The Design, Testing, and Implementation of a Halon 1301 Fire Extinguishment System for Use in the Service Lunar Adapter at KSC Launch Complex 39

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INTRODUCTION

Since the advent of hypergolic fuels usage at the Kennedy Space Center and the Kennedy Air Force Station, personnel safety during fueling operations has been provided by limiting the number of persons having access to hazardous areas to those who were essential to the operation, and by providing these people with protective clothing.

With the Apollo Program, a new problem has introduced itself; the Lunar Module (LM) (Fig. 1) is actually two launch vehicles which leave the launch pad as part of the Apollo payload. Fueling of these launch vehicles takes place approximately two weeks before the launch of the Apollo/Saturn V. Personnel are required to continue servicing the LM after fueling; this requires them to be enclosed within the Saturn/Lunar Module Adapter (SLA). Special egress equipment has been installed but will not be discussed in this presentation.

To minimize the hazard of a flash fire resulting from the ignition of a spilled hypergol, a Halon 1301 (bromotrifluoromethane) protection system has been designed and has been available during the launches of AS-204 and AS-504. Since improvements over the original system which was installed at Launch Complex 37 were incorporated into the design of the system for Launch Complex 39, our discussion will deal only with the Launch Complex 39 system.

SYSTEM DESCRIPTION

The system is made up of three basic subsystems, two of which are Halon 1301 Storage and Delivery Subsystems; the third is the Control Subsystem. Since Halon 1301 breaks down into toxic by-products when exposed to temperatures in excess of 800° centigrade, it was determined that the initial application of the agent must be rapid. Extinguishment will occur within milliseconds of achieving the required concentrations. This requirement is achieved by the first subsystem which consists of six 85-pound containers and their associated valves and piping which have been placed in groups of two, at three different locations (Figures 2 and 3). Each group enters the SLA from a different access point. The access points were selected to provide as close a uniform dispersalment as possible in accordance with operational demands.

The second subsystem consists of three 1-ton cylinders of the extinguishing agent, manifolded in such a way that the discharge from these cylinders enters the SLA through a common piping system which utilizes the same entrance ports as the first system. The Halon 1301 stored in the containers is pressurized with nitrogen to 600 psi, which remains constant throughout discharge (Figures 2 and 3). The piping system is so designed, a sustained rate of flow of either 2.3 or 4.6 pounds per minute can be introduced into the SLA.
The Control Subsystem is so designed that by actuating one switch, the operator can release half (255 pounds) of the rapid discharge system into the SLA and activate a flow rate of 2.3 pounds per minute from the sustaining system. The actuation of another switch can simultaneously release the total contents of the rapid discharge system, and activate the flow rate of 4.6 pounds per minute from the sustaining system.

OPERATIONAL CONCEPTS

The Halon 1301 system has been designed to have two modes of operation. The first mode (Inert Mode) is to be used if a hypergol spill is detected within the SLA. After the system has been armed, by throwing a single toggle switch, the 10% switch is thrown, causing the immediate release of a 10% concentration of the halon, and a sustaining flow of approximately 2.3 pounds per second. The second mode of operation (Extinguish Mode) will be used if a fire is detected within the SLA. After arming as described previously, the Extinguish switch is thrown, releasing a 20% concentration which will extinguish the fire and initiate a flow of 4.3 pounds per second which will prevent re-ignition. Concentration versus time curves are provided in Figures 4 and 5.

TESTING

In the fall of 1968, tests were conducted utilizing full scale mockups for a major portion of the test program. Test results indicated that concentration of Halon 1301 which would inert or extinguish would be obtained within 2 seconds of activation, and that the sustaining system would prevent combustion for a period of not less than 20 minutes. The rapid introduction of this quantity of Halon 1301 into the SLA did not cause critical overpressures because of the associated cooling.

Sound pressure levels reached 120 decibels for periods not exceeding 20 milliseconds. While this approaches the threshold of pain, the short duration minimizes the probability of permanent ear damage.

While the Halon 1301 gas is colorless and odorless, its rapid discharge causes cooling which condenses the moisture within the air and does cause limited visibility within the SLA. Visual acquisition was recorded with a high speed camera.

In general, it has been determined that the present configuration of the system installed at the Kennedy Space Center Launch Complex 39 will provide a significant level of safety not heretofore possible for those personnel required to work in what could be an extremely hazardous environment.

BIBLIOGRAPHY

SLA FREON

FROM GN₂ SUPPLY

2,000 LB SUSTAINING FREON BOTTLES

FIG. 2
FREON SUSTAINING

LC-39 SLA FREON
INERTING SYSTEM (10%)

FIG. 3

FIG. 4
LC-39 SLA FREON
EXTINGUISHING SYSTEM (20%)