Suppression of Class A Fires

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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

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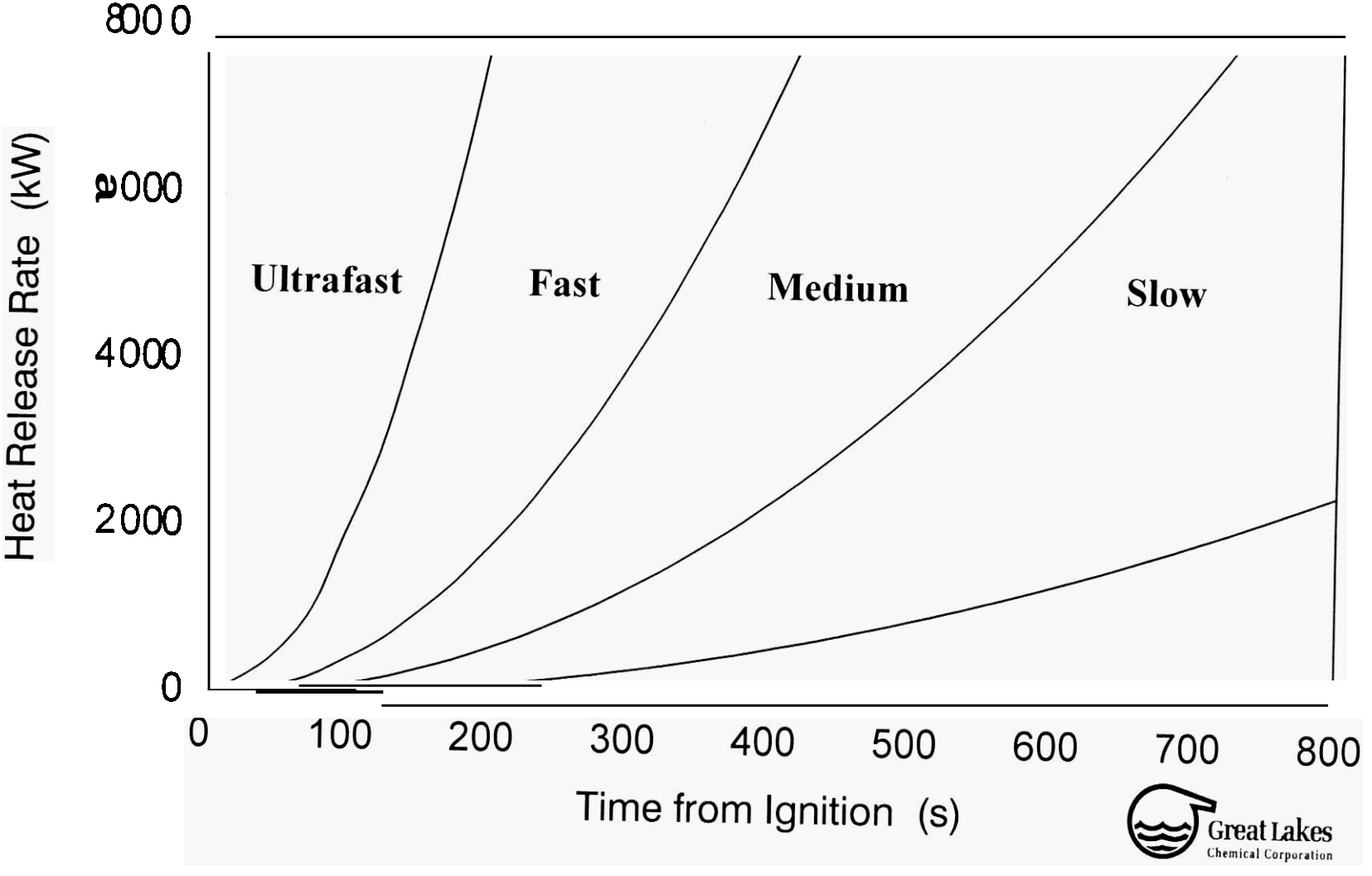
T-Squared Fire Growth Curves



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

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TOTAL FLOODING 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

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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

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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

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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

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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

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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

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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**

B.J. Meacham, Fire Technology, First Quarter 1993, 35; L.A. McKenna, et. al. "In Situ Tests of Smoke Detection Systems'" 1993.

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TOTAL FLOODING APPLICATIONS

CLASS A HAZARDS: DECOMPOSITION PRODUCTS

Test Fire	FM-200 HF, ppm	Halon 1301 HF, ppm	Halon 1301 HBr, ppm
Shredded Newsprint	48 - 175	–	–
PC Boards	9 - 31	–	–
PVC Cable	37 - 58	37	not determined
Magnetic Tape	56 - 94	52	62

H1301 Data: C.L. Ford, Halon 1301 Computer Fire Test Program, Interim Report, January 10, 1972

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TOTAL FLOODING APPLICATIONS
CLASS A HAZARDS: DECOMPOSITION PRODUCTS

Test Fire	FM-200 HF, ppm	Halon 1301 HF, ppm	Halon 1301 HBr, ppm
Shredded Newsprint	40 - 175	192	298
PC Boards	9 - 31	–	–
PVC Cable	37 - 58	–	–
Magnetic pe	56 - 94	–	–

H1301 Data: R. Cholin, Fire Journal, Sept. 1972.

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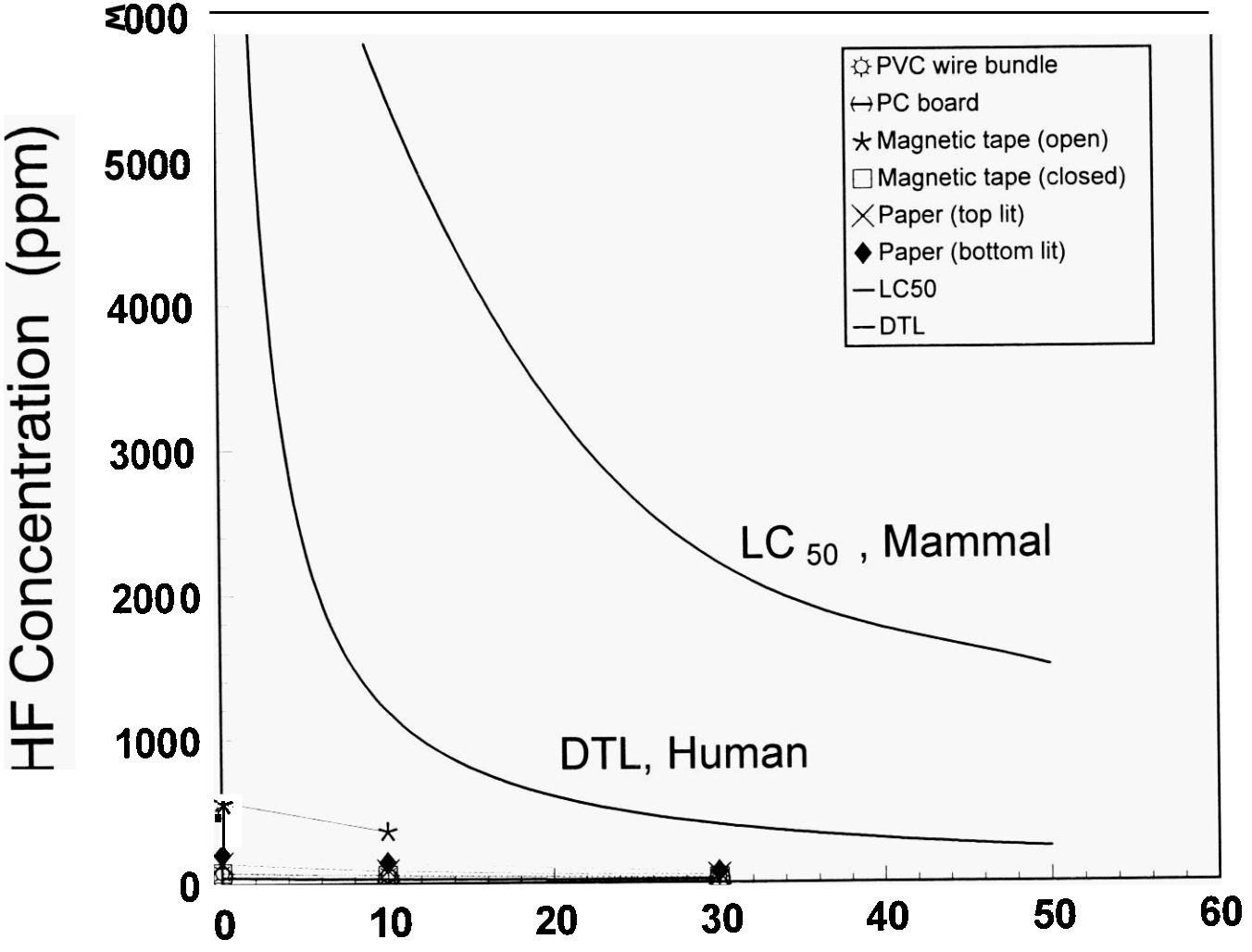
HAZARD ASSESSMENT OF HF CONCENTRATIONS



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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

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Halogen Acids: Damage to Equipment

Dumayas

- I/O Cards
- Six minute exposure

- 514 ppm HF
  - no failures

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

Hughes Associates, 1994.

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Halogen Acids: Damage to Equipment

Amsul, DuPont, Carbox, Femwal

- PC boards, magnetic tape
- One hour exposure

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

C.L. Ford, Halon 1301 Computer Test Program, 1972.

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Halogen Acids: Damage to Equipment

Hughes Associates, Inc.

- I/O Cards
- 30 minute exposure

- No damage up to 1632 ppm HF (peak)

Hughes Associates, 1995.

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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

TR-339-001 NASA, 1985.

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Heat Release Rates

Hazard	Heat Release Rate (kW)
USCG Tests	3,000 to 5,500
UL 1B Pan, n-heptane	460
UL "1058a" Crib	230
Newsprint, shredded	19
Magnetic Tapes	23
PC Boards	11
PVC Cables	4

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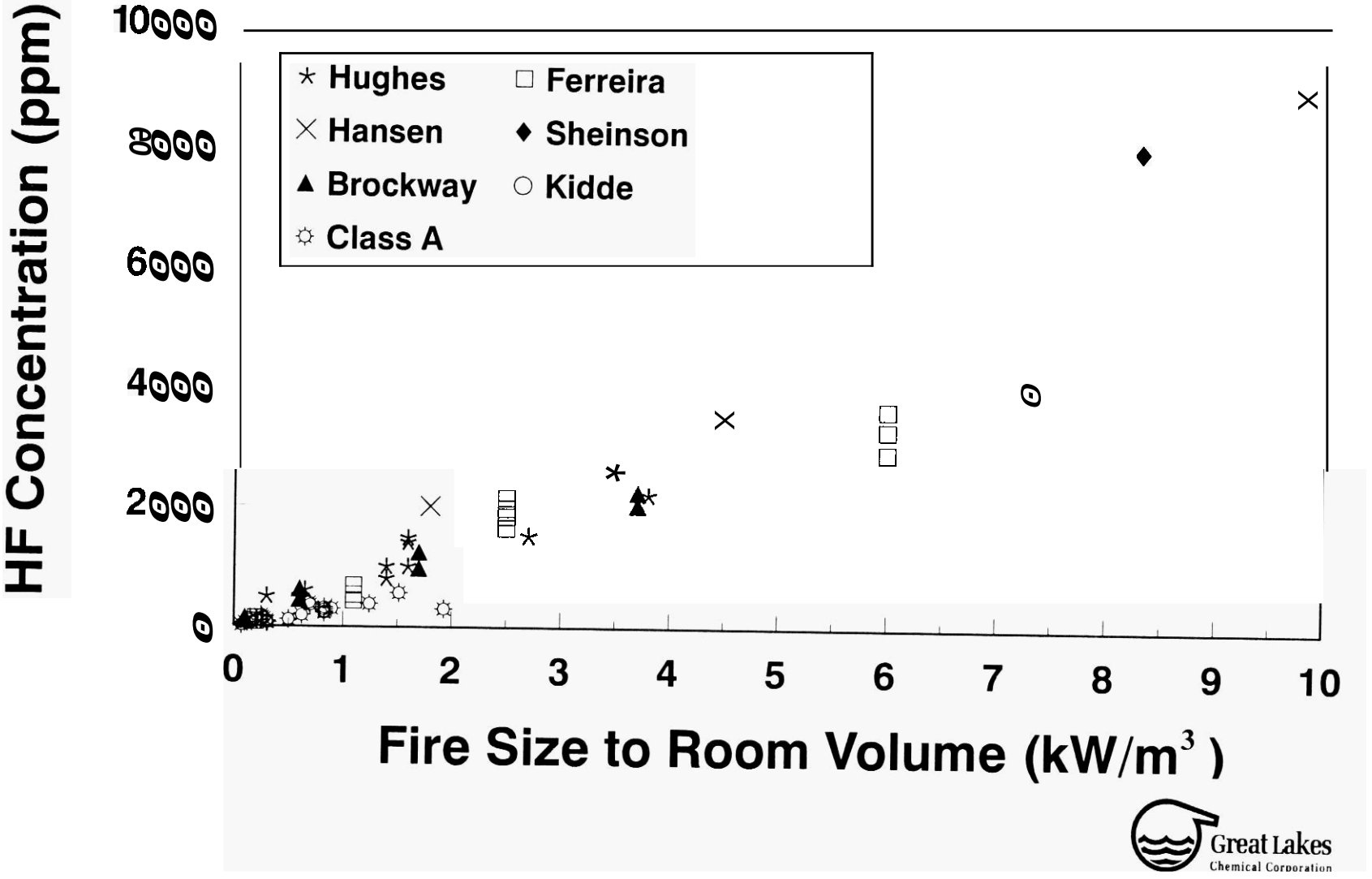
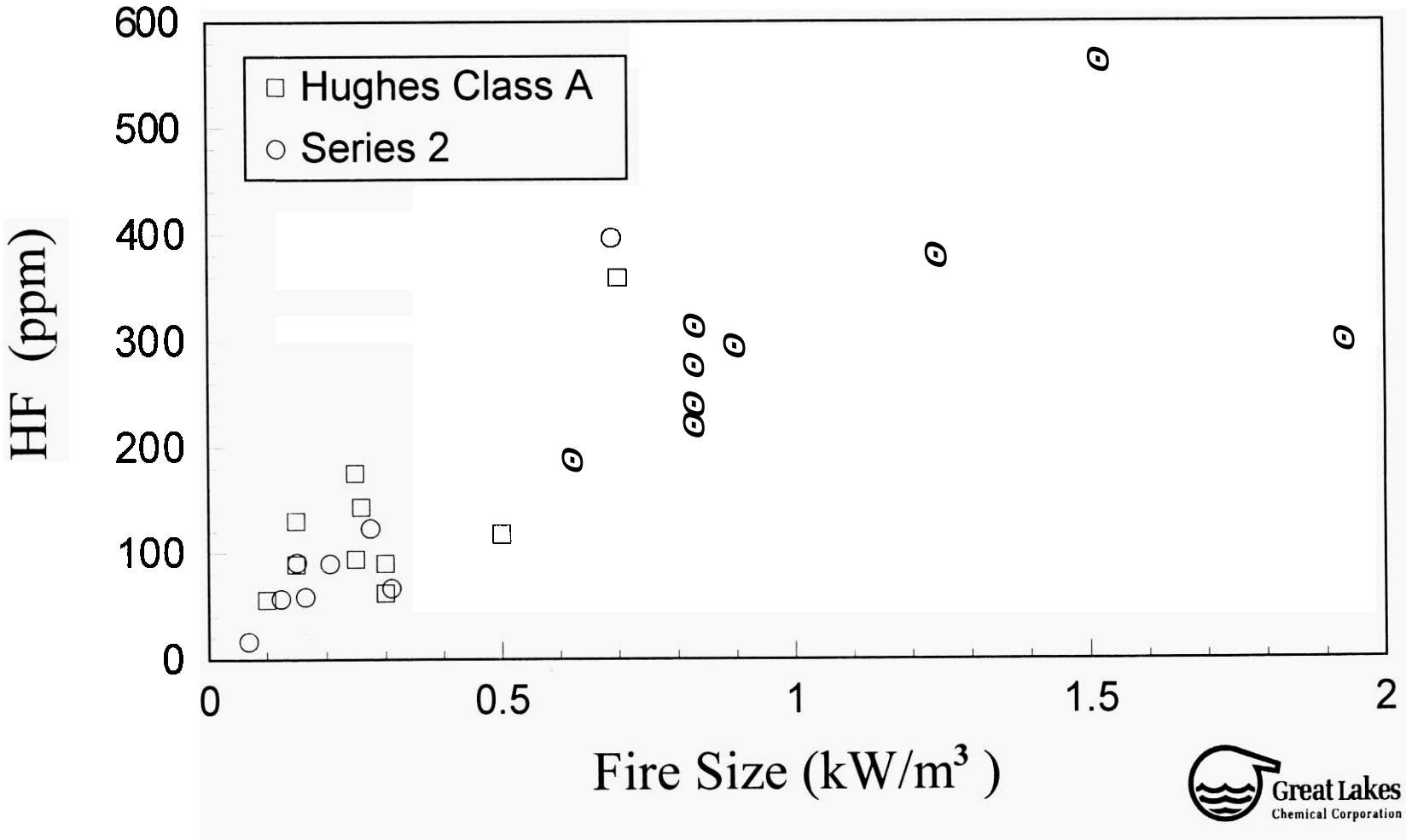
HF CONCENTRATION: CLASS A AND CLASS B FIRES EXTINGUISHED WITH 7 - 8% FM-200



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

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