWAVE	AED	AED	TRITONAL FILLER	TRIED

RECLAMATION FAMILY

SOLVATION:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
WATER	THIOKOL	THIOKOL	LRM AP PROPELLANT	TRIED
WATER	AEROJET	AEROJET	LRM AP PROPELLANT	EXISTS

CONVERSION:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
HEAT AND SCRUBBING	NWSC, CRANE	NWSC, CRANE	RP TO PHOSPHORIC ACID	TRIED
HEAT AND SCRUBBING	CAAA	AMCCOM	WP TO PHOSPHORIC ACID	EXISTS

RECOVERY:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
REUSE/ REBLENDING	USATHAMA	USATHAMA	WASTE PROPELLANT PROPELLANT REUSE	EMERG-ING
ENERGY	USATHAMA	USATHAMA	SUPPLEMENTAL FUEL	EMERG-ING

CONTROLLED INCINERATION FAMILY

INCINERATORS:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
FLASHING CHAMBER SYS	WADF	AMCCOM	LARGE ITEM	TRIED
DEACT (APE 1236)	AED	AED	SMALL ARMS, ETC.	EXISTS
DEACT (APE 1236 MODIFIED)	PBA	PBA	SMOKES/DYES, ETC.	EXISTS
ROTARY (APE 2210)	WADF	AMCCOM	SMALL ARMS, ETC.	EXISTS
EXPLOSIVE WASTE INCIN-ERATOR (EWI)	AED	AED	EXPLOSIVE WASTE	EXISTS
CONTAMINATED WASTE PROCESSOR (CWP)	AED	AED	CONTAMINATED WASTE	EXISTS
CAR BOTTOM	PBA	PBA	CONTAMINATED WASTE, ETC.	EXISTS

CONTROLLED INCINERATION FAMILY (CON'T)

INCINERATORS (CON'T):

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
FLASHING FURNACE (WALKING BEAM)	WADF	AMCCOM	METAL PARTS	EXISTS
ROTARY KILN	WADF	AMCCOM	EXPL SLURRIES OTTO FUEL	EXISTS
ROTARY KILN	ENSCO	ENSCO	CONTAMINATED WASTE	EXISTS
CHAIN GRATE	PBA	PBA	CONTAMINATED WASTE	EXISTS
FLUIDIZED BED INCINER-ATOR (FBI)	PBA	PBA	SMOKE & DYES IN SLURRIES	EXISTS
CIRCULATING BED COMBUSTOR (CBC)	OES	OES	CONTAMINATED SOIL, ETC.	EXISTS
AIR CURTAIN BURNER	PBA	PBA	SIZE REDUCE SCRAP	EXISTS
AIR CONTROL INCINERATOR (ACI)	NWSC & LANL	LANL	SMOKES & DYES	EMERG-ING

CONTROLLED INCINERATION FAMILY (CON'T)

INCINERATORS (CON'T):

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
PLASMA ARC INCINERATOR	HUNTSVILLE, AL	MASON & HANGER NATL INC	SMOKES & DYES, PYROTECHNICS, & RIOT CONTROL	EMERG-ING
STATIC FIRING	LHAAP & MICOM	MICOM	PERSHING IA & II AND SRM	EXISTS
STATIC FIRING	LOCKHEED	LOCKHEED	LRM	CONCEPT

756

DISASSEMBLY FAMILY

CUTTING:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
LASER GROOVING	AED	AED	METAL REMOVAL	TRIED
WATERJET (EOD)	PM-AMMOLOG	PM-AMMOLOG	METAL CUTTING	EXISTS
WATERJET ABRASION	KENT, WA	FLOW INT.	METAL CUTTING	EXISTS

CRYOFRACTURE:

CRUSHING	SAN DIEGO, CA	GEN ATOMICS	METAL/FILLER EMBRITTLEMENT	EMERG-ING

ELECTROCHEMICAL REDUCTION FAMILY:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
ELECTRO-CHEMICAL REACTION	SVADA	MASON-HANGER	LEAD AZIDE	EXISTS

CHEMICAL CONVERSION FAMILY:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
NEUTRALIZATION	PBA	AMCCOM	FS DISPOSAL	EXISTS

DETONATION CHAMBER FAMILY:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
STEEL SPHERE	SAN DIEGO	S-CUBED	EXPLOSIVE CONTAMINANT	EXISTS

SUPER/SUB-CRITICAL FLUIDS FAMILY:

PROCESS	LOCATION	TECH AGENCY	LOCATION	TECH STATUS
AMMONIA	MICOM	MICOM	LRM AP PROPELLANTS	EMERG-ING

OXIDATION FAMILY:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
HIGH/LOW TEMP	BLOOMFIELD, NJ	COMBUSTION ENGINEERING	RED/PINK WATER	EMERGING

BIODEGRADATION FAMILY:

PROCESS	LOCATION	TECH AGENCY	APPLICATION	TECH STATUS
DEGRADATION BY MICRO-ORGANISMS	LIVERMORE, CA	LAWRENCE LIVERMORE LABS	RDX, HMX CONTAMINATED SOIL	EMERG-ING
WHITE ROT FUNGUS	BLOOMFIELD, NJ	COMBUSTION ENGINEERING	PINK WATER	EMERG-ING

CURRENT STATUS OF REPORT

- VOLUME II, TITLED "DEMILITARIZATION ALTERNATIVES TO OPEN BURNING/OPEN DETONATION - TECHNOLOGY COMPILATIONS PROJECT NUMBER DEV 12-88" IS CURRENTLY BEING PRINTED

- VOLUME III, TITLED "APPENDIXES," WHICH INCLUDES THE FOLLOWING IS ALSO BEING PRINTED:
  - BIBLIOGRAPHY OF 99 SEPARATE REPORTS
  - POCs AT 28 LOCATIONS/AGENCIES VISITED
  - APPLICABLE DEMIL/DISPOSAL REGULATIONS
  - LISTING OF CURRENT DEMIL DMWRs CROSS-REFERENCED TO DODIC
  - BRIEF DESCRIPTION OF CURRENTLY AVAILABLE AMMUNITION PECULIAR EQUIPMENT (APE) AND NEW APE PROGRAM (FY 90-92)
  - LISTING OF CURRENT DEMIL/DISPOSAL CAPABILITIES AT DOD INSTALLATIONS WORLDWIDE

- VOLUME I CONTAINING RECOMMENDATIONS FOR TECHNOLOGY FUNDING WILL BE AVAILABLE FOR AMCCOM STAFFING 1 SEPTEMBER 1990