ODH Assessment

Date: 6-9-2000
Location: Hall B Gas Shed
Contacts: George Jacobs ext. 7115

Requirements needed to meet ODH 0 for the Hall B Gas Shed:
1. Remove the dewar filling station from inside the shed
2. Weld open or remove louvers for the 4 floor level fans and the 2 ceiling exhausts (alternative: administrative locks)
3. Install padlock to keep garage door open (alternative: weld existing bolt to the frame)
4. Disconnect and cap off the 6 fittings for the SGA input selector
5. Remove ceiling exhaust fans and replace or reinstall so that air blows into the shed instead of exhausting the shed

Risk Assessment
1. significant sources that feed into or are in the shed:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Location</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1500 gallon</td>
<td>LN2</td>
<td>outside</td>
<td>Cooling supply to distillation unit. Boiler off to Hall B N2 manifold</td>
</tr>
<tr>
<td>2 1250 lbs liquid @70F: 1.628 ft^3/lb</td>
<td>C4F10</td>
<td>Gas shed</td>
<td>Detector gas</td>
</tr>
<tr>
<td>3 1000 gallon</td>
<td>Spare C4F10 tank</td>
<td>outside</td>
<td>Holds recycled C4F10 from the distillation unit</td>
</tr>
<tr>
<td>4 1500 gallons</td>
<td>LAr</td>
<td>outside</td>
<td>Supply for the mixing unit located in the shed</td>
</tr>
<tr>
<td>5 385 liter</td>
<td>CO2</td>
<td>outside</td>
<td>Supply for the mixing unit located in the shed</td>
</tr>
<tr>
<td>6 3000 gallon</td>
<td>Ar/CO2 Buffer 1</td>
<td>outside</td>
<td>Outside storage for the mixing unit located in the shed</td>
</tr>
<tr>
<td>7 3000 gallon</td>
<td>Ar/CO2 Buffer 1</td>
<td>outside</td>
<td>Outside storage for the mixing unit located in the shed</td>
</tr>
<tr>
<td>8 1000 gallon</td>
<td>Ar/CO2 Buffer 2</td>
<td>outside</td>
<td>Outside storage for the mixing unit located in the shed</td>
</tr>
<tr>
<td>9 1000 gallon</td>
<td>Ar/CO2 Buffer 2</td>
<td>outside</td>
<td>Outside storage for the mixing unit located in the shed</td>
</tr>
<tr>
<td>10 1800 cubic feet</td>
<td>Ar/CO2 (6 x 300 cubic feet) cylinders</td>
<td>Gas shed</td>
<td>Calibration</td>
</tr>
<tr>
<td>11 600 ft^3He</td>
<td>He (2 x 300 ft^3 bottles)</td>
<td>outside</td>
<td>Helium supply to downstream He bag beam pipe</td>
</tr>
</tbody>
</table>
2. Mechanisms for failure:
   • pressure relief
   • ½" stainless pipe/val

3. Operations: basically four: Mixing, Metering, and Storage of Detector Gases, and purification of C4F10:
   • The pipe chase for all gases to hall B are located in the shed.
   • The shed houses a metering system which sends C4F10, Ar/CO2, nitrogen, and helium gas down to the hall.
   • The shed houses a mixing unit for argon and CO2.
   • The shed houses a distillation unit for C4F10. The unit purifies this detector gas, which is then stored in an outside tank. The distillation unit uses about 1-2 liquid liters of N2.

4. Gas dynamics:
   • helium: rises
   • argon: falls
   • CO2: falls
   • N2: diffuses

5. Existing controls
   a. Passive vents located in the shed:
      • garage door vent: 2 ft² vent located at floor level
      • garage door vent: 2 ft² vent located at 8 feet
      • 4 x 0.64 ft² vents also located at floor level
      • 2 x 1 ft² ceiling louvres: permanently open
      • distillation unit vent is hard piped outside the shed
   b. Local exhaust
      • 2 x 300 cfm ceiling exhaust fans
   c. Pressure rated components/pressure reliefs
      • ½" stainless steel piping rated at 3000 lbs
      • all fittings: are swage locked fittings rated at 3000 lbs
      • C4F10 pressure relief is on the tank located inside the shed: fusible plug relieves at temperature greater than 250 F.
      • Regulator for helium relieves at 300 lbs, located outside the shed
      • Relief for LN2 located at the tank outside
      • Distillation unit: 38 psi relief for LN2
      • Metering system: none
      • Mixing system: none
   d. Shed volume: 4800 ft³

Estimation of ODH Fatality Rates: See attached spreadsheet

<table>
<thead>
<tr>
<th>ODH levels:</th>
<th>ODH 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>ODH0</td>
</tr>
<tr>
<td>Personnel in continuous communication</td>
<td>x</td>
</tr>
<tr>
<td>ODH training</td>
<td></td>
</tr>
<tr>
<td>Medical approval</td>
<td>x</td>
</tr>
<tr>
<td>5 minute escape pack</td>
<td>x</td>
</tr>
<tr>
<td>personal oxygen monitor</td>
<td>x</td>
</tr>
</tbody>
</table>

Approval/Date

Senior Cryogenic Coordinator

Reference: EHS Manual 6506-T3 ODH Assessment
Table A.5.5.1(a) FC-85-10 Total Flooding Quantity (SI Units)*

<table>
<thead>
<tr>
<th>Specific Vapor Weight Requirements of Hazard Volume, W/V (kg/m³)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Concentration (% by Volume)*</td>
</tr>
<tr>
<td>Temp.</td>
</tr>
<tr>
<td>(°C)*</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>65</td>
</tr>
<tr>
<td>75</td>
</tr>
<tr>
<td>85</td>
</tr>
<tr>
<td>90</td>
</tr>
<tr>
<td>100</td>
</tr>
</tbody>
</table>

* The manufacturer’s listing specifies the temperature range for operation.
** W/V: Weight requirement (kg/m³) • Kilograms required per cubic meter of protected volume as produced indicates concentration at temperatures specified.

w = ∫(T (100-C) )

1) (temperature (°C)) = the design temperature in the hazard area.
2) (specific volume (m³/kg)) • specific volume of superheated FC-85-10 vapor can be approximated by the formula:

w = 0.001015 + 0.0000458C

where (temperature (°C))

C (concentration (%)) • volumetric concentration of FC-85-10 in air at the temperature indicated.

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<table>
<thead>
<tr>
<th>Temp.</th>
<th>Specific Vapor Volume</th>
<th>Weight Requirements of Hazard Volume, W/(V lb/m³)</th>
<th>Design Concentration (% by Volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-70</td>
<td>1.5280</td>
<td>0.0277</td>
<td>0.0500</td>
</tr>
<tr>
<td>-60</td>
<td>1.5515</td>
<td>0.0263</td>
<td>0.0416</td>
</tr>
<tr>
<td>-50</td>
<td>1.5640</td>
<td>0.0261</td>
<td>0.0408</td>
</tr>
<tr>
<td>-40</td>
<td>1.5750</td>
<td>0.0259</td>
<td>0.0396</td>
</tr>
<tr>
<td>-30</td>
<td>1.5860</td>
<td>0.0256</td>
<td>0.0383</td>
</tr>
<tr>
<td>0</td>
<td>1.5970</td>
<td>0.0251</td>
<td>0.0365</td>
</tr>
<tr>
<td>10</td>
<td>1.6080</td>
<td>0.0247</td>
<td>0.0346</td>
</tr>
<tr>
<td>20</td>
<td>1.6190</td>
<td>0.0243</td>
<td>0.0328</td>
</tr>
<tr>
<td>30</td>
<td>1.6290</td>
<td>0.0240</td>
<td>0.0310</td>
</tr>
<tr>
<td>40</td>
<td>1.6390</td>
<td>0.0236</td>
<td>0.0285</td>
</tr>
<tr>
<td>50</td>
<td>1.6490</td>
<td>0.0233</td>
<td>0.0259</td>
</tr>
<tr>
<td>60</td>
<td>1.6590</td>
<td>0.0230</td>
<td>0.0233</td>
</tr>
</tbody>
</table>

* The manufacturer's listing specifies the temperature range for operation.

W/V [agent weight requirements (lb/m³)] = pounds of agent required per cubic foot of pressurized volume to produce indicated concentration at temperature specified.

where:

\[
W = \frac{Y}{(100 - C)}
\]

C [temperature (°C)] = the design temperature in the hazard area

Y [specific volume of superheated agent vapor at 1 at and temperature, (lb/ft³)] = specific volume of superheated FC-3-3-10 vapor can be approximated by the formula:

\[
Y = 1.069 + 0.0024C
\]

where:

C [concentration (%)] = volumetric concentration of FC-3-3-10 in air at the temperature indicated
THIS PACKET CONTAINS MSDS TEXTS FOR THE
FOLLOWING PURCHASE ORDERS:

11523
DIVISION:  SPECIALTY CHEMICALS DIVISION
TRADE NAME:  CCA-419 3M Brand Clean Fire Extinguishing Agent
ISSUED:  FEBRUARY 20, 1995
SUPERSEDES:  NOVEMBER 11, 1994
DOCUMENT:  86-9247-4

1. INGREDIENT  CAS #  NO.  PERCENT
Perfluorobutane  355-25-9  >  99.5
Perfluoro Compounds  86508-62-1  0.1  0.5

NOTE:  The ingredients of this product are included on TSCA.

2. PHYSICAL DATA

BOILING POINT:  ca. -2 C
VAPOR PRESSURE:  ca. 1980 mmHg
VAPOR DENSITY:  ca. 2.5 C 1.0
EVAPORATION RATE:  > 1 Butyl Acetate = 1 (30°C/34%)
SOLUBILITY IN WATER:  mg/l
SP. GRAVITY:  1.5 Water = 1
PERCENT VOLATILE:  99.5
VOC LESS N2O & ERUPT. BUBBLE:  2 gm/liter
PT:  N/A
VISCOITY:  N/A
MELTING POINT:  N/A
APPEARANCE AND ODOR:  Compressed Gas

3. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:  None
FLAMMABLE LIMITS - LEL:  N/A
FLAMMABLE LIMITS - VLE:  N/A
AUTOIGNITION TEMPERATURE:  N/D
EXTINGUISHING MEDIA:  Product is a fire-extinguishing agent.

Use firefighting procedures appropriate for materials in the fire zone.

SPECIAL FIRE FIGHTING PROCEDURES:
When fire conditions are severe and total thermal decomposition of the product is possible, wear full protective clothing, including helmet, self-contained, positive pressure or pressure-demand breathing apparatus, bunker coat and Pants, and bands around arms, waist

Abbreviations:  N/D = Not Determined  N/A = Not Applicable
3. FIRE AND EXPLOSION HAZARD DATA (continued)

and legs, face mask, and protective covering for exposed areas of the head.

No unusual effects are anticipated during fire extinguishing operations. Avoid breathing the product and substances that may result from the thermal decomposition of the product or the other substances in the fire zone.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
Exposure to heat may cause the cylinder to rupture.

4. REACTIVITY DATA

STABILITY: Stable
INCOMPATIBILITY - MATERIALS TO AVOID:
Not Applicable
HAZARDOUS POLYMERIZATION: Will Not Occur
HAZARDOUS DECOMPOSITION PRODUCTS:
Carbon Monoxide and Carbon Dioxide, Hydrogen Fluoride
Thermal decomposition during intended usage is not expected to present a hazard.

5. ENVIRONMENTAL INFORMATION

SPILL RESPONSE:
Observe precautions from other sections. Ventilate. Place leaking container in hood. Camp cylinder.

RECOMMENDED DISPOSAL:
Incinerate at a facility equipped to handle gaseous waste. Combustion products will include HF.

if necessary, vent in hood or remote area.

ENVIRONMENTAL DATA:
No data available.

REGULATORY INFORMATION:
Since regulations vary, consult applicable regulations or authorities before disposal. U.S. EPA Hazardous Waste Number = None (Not U.S. EPA Hazardous).

EPCRA HAZARD CLASS:
FIRE HAZARD: Yes
PRESSURE: Acute
REACTION: No
ACUTE: No
CHRONIC: No

6. SUGGESTED FIRST AID

EYE CONTACT:
Immediately flush eyes with large amounts of water. Get immediate medical attention.

SKIN CONTACT:
Flush skin with large amounts of water. If irritation persists, get

Abbreviations: N/D - Not Determined  N/A - Not Applicable
6. SUGGESTED FIRST AID (continued)

INHALATION:
Remove person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, get immediate medical attention.

IF SWALLOWED:
Not applicable.

7. PRECAUTIONARY INFORMATION

EYE PROTECTION:
Avoid eye contact.

SKIN PROTECTION:
Avoid prolonged or repeated skin contact. Wear appropriate gloves when handling this material.

VENTILATION PROTECTION:
Do not remain in area where available oxygen may be reduced by product usage.

RESPIRATORY PROTECTION:
If thermal decomposition occurs:
Avoid breathing of thermal decomposition products.

PREVENTION OF ACCIDENTAL INGESTION:
Not applicable.

RECOMMENDED STORAGE:
Keep container closed when not in use. Contents may be under pressure, open carefully. Store in explosion-proof containers.

FIRE AND EXPLOSION AVOIDANCE:
Not applicable.

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>EXPOSURE LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VALUE</td>
</tr>
<tr>
<td>Perfluorobutane</td>
<td>NONE</td>
</tr>
<tr>
<td>Perfluoro Compounds</td>
<td>NONE</td>
</tr>
</tbody>
</table>

* SKIN NOTATION: listed substances indicated with "X" under SKIN refer to the potential contribution to the overall exposure by the cutaneous route including mucous membrane and eye, either by airborne or, more particularly, by direct contact with the substance. Vehicles can alter skin absorption.

Abbreviations: N/D - Not Determined N/A - Not Applicable
7. PRECAUTIONARY INFORMATION (CONTINUED)

SOURCE OF EXPOSURE LIMIT DATA:
- ACGIH: American Conference of Governmental Industrial Hygienists, Workplace Environmental Exposure Level
- NONE: None Established

8. HEALTH HAZARD DATA

EYE CONTACT:
Eye contact is not expected to occur during normal use of the product.
Frostbite: signs/symptoms can include pain, clouding of the cornea, redness, swelling and blindness.

SKIN CONTACT:
Frostbite: signs/symptoms can include firm blanched areas, redness, pain, tissue destruction, swelling and scarring tissue formation.

INHALATION:
Simple asphyxiation; signs/symptoms can include light-headedness, rapid heart beat, a feeling of suffocation and blue color.
Unconsciousness and death may occur if oxygen deprivation is severe or prolonged. Simple asphyxiation results from the displacement of oxygen in air to a concentration which is less than that necessary to maintain life.

IF SWALLOWED:
Ingestion is not a likely route of exposure to this product.
No information was found regarding effects from swallowing.

OTHER HEALTH HAZARD INFORMATION:
A 3M Product Toxicity Summary Sheet is available.

SECTION CHANGE DATES

SECTION CHANGED SINCE NOVEMBER 11, 1994 ISSUE

Abbreviations: N/D - Not Determined N/A - Not Applicable

The information on this Data Sheet represents our current data and best opinion as to the proper use in handling of this material under normal conditions. Any use of the material which is not in conformance with this Data Sheet or which involves using the material in combination with any other material or any other process is the responsibility of the user.