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KSC FIRE SERVICE
TRAINING DIVISION

A SYNOPSIS ON THE TECHNIQUES AND EQUIPMENT REQUIRED TO CONTROL SMALL HYPERGOLIC SPILLS AND FIRES

Physical close-in fire combat and rescue operations under free flow/mixing conditions of UDMH (Unsymmetrical-Dimethyhydrazine) and N_2O_4 (Nitrogen Tetroxide) have been successfully conducted at the Kennedy Space Center facility.

Flows of varying quantities and percentages up to 25 gpm were generated which resulted in running the gamut from extremely heavy gas-off of toxic residuals, to low order explosions which were assessed as having a rating of from .5 to 2.2 psi overpressure at 10 feet.

It is to be remembered that the design of the facility is such that the explosion cone can be controlled to maximum effect at from 3 to 20 feet dependant upon percentages and quantities flowed, and that open flows on terrain will react differently, dependant upon weather conditions and terrain absorbancy.

The fire fighters prime concern when fighting hypergolic fires should be the toxicity factor of the medium, with the heat or explosions secondary.

Any of the Hydrazine family of fuels may be treated as hydrocarbons in regards to fire fighting techniques when an oxidizer is not associated with the general hazard. However, self-contained breathing apparatus is a must for these personnel who become intimately involved with control. Where an oxidizer (other than ambient air) is involved with a Hydrazine fuel spill, a number of factors insert themselves into the picture.

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Firstly, the quantity and/or ratio of each material spill and the face contact area of the materials will determine the rate of fire propagation and the destructive potential of the initial explosion. The scope of successive explosions from the oversplash, will determine the overall area that will be involved in fire. Secondly, the area affected by oversplash or spill will proportionately determine the gas-off volume of the materials at a ratio of approximately 2000:1. Thirdly, the weather conditions that prevail will determine the gas-off rate of the materials.

It has been noted that in winds of 10 knots at a temperature of 50° F with a humidity factor of 40%, UDMH and N_2O_4 flowing at a rate of 10 gpm in the pan will generate a cloud of high concentrate toxic gases that extend from the fire pan to 2000 feet downwind.

Inversions and humidity factors have a great deal to do with rise characteristic of the toxic clouds, for example, on a warm morning where ground mist has formed, toxic clouds will invariably hang in heavy concentration (the vapors being hygroscopic) for the length of time that the mist remains at ground level. This could generate systemic poisoning of unprotected personnel through inhalation or skin ingestion; the seriousness of which depends on the initial quantity of spill, the length of time the cloud has existed and the length of exposure.

Based upon the above realtime findings, a rule of thumb has been established that has proven extremely successful. The fire fighter must get in close and he must attempt to knock down the heart flame to prevent the explosions. Speedy attack is definitely required. Plain water, applied as a fine 30° fog cone, with approximately 100 psi at the nozzle, has been found to be most effective. Shutting off of fuel or oxidizer where possible is the most effective method to establish positive control of hypergolic fuel/oxidizer fires with followup of large quantities of water for dilution of residuals. Unless large quantities (20-50 gpm) of both fuels and oxidizers are involved, the explosive potential may be safely ignored except for liquid splash hazards, however, immediate washdown with water usually suffices to render residuals on normal fire fighting protective clothing harmless.

Do not use vinyl splash protective clothing when fighting fires of this nature, such clothing has disassociated or melted when exposed to large flow heart flame temperatures.

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