Response to:
Request for Information (RFI) No. OB-VAL-121817-01– HSAAP Thermal-Non Thermal Open Burning Grounds Study

by

Hallett Environmental and Technology Group Incorporated

to

BAE Systems Ordnance Systems Inc.

Submission date: January 25, 2018

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Part 1: Technology Review

Hydrogen Reduction is a non-incineration technology used to treat hazardous and non-hazardous wastes. Hydrogen Reduction is the result of decades of development of a technology originally invented by Dr. Douglas Hallett called Gas Phase Chemical Reduction (GPCR). Through Hallett Environmental and Technology Group Inc. (Hallett Environmental) Dr. Hallett has continued to develop the technology for other applications now with a focus on generating energy from waste. The current process, referred to as Hydrogen Reduction, can now be applied to municipal wastes such as sewage sludge, municipal solid waste (MSW), as well as industrial wastes.

Dr. Hallett first invented GPCR with a focus on the destruction of hazardous chlorinated chemicals such as PCBs and chlorinated dioxins. Dr. Hallett founded the company ELI Eco Logic Inc and through this company his technology was ultimately commercialized in Australia, Japan, and North America. Eli Eco Logic Inc operated the GPCR process at commercial-scale in Australia treating PCB-contaminated wastes including PCB oils and contaminated capacitors, transformers and soils as well as DDT, 2,4,5-T, hexachlorobenzene and organochlorine pesticide mixtures. A commercial-scale GPCR unit also operated in Canada treating the afore-mentioned PCB wastes (See Table 1 and Table 2). Table 1 shows the worldwide permits that were previously obtained for GPCR. Table 2 shows regulatory testing results for the various programs completed using GPCR.

Table 1 - Worldwide Permits Obtained for the GPCR Process

Project/Location	Regulatory Review
Bay City, Michigan	– USEPA SITE Program – TSCA R&D Permit, Michigan DNR State Air Permit
R&D Activities	– Province of Ontario – Air Permit – USEPA – TSCA R&D Permit – State of Maryland Notification
General Motors of Canada Limited	– Province of Ontario (Air Permit, Waste Disposal Site Permit, Water Discharge Permit)
Kwinana, Australia	– Western Australia Department of Environment License
Ontario, Canada	– Province of Ontario Technology approval for commercial operation of GPR within Ontario
Japan (PCBs)	– Regulatory testing conducted November 1998 – MITI approval received May 1999 – Environmental Agency approval received August 1999 – Final approval received July 2001
Japan (Dioxin)	– Regulatory testing conducted April 1999 – MITI, Environmental Agency, and Final approval received December 1999

Table 2 - Regulatory Testing Results for GPCR Programs

Project	Contaminant	*Destruction and Removal Efficiency (%)*	*Target Criteria (%)*
Bay City (oily water – 3 tests) (4000 ppm PCB in water)	Tetrachloroethene	> 99.99	99.99
	PCBs	> 99.9999	99.9999
Bay City (oil – 3 tests) (250 000 ppm PCB in oil)	Tetrachloroethene	> 99.99	99.99
	PCBs	> 99.9999	99.9999
General Motors of Canada Limited (PCB Askarel Oil - 3 tests)	PCBs	99.9999996	99.9999
	PCBs	99.9999985	
	PCBs	99.9999808	
95%PCB Oil (Kwinana Regulatory Testing)	PCBs	99.999998	99.9999
17%DDT in Toluene (Kwinana Regulatory Testing)	DDT	99.999984	99.9999
PCB Oil (Japanese Regulatory Testing)	PCBs	99.99998098	99.9999
	PCBs	99.99999977	99.9999
HCB Treatment Trials (HCB crystals - 3 Tests)	HCB	99.999999	99.9999
	HCB	99.999999	99.9999
	HCB	99.99999	99.9999

The GPCR process has also been operated at pilot-scale as part of the Assembled Chemical Weapons Assessment Program (ACWA) at the Edgewood Test Chamber at Aberdeen Maryland. Substances tested for destruction included explosives (TNT, RDX, and HMX) and napalm as well as chemical warfare agents such as VX, HD (distilled sulphur mustard), GB (sarin), contaminated DPE suit material (plastic, Teflon) and chemical agent neutralents.

The ACWA demonstration tests had the following specific objectives:

1. Validate the ability of the GPCR process to achieve the 5X condition for metal parts and dunnage.
2. Demonstrate the effectiveness of the GPCR process to treat the product gases generated during the treatment of metal parts and dunnage.
3. Validate the ability of the GPCR process to achieve a Destruction and Removal Efficiency (DRE) of 99.9999% (six nines) for HD (4.2-inch mortar with a 10% HD heel) and neat GB (liquid).
4. Characterize the gas, liquid and solid process streams from the GPCR process for selected chemical constituents and physical parameters and the presence or absence of hazardous, toxic, agent and Chemical Weapons Convention (CWC) Schedule 2 compounds.
5. Demonstrate the ability of the GPCR process to produce a gas effluent that meets either EPA Syngas or Boiler and Industrial Furnace (BIF) requirements.
6. Determine the need for stabilization of residual dunnage solids based on TCLP results.

This program was completed and ALL destruction targets were met.

Similar principals the GPCR process have been incorporated into Hydrogen Reduction. In addition, Hallett Environmental possesses designs and drawings for the construction of commercial plants which would be suitable for replacing the open burning programs at Holston.

A process flow diagram for Hydrogen Reduction is shown in Figure 1. The process flow diagram includes the potential for energy products such as synthetic natural gas (SNG) and electricity to be produced from the materials processed, if desired.

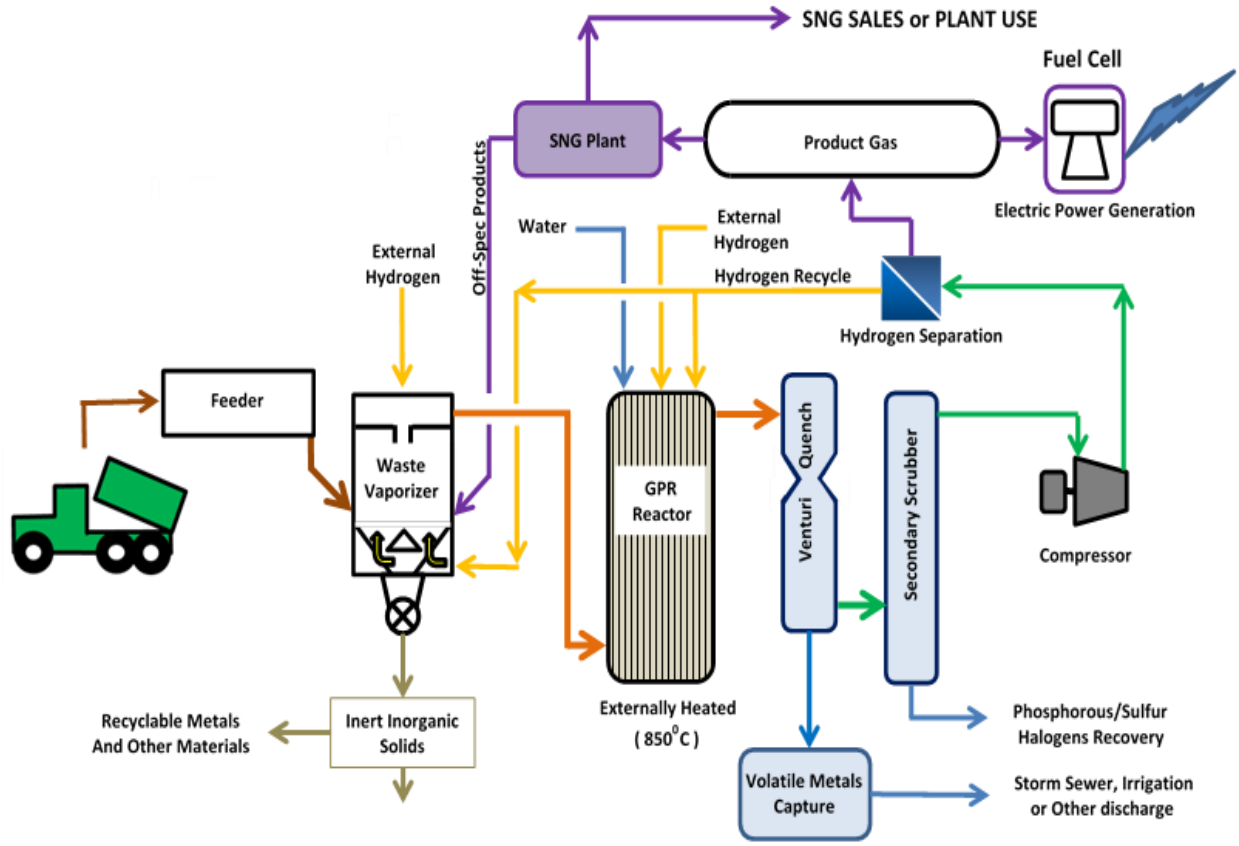

Figure 1 – Hydrogen Reduction Process Flow Diagram

Figure 2 shows the sequencing batch vaporizer (SBV) from the commercial scale plant built by ELI Eco Logic Inc for the destruction of PCBs. The SBV shown had the capacity to run up to twenty-seven 45-gallon steel drums or up to 12 tonnes of electrical capacitors in a single batch. A similar design would be used by Hallett Environmental in order to process the materials found at Holston.

Figure 2 – ELI Eco Logic Inc commercial PCB destruction plant in Kwinana Australia.

With regards to ANSOL, we believe that Hydrogen Reduction can provide a suitable solution. In Hydrogen Reduction, solid and liquid materials are placed into an SBV and then heated carefully in order to vaporize the material into a gas phase. The material, now in a gas phase, is mixed with an excess of hydrogen (reducing agent) throughout the process and further heated in the reactor. The hydrogen interacts with the gaseous material reducing it to simpler molecules. All of these chemicals will form a gas at a relatively low temperature and will reduce to form N2, CH4, CO2, CO, and H2. The N2 and CO2 can be separated and emitted directly to the atmosphere. The H2, CH4 and CO are available to recycle back into the reaction as reducing agents or to use as clean gas to heat the process.

Energetic wastes such as TNT, RDX, and HMX have previously been processed in the same fashion by ELI Eco Logic Inc (described above) at Holston. A large-scale pilot unit was designed for this program. A report on this program can be made available on request. Hallett Environmental employs a number of key members from the group that performed this program.

Part 2: Capabilities Review

As previously described, Hallett Environmental has further developed the technology originally used by ELI Eco Logic Inc. This technology, previously known as Gas Phase Chemical Reduction (GPCR), has been used to destroy hazardous wastes and energic materials such as TNT, RDX, and HMX. Dr. Hallett, through his company Hallett Environmental, has further developed his original invention, which is now known as Hydrogen Reduction.

The previous company, ELI Eco Logic Inc, under the direction of Dr. Hallett, participated in the Assembled Chemical Weapons Assessment (ACWA) Program. This company also participated in programs involving energetics including TNT, RDX, and HMX which was funded by the Department of Energy. Hallett Environmental would like to provide the current form of the technology, Hydrogen Reduction, at Holston again. Hallett Environmental has a team of experienced experts who worked on the previously mentioned programs through ELI Eco Logic Inc. In addition, Hallett Environmental has commercial scale plant designs which can be used as the basis for treating the explosives and explosive contaminated wastes referred to in this RFI.

With regards to permits, ELI Eco Logic Inc previously obtained the permits described in Table 1 for GPCR. These permits were obtained without any issues. GPCR is a recommended technology by Green Peace and the Sierra Club. It is expected that Hallett Environmental should be able to obtain similar necessary permits for Hydrogen Reduction within an estimated time frame of 6 to 12 months. It should be noted, that Hydrogen Reduction has no direct emission to the atmosphere.

Previous commercial scale plants built by ELI Eco Logic Inc had the capacity to run up to twenty-seven 45-gallon steel drums or up to 12 tonnes of electrical capacitors in a single batch. A similar design would be used by Hallett Environmental in order to process the materials found at Holston.

ELI Eco Logic Inc ceased operations in 2004 and all plants built were decommissioned.

A total of four commercial scale plants were built and operated by ELI Eco Logic Inc. The plants were built and operated in Australia, Japan, and North America. Hallett Environmental is intending to begin construction of commercial scale Hydrogen Reduction plants in 2018.

Hydrogen Reduction allows for both liquids and solid materials to be processed. Bulk materials containing metals can be processed as is, such as whole capacitors. The metal remaining after processing can be recovered and recycled. During the ACWA program, whole M55 rockets and mortar shells were successfully processed. The only preprocessing necessary was partial dismantling of the M55 rockets and mortar shells to allow the entry of hydrogen. No other preprocessing should be necessary.

The physical limitations of the process are only bound by the dimensions of the SBV available. The current design provides a 9ft internal diameter and a length of 25ft.

The three key features of Hydrogen Reduction are:

1. The ability to process contaminated large metal objects without significant pre-treatment
2. There is no direct emission from the process.
3. GPCR has proven to be publicly acceptable and permitting has not been an issue. Regulatory discussions involving Hydrogen Reduction have recognized the same environmental advantages as received by GPCR.

The only limitation of Hydrogen Reduction is the need from hydrogen to have access to the material it is trying to reduce. As an example, whole shells containing energetics would have to be partially dismantled, opened, or perhaps punctured in order to process.