Suppression of Class A Fires

Mark L. Robin, Ph.D.
Fluorine Chemicals Department
Great Lakes Chemical Corporation
1801 Highway 52 NW
West Lafayette, IN 47906

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Fire Suppression with Clean Agents

- Vast majority (> 90%) of applications involve protection of Class A hazards
  - Electronic data processing (EDP) facilities
  - Telecommunication facilities

- Protection of Class B Hazards
  - represents only up to 10% of applications

- However, very little information available regarding the performance of clean agents on Class A fires
Class A Hazard Protection

- Agent requirements for Class A protection linked to n-heptane requirements solely on an historical basis

- No technical justification for relating Class A requirements to Class B requirements
  - Class A: base agent requirements for Class A protection on testing of Class A materials
  - Class B: base agent requirements for Class B protection on testing of Class B materials (e.g., cup burner)
  - Accepted by ISO TC 21/WG 8, Kyoto Spring 1996
TOTAL FLOODED APPLICATIONS

CLASS A HAZARDS: HUGHES ASSOCIATES

TEST FACILITY
- 2,562 cu. ft.
- Ionization Detection
- 20' On-Center Detector Spacing

INSTRUMENTATION
- 3 Vertical Temperatures Trees
- Pressure - Nozzle and Enclosure
- Load Cell - Cylinder Mass
- OD Meter - Smoke Production
- Hydrogen Fluoride - in situ FTIR
- Oxygen - Servomex 540A
- Carbon Dioxide - Horiba 510
- Carbon Monoxide - Rosemount 880A
- Ionization detector - Simplex
TOTAL FLOODING APPLICATIONS
CLASS A HAZARDS: HUGHES ASSOCIATES

- TEST FIRES
  - Shredded Newsprint
  - Printed Circuit Boards
  - PVC Wire Bundles
  - Magnetic Tape

- EXPOSURE TARGETS
  - Relialogic ISA I/O cards
  - 30 Minute Exposure to Post-Suppression Atmosphere
  - Operation Check: Service Diagnostics, v. 2.13.18

- AGENT
  - 7% FM-200
  - 10 Second Discharge
  - 30 Second Delay Time
TOTAL FLOODING APPLICATIONS

CLASS A HAZARDS: SHREDDED NEWSPRINT

- **TEST FIRE**
  - 200 g Newsprint
  - Shredded Into 6 mm Strips, 30 to 61 cm in Length
  - Packed into Polyethylene Wastebasket
  - Ignite With Match on Top of Paper
  - Heat Release Rate 11 to 36 kW, 19 kW Average

- **SUPPRESSION**
  - All Test Fires Extinguished
  - Extinguishing Times 8 to 15 seconds
TOTAL FLOODING APPLICATIONS

CLASS A HAZARDS: PRINTED CIRCUIT BOARD FIRES

- TEST FIRE
  - 2 Zenith Data Systems 85-3334 boards
  - Vertically Mounted onto Frames 2.9 cm Apart
  - Ignition via Glo-Coil
  - Heat Release Rate 5 to 18 kW, 11 kW Average

- SUPPRESSION
  - All Test Fires Extinguished
  - Extinguishing Times 2 to 7 Seconds
TOTAL FLOODING APPLICATIONS

CLASS A HAZARDS: MAGNETIC TAPE FIRES

• TEST FIRE
  ▶ 26.7 cm (10.5 in) Round Reel Tapes
  ▶ Double Sided 120 Tape Rack Library
  ▶ 4 Tapes per Row, 3 Rows High
  ▶ Ignition via Glo-Coil
  ▶ Heat Release Rate 21 to 35 kW, 23 kW Average

• SUPPRESSION
  ▶ All Test Fires Extinguished
  ▶ Extinguishing Times 6 to 11 Seconds
TOTAL FLOODING APPLICATIONS

CLASS A HAZARDS: PVC WIRE BUNDLE FIRES

• TEST FIRE
  ▶ PVC Telephone Cable, 100 Pair
  ▶ Ignition via 5.1 cm Square Pan of n-Heptane
  ▶ Heat Release Rate 3 to 6 kW, 4 kW Average

• SUPPRESSION
  ▶ All Test Fires Extinguished
  ▶ Extinguishing Times 6 to 10 Seconds
EDP, Telecommunication Facilities

- Low Fuel Load
  - Wire insulation
  - PC boards
  - Electronic components
  - Transformers
  - Insulating materials
  - Plastic housings

- Fires of Low Energy Output
  - often less than 5 to 10 kW

# TOTAL FLOODING APPLICATIONS
## CLASS A HAZARDS: DECOMPOSITION PRODUCTS

<table>
<thead>
<tr>
<th>Test Fire</th>
<th>FM-200 HF, ppm</th>
<th>Halon 1301 HF, ppm</th>
<th>Halon 1301 HBr, ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shredded Newsprint</td>
<td>48 - 175</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PC Boards</td>
<td>9 - 31</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PVC Cable</td>
<td>37 - 58</td>
<td>37</td>
<td>not determined</td>
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<tr>
<td>Magnetic Tape</td>
<td>56 - 94</td>
<td>52</td>
<td>62</td>
</tr>
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### TOTAL FLOODING APPLICATIONS

**CLASS A HAZARDS: DECOMPOSITION PRODUCTS**

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HAZARD ASSESSMENT OF HF CONCENTRATIONS

![Graph showing the relationship between HF concentration (ppm) and exposure time (min) for LC50, Mammal, and DTL, Human. The graph includes various symbols and lines indicating different scenarios and concentration levels.](image)
Halogen Acids: Damage to Equipment

- Decomposition Product Concentration
- Exposure Time
- Deposition Rate of Acids on Equipment Surfaces
- Relative Humidity
- Temperature
- Sensitivity of Equipment
- Combined Effects with Smoke
Halogen Acids: Damage to Equipment

Dumayyas

• I/O Cards
• Six minute exposure

• 514 ppm HF
  ➤ no failures

• 2126 ppm HF
  ➤ no permanent damage
  ➤ reinsertion required for some cards for operation

Halogen Acids: Damage to Equipment

Ansul, duPont, Cardox, Fenwal

- PC boards, magnetic tape
- One hour exposure

- No damage for:
  - 294 ppm HF
  - 30 ppm HBr
  - 2425 ppm HCl

Halogen Acids: Damage to Equipment
Hughes Associates, Inc.

- I/O Cards
- 30 minute exposure

- No damage up to 1632 ppm HF (peak)

Halogen Acids: Damage to Equipment
Pedley (NASA)

- Unpowered, powered electronics
- Nonmetallics, conformal coatings
- 4 hour exposures

- 50,000 ppm HF; 20,000 ppm HBr
  ▶ all equipment failed

- 5,000 ppm HF; 2,000 ppm HBr
  ▶ 50% of PC boards failed
  ▶ coatings damaged

- 500 ppm HF; 500 ppm HBr
  ▶ no damage to powered electronics
  ▶ no damage to coatings
# Heat Release Rates

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Heat Release Rate (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USCG Tests</td>
<td>3,000 to 5,500</td>
</tr>
<tr>
<td>UL 1B Pan, n-heptane</td>
<td>460</td>
</tr>
<tr>
<td>UL &quot;1058a&quot; Crib</td>
<td>230</td>
</tr>
<tr>
<td>Newsprint, shredded</td>
<td>19</td>
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<tr>
<td>Magnetic Tapes</td>
<td>23</td>
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<tr>
<td>PC Boards</td>
<td>11</td>
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<tr>
<td>PVC Cables</td>
<td>4</td>
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</table>
HF CONCENTRATION: CLASS A AND CLASS B FIRES EXTINGUISHED WITH 7 - 8% FM-200

- Hughes
- Ferreira
- Hansen
- Sheinson
- Brockway
- Kidde
- Class A

HF Concentration (ppm)

Fire Size to Room Volume (kW/m³)
HF Concentration: Class A Fires
Extinguished with 7% v/v FM-200
Summary

- Over 90% of clean agent fire suppression applications involve the protection of Class A Hazards

- Fires in typical hazards (EDP, Telecommunication Facilities) are characterized by low fuel loadings and low energy output, often 5-10 kW

- For the extinguishment of Class A fires typical of those encountered in an EDP or telecommunications facility with 7% FM-200, the levels of HF produced were well below the estimated mammalian LC-50 and the human Dangerous Toxic Load (DTL).

- For the extinguishment of Class A fires typical of those encountered in an EDP or telecommunication facility, the levels of HF produced do not appear to present a threat to electronic equipment