"FIREBOX" AN ENVIRONMENTALLY SOUND TEST ENCLOSURE

D.W. Erdley
Combat System Test Activity
Aberdeen Proving Ground, MD 21005

ABSTRACT

The Fire Safety Test Enclosure, Firebox, is a state-of-the-art, environmentally sound, test enclosure designed for full scale fire suppression, live fire, vulnerability, insensitive munitions, blast, and weapons firing tests. The 84 ft diameter dome enclosure is designed to contain a 100 lb TNT equivalent high explosive event. The internal dome design will completely contain and recover all test fluids and gaseous effluents produced during the various types of testing. The liquid effluents, once recovered, are filtered, separated, and disposed of in accordance with environmental regulations or, in the case of fuels, and oils, reused. Gaseous effluents, consisting of unburned hydrocarbon, Halons, propellants combustion products, CO and particulates are drawn from the enclosure top and scrubbed in a multi-stage 60,000 CFM scrubber system. The first stage consists of an oxidizer which completes the combustion of the gaseous effluents. The resulting acidic combustion products and particulates are then passed through a scrubber where the acidic compounds are neutralized via an acid/base reaction. This reaction produces various salt products. The salts are recovered and disposed of in accordance with current environmental regulations. Combustion particulate matter is also captured and appropriately disposed. The remaining gaseous effluents are CO_2 and water vapor which are released out the stack. All captured effluents are separated, and either recycled or disposed of in a method to meet current environmental regulations.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **AUG 1992**	2. REPORT TYPE	3. DATES COVERED **00-00-1992 to 00-00-1992**

4. TITLE AND SUBTITLE **'Firebox'--An Environmentally Sound Test Enclosure**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Combat System Test Activity, ,Aberdeen Proving Ground,MD,21005**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADA261116, Volume IV. Minutes of the Twenty-Fifth Explosives Safety Seminar Held in Anaheim, CA on 18-20 August 1992.

14. ABSTRACT
see report

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**6**	

"FIREBOX"
AN ENVIRONMENTALLY SOUND TEST ENCLOSURE

D.W. Erdley
Combat System Test Activity
Aberdeen Proving Ground, MD 21005

INTRODUCTION

Historically fire suppression testing and live fire vulnerability testing for the Army has been conducted by the U.S. Army Combat Systems Test Activity (CSTA), at Aberdeen Proving Ground. As a proactive solution and because of the ever changing environmental regulation an enclosed environmentally sound test facility was envisioned. The original design concept was intended to eliminate the release of Halons and chlorofluorocarbons (CFC) to the atmosphere during fire suppression and live fire vulnerability testing. More recently the design has evolved into being able to capture and scrub other waste effluents which are produced during fire suppression and live fire vulnerability testing.

LIVE FIRE VULNERABILITY AND FIRE SUPPRESSION TESTING

Vulnerability and lethality testing of major combat systems is mandated by Chapter 139 of title 10, United States Code. Fire suppression testing is a major survivability subcomponent of this requirement. Typically testing of this type has been divided into two separate areas: those fires which occur during peace time and those which result from perforations by overmatching threat munitions during time of war. This distinction is made because peace time fires usually occur in the engine compartment as a result of electrical shorts or fuel line rupture. Crew compartment fires are usually a result of perforating impacts from threat munitions during combat.

Halon 1301 has been the fire suppression agent of choice because of it's overwhelming ability to effectively control fires at low concentrations without killing or injuring the crew. Therefore it is widely used in crew occupied spaces of combat vehicles, watercraft, and aircraft. Halon 1301 is also used because of its friendly handling qualities over a broad range of conditions. and its ease of distribution such as in engine compartments. Unfortunately Halon 1301 also has a detrimental affect on the ozone layer, i.e., by being approximately 14 times more destructive than the common household refrigerants like R12. The DoD has classified combat vehicle crew compartments as a critical use of Halon 1301 and will continue to use Halon 1301 in combat vehicle crew compartment until a suitable replacement can be found. Currently no suitable replacement exists for Halon 1301 in crew compartments. There does appear to be some evidence that Hydrochloroflourocarbon (HCFCs) could be used as a "transitional substances". HCFCs are intended as short term replacements only, because they are also ozone depleting substances and are banned by the Clean Air Act after 2015. They are however less destructive to the ozone layer than Halon and CFCs. No fire suppression agents are currently available which possess the unique performance qualities of Halon 1301 without having an adverse affect on the ozone layer and/or personnel safety. Whatever the substance that is found to replace Halon, it will inevitably be compared to and directly tested against Halon 1301. Thus Halon 1301 will continue to be used for baseline comparison purposes. At least in the near term, 8 to 10 years, substances having some potential to deplete the ozone layer will continue to be use in lifesaving conditions.

HALON AND CHLOROFLUOROCARBON REGULATIONS

Scientific evidence has indicated that the ozone layer is being depleted by (CFCs) and Halons which have been released into the atmosphere. Most recently the predictions of the rate of depletion have increased to as much as four time times that of what was originally thought. This depletion allows an increasing amount of harmful ultraviolet radiation from the sun to reach the earth's surface.

The U.S. Government has responded to such a threat to our environment by enacting several laws to limit the production and release of Halons and CFCs. The government has also entered into international agreement, specifically the Montreal Protocol and its subsequent amendments to limit the production of the ozone depleting chemicals. By law, production will be reduced by 15% in 1991, 50% by 1995, and 100% by the year 2000. President Bush has announced that these reduction schedules will be moved up to a complete phase out by 1995. In addition, the Omnibus Budget Reconciliation Act of 1989 imposes a heavy tax on high ozone depletion potential substances. This tax is designed to incrementally increase through 1994 thus making the purchase of ozone depleting chemicals prohibitively expensive. Additionally the Clean Air Act and its amendments require the quantification of emissions and prohibits venting of CFCs to the atmosphere. The Department of Defence has also issued directives and implemented regulations regarding the use of Halons and CFCs through DoD Directive 6050.9 and AMC Reg. 70-68. However, the regulations provide for the use of Halons in mission critical lifesaving uses, i.e., in the crew compartment of combat vehicles.

The driving issue, however, for CSTA is the National Environmental Policy Act which requires the individual in charge of a test to make an assessment as to whether the test will have a lasting detrimental effect on the environment. When conducting fire suppression testing involving the use of Halon, CSTA will not make the statement "there will be no lasting significant impact on the environment". Therefore an environmental impact statement will have to be prepared prior to conducting the test. This process can take upwards of 18 months to complete with no firm assurance that the testing will be approved. Consequently, this can jeopardize fire suppression and live fire testing which could subsequently affect the survivability of a combat vehicle or aircraft and their crew.

FIREBOX AN ENVIRONMENTAL SOLUTION

To reduce the release of Halons to the atmosphere and to capture other emissions produced during fire suppression and live fire vulnerability testing, CSTA has developed a test facility concept known as the Fire Safety Test Enclosure, nicknamed Firebox. The facility will be a state-of-the-art, environmentally sound, test enclosure designed for full scale fire suppression tests, and live fire vulnerability testing. It will provide DoD with the means to test and evaluate potential fire suppression agents, used to prevent the loss of life, with out adversely effecting the environment.

The Firebox design will be based on the Superbox[1] design and will consist of several major subsystems including the pressure containment vessel, the emissions control system (ECS), and the washdown/asset protection system. However the ECS will differ considerably from that of

---

1. Grove, C. A. Live Fire Testing: The Environmentally Safe Way, U.S. Army Combat Systems Test Activity, July 1992.

Suberbox because of the inherent design difference between the two, i.e., Superbox being designed to filter Depleted Uranium particulates and Firebox being designed to filter the test effluent produced during fire suppression testing (DU will not be tested in Firebox).

The pressure containment vessel will consist of a 84 ft diameter hemispherical steel enclosure which is designed to contain the test effluent under the test scenarios described below:

a) A high explosive blast equivalent to 100 lb TNT detonated in the center of the containment vessel within ± 2 ft and approximately 12 ft from the center of the floor surface.

b) Test scenario a) combined with the burning of 650 lb of JA-2 propellant.

c) Test scenario a) combined with the burning of a maximum of 500 gallons of JP-8 fuel. Maximum fuel consumption is expected to be 200 lb/min for a 15 minute duration. Maximum Halon 1301 discharge is 1000 lbs.

d) Test with a high explosive blast no greater than the equivalent of 10 lb of TNT

e) Test scenario d) combined with the burning of a maximum of 500 gallons of diesel fuel.

f) Test scenario d) combined with the burning of a maximum of 250 gallons of diesel fuel and 500 lb of JA-2 propellant.

The vessel will prevent the direct release of the test effluents to the atmosphere. There will be a plenum chamber at the base of the sphere to provide fresh air to the vessel. The air handling system will be able to completely ventilate the interior of the containment vessel and provide sufficient air to sustain combustion as described in the test scenarios above. The spilled liquid effluent, e.g., diesel, JP-8, hydraulic fluids, etc., will be captured by the washdown/asset protection system and subsequently separated and filtered. The gaseous test effluents will be dawn off the top of the hemisphere and fed to the ECS thought attached duct work.

The 60,000 cfm ECS consist of two major subsystems which will be able to efficiently operate under the input test scenario described above and will be able to operate over intermittent duty cycles of up to several hours. The first stage will consist of an oxidizer which will complete the combustion of the gaseous effluents, i.e., smoke, particulates, volatile organic compounds, unburned hydrocarbons, acidic gases, and unreacted Halons. After passing through the oxidizer the resulting exhaust gases will consist of carbon dioxide, nitrogen dioxide, and halogen acids (HCl, HBr, etc). These exhaust gases will then pass through a heat exchanger where the gases are cooled. The second stage will consist of a spray dryer absorber containing an alkaline mixture. In the spray dryer an acid base reaction will occur resulting in a neutralization reaction, producing solid salts. The acid-base reaction will be optimized to produce the least environmentally offensive products. These will be collected, separated, and deposed of in accordance with environmental regulations. It is important to note that wherever possible, captured and separated effluents as well as heat will be recycled. Ultimately, what is released to the atmosphere at the end of the ECS exhaust train will be water vapor and CO_2.

The following diagram, Fig 1, illustrates the flow of effluent through the proposed concept.

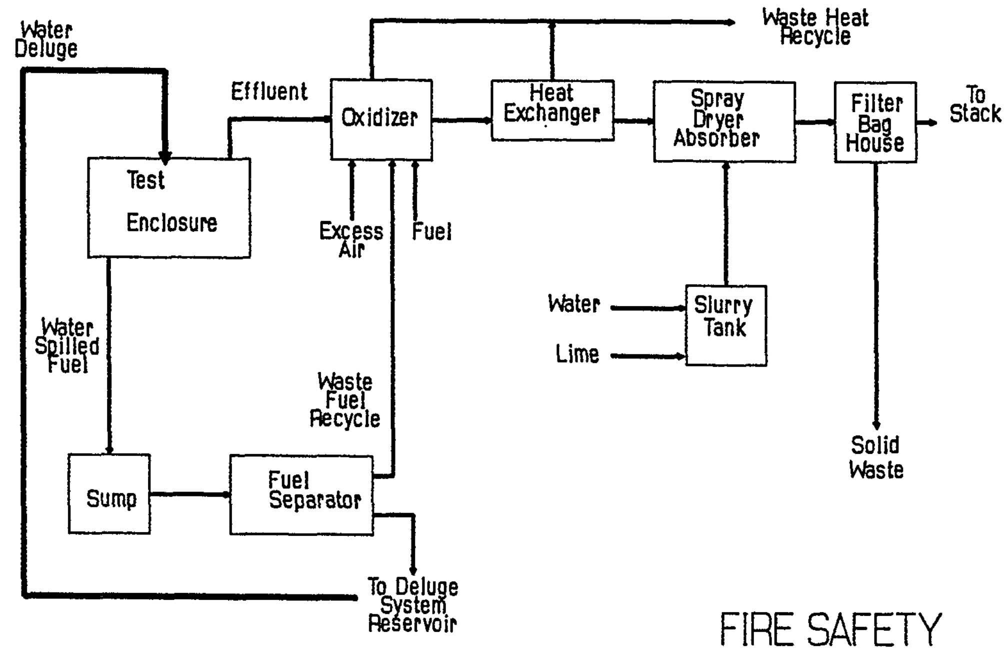

Figure 1

FIRE SAFETY
TEST ENCLOSURE
Design Concept
10 Jul 92

The washdown/asset protection system will be similar in design to the system used in Superbox. It will provide for the ability to fight fires which were not extinguished by the vehicle fire suppression system. It will also provide for a source of cooling for the containment vessel. As part of the washdown/asset protection system, a drainage system will be provided for the removal of liquid effluent waste from within the vessel. The drainage system will be a self contained system to prevent the release of waste effluent to the environment. The waste effluents will be processed through automatic processing equipment to remove and separate oils, fuels, and solid wastes form the water used in the system. The recovered materials, once separated, will be either recycled or disposed of in accordance with state and federal regulations. The water will be returned to the system.

SUMMARY

The completed test facility will provide multiple capabilities to include Live Fire Vulnerability Testing, Automatic Fire Extinguishing System (AFES) Test, Flammability tests, DOT Hazard Classification tests, and insensitive munitions test. It will provide the DoD, other government agencies, and private industry with the ability to comply with the various laws, regulations, and international protocols, which address the release of ozone depleting chemicals and the other waste effluents to the atmosphere. The Fire Safety Test Enclosure will be a state-of-the-art environmentally sound test facility designed for the testing of fire suppression agent without adversely affecting the environment.

ACKNOWLEDGMENTS

I would like to acknowledge and express my appreciation to Mr. Craig Herud, Mr. William Bolt, and Mr. David Grow for their insight as the concept originators and for their input into this paper. I would also like to acknowledge Mr. James Fasig, Director of CSTA's Live Fire Vulnerability Directorate for his environmental insight and in going forward with this concept. I would like to thank Mr. Joseph Ondek, CSTA's Environment Officer, for his personal and his staff's support and help during this project.

REFERENCES

1. Omnibus Budget Reconciliation Act, 1989.

2. Clean Air Act and Amendments (Title III & VI), 1990.

3. DoD Directive 6050.9, SUBJECT: Chlorofluorocarbons (CFCs) and Halon, 13 February 1989.

4. AMC Reg. 70-68, Elimination of Ozone Depleting Substances, 4 September 1989.

5. National Environmental Protection Act, 1972.

6. Grove, C. A."Live Fire Testing: The Environmentally Safe Way," U.S. Army Combat Systems Test Activity, July 1992.