Microscale Combustion Calorimeter Testing of Contaminated Insulation Films

Presented to Materials Fire Test Working Group

By: Richard E. Lyon

For: N. Safronava, P. Cahill, and B. Cononver,

Date: October 22, 2008

INCIDENT REPORT (Preliminary)

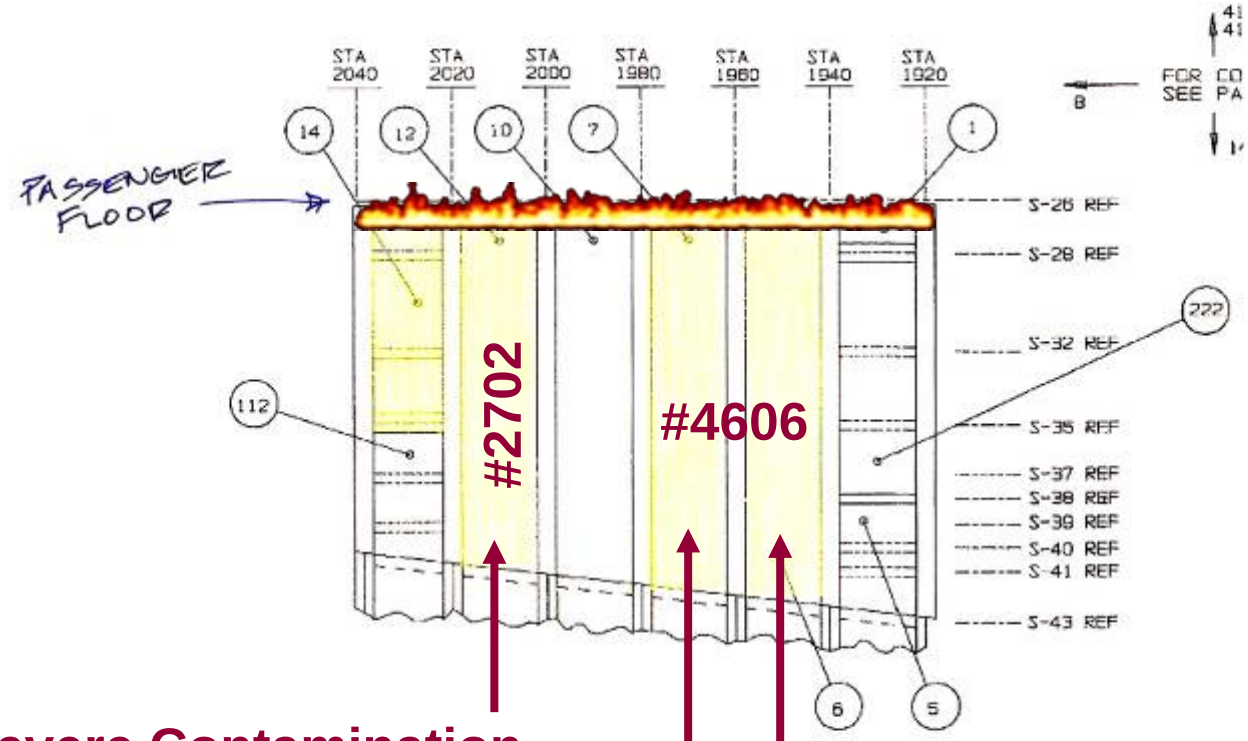
- **Date: 23 February 2008**
- **Flight: BR67**
- **Type: Boeing 747-400**
- **Operator: EVA Air Transportation**
- **Location: Bangkok, Thailand**
- **Passenger Injury: No**

Disembarking passengers notice smoke coming out of sidewall below seats.

Smoke suppressed by fire extinguisher.

APU had abraded power cable that caused arcing and burning of thermo-acoustic insulation blanket.

6 & 7 = 411U4120-4606
12 = 411U4120-2702
14 = 411U4120-4302



Severe Contamination

Moderate Contamination

411U4616-75
411U4616 Sheet 1 Page 6

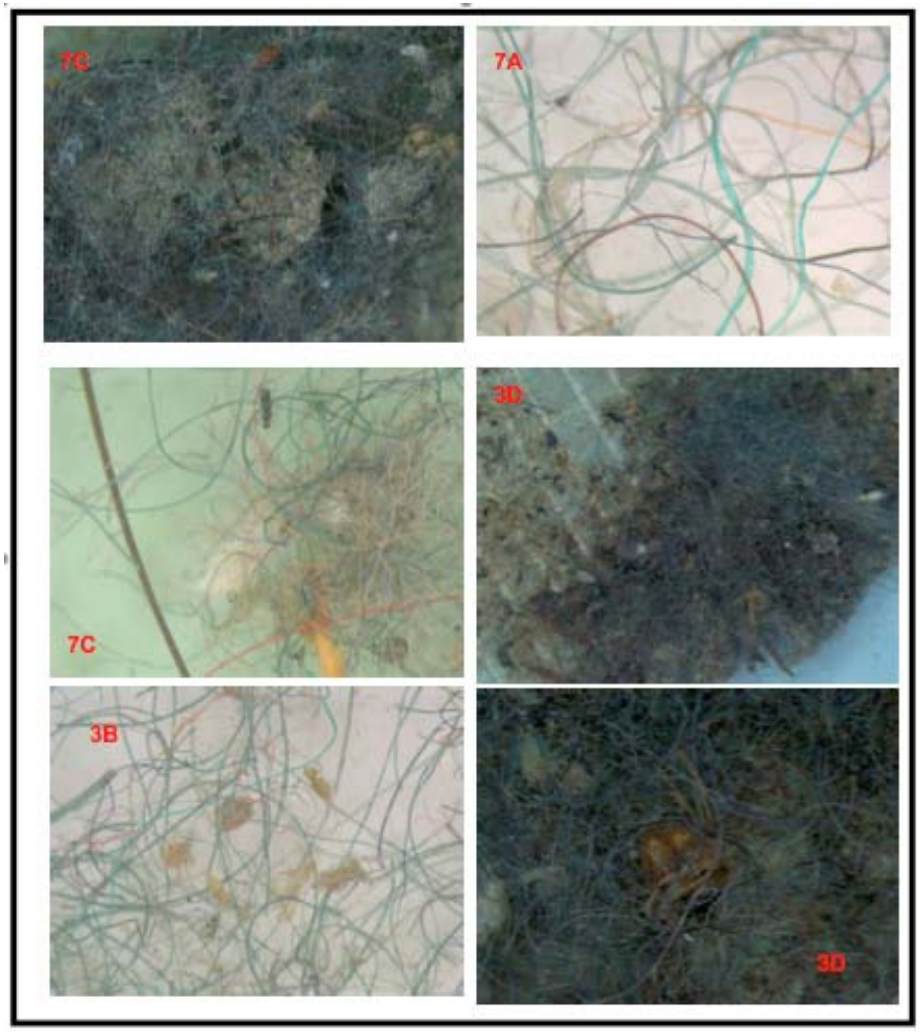


Figure 7: Particulate and Fibrous Particulate and Fibrous Surface Contamination, showing overall view and fibers dispersed view.

CONCLUSION FROM BOEING ANALYSIS*

- The insulation blanket film was polyethylene terephthalate (PET).
- The surface contamination was corrosion inhibiting compounds (CIC) and particulate matter, including

  Synthetic, natural and cellulose fibers

  Animal hair

  Mineral particles

  Styrofoam

  Metal fragments

  Insects

*M.M. LaBerta, "Material Analysis of Insulation Blankets from EVA 747-400," Special Report 11299, Boeing Company, July 22 2008.

12 Second Bunsen Burner Testing of Contaminated Thermal-Acoustic Insulation at FAA Technical Center

June 24, 2008

- No contamination (#2383)
- Moderate contamination (#4606)
- Severe contamination (#2702)

All Samples Pass 12 s VBB Requirement

Cotton Swab + Rubbing Alcohol Testing of Contaminated Thermal-Acoustic Insulation at FAA Technical Center

June 24, 2008

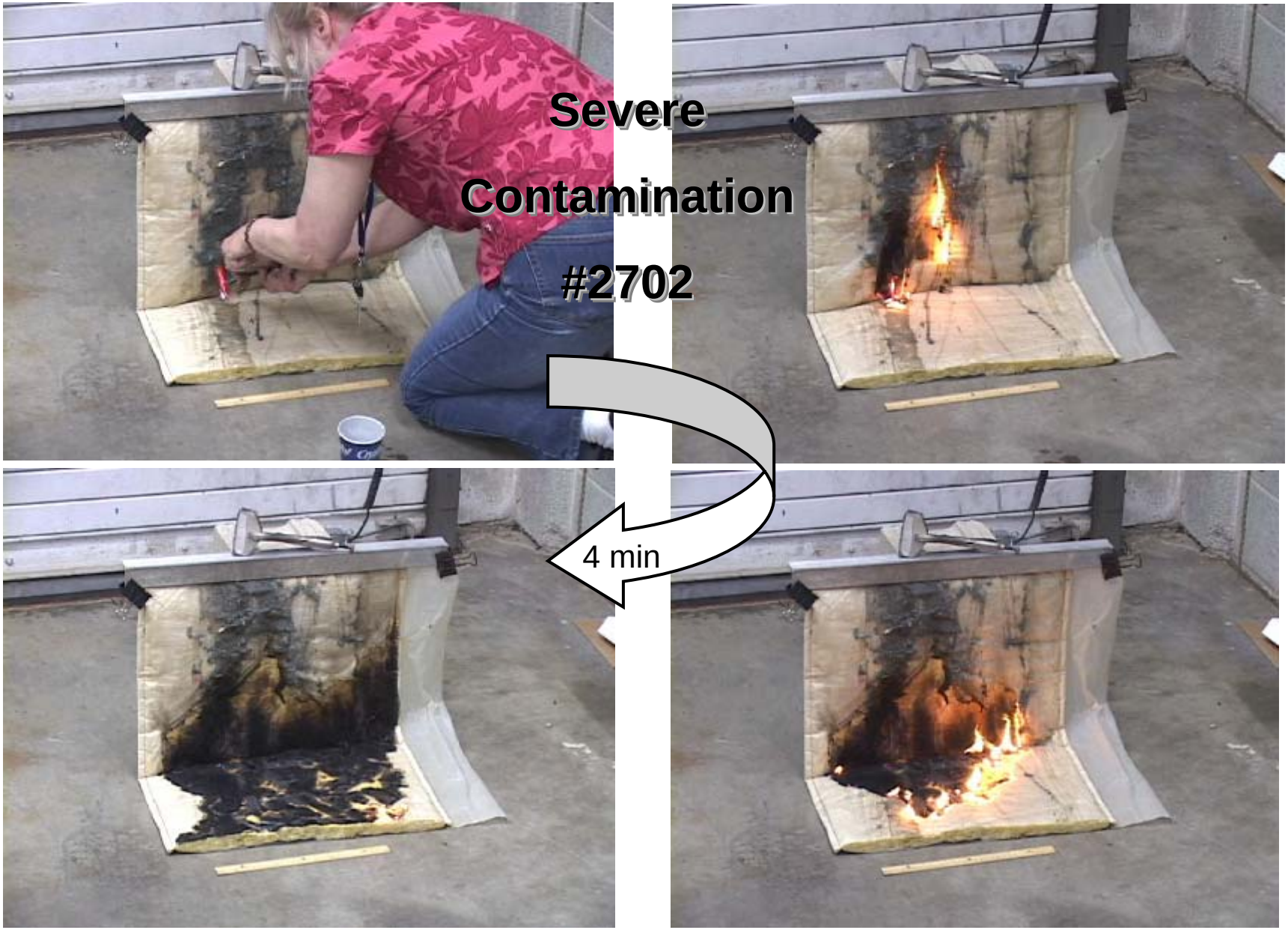
- No contamination (#2383)
- Moderate contamination (#4606)
- Severe contamination (#2702)

No
Contamination
#2383

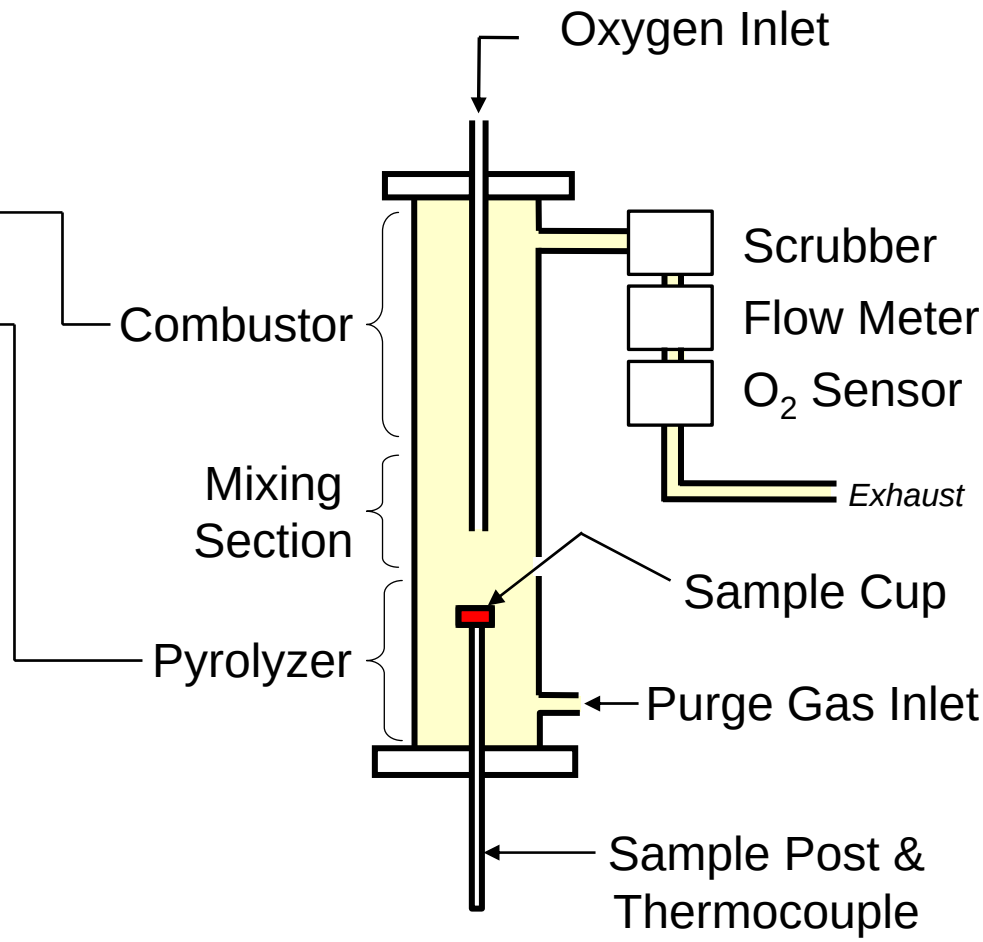
Moderate

Contamination

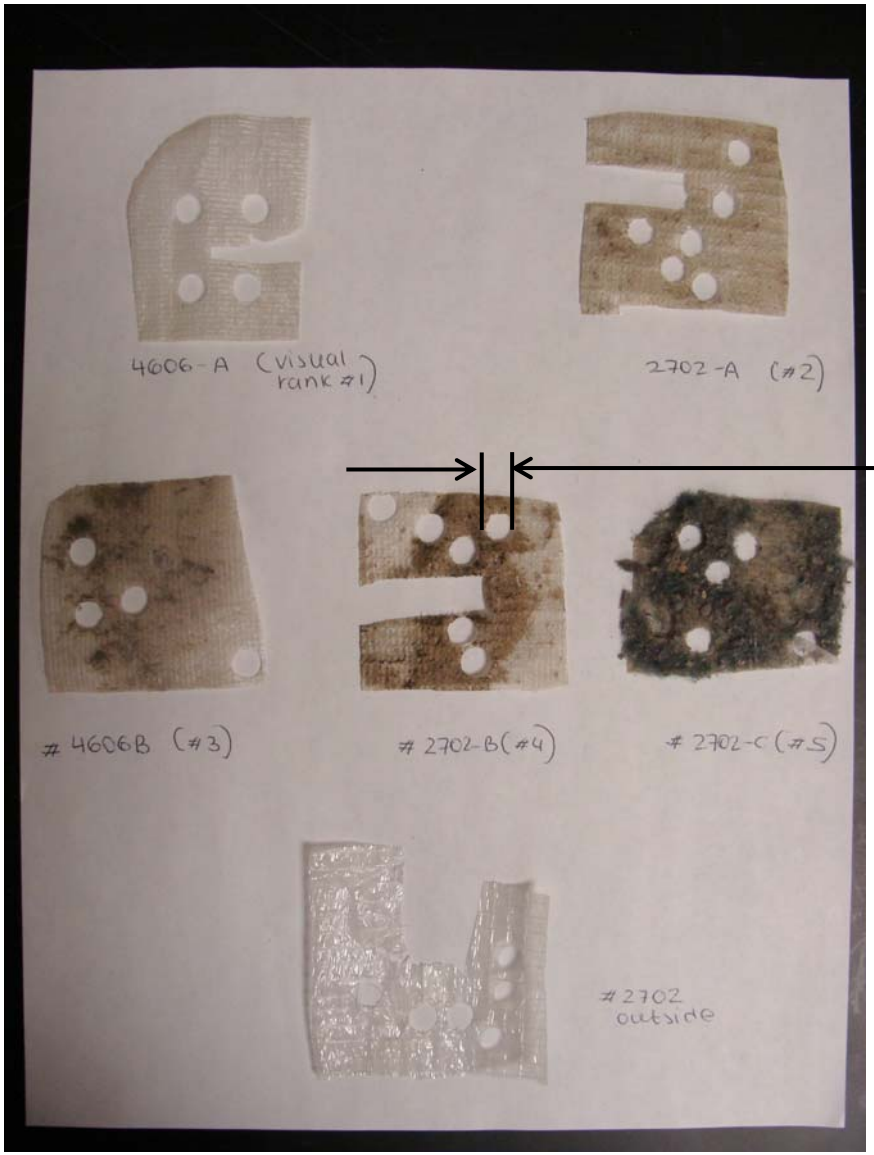
#4606


Severe
Contamination
#2702
4 min

MICROSCALE COMBUSTION CALORIMETRY (ASTM D 7309-07)



FILM SAMPLING FOR MCC TESTING



7-mm circular samples cut with hole punch.

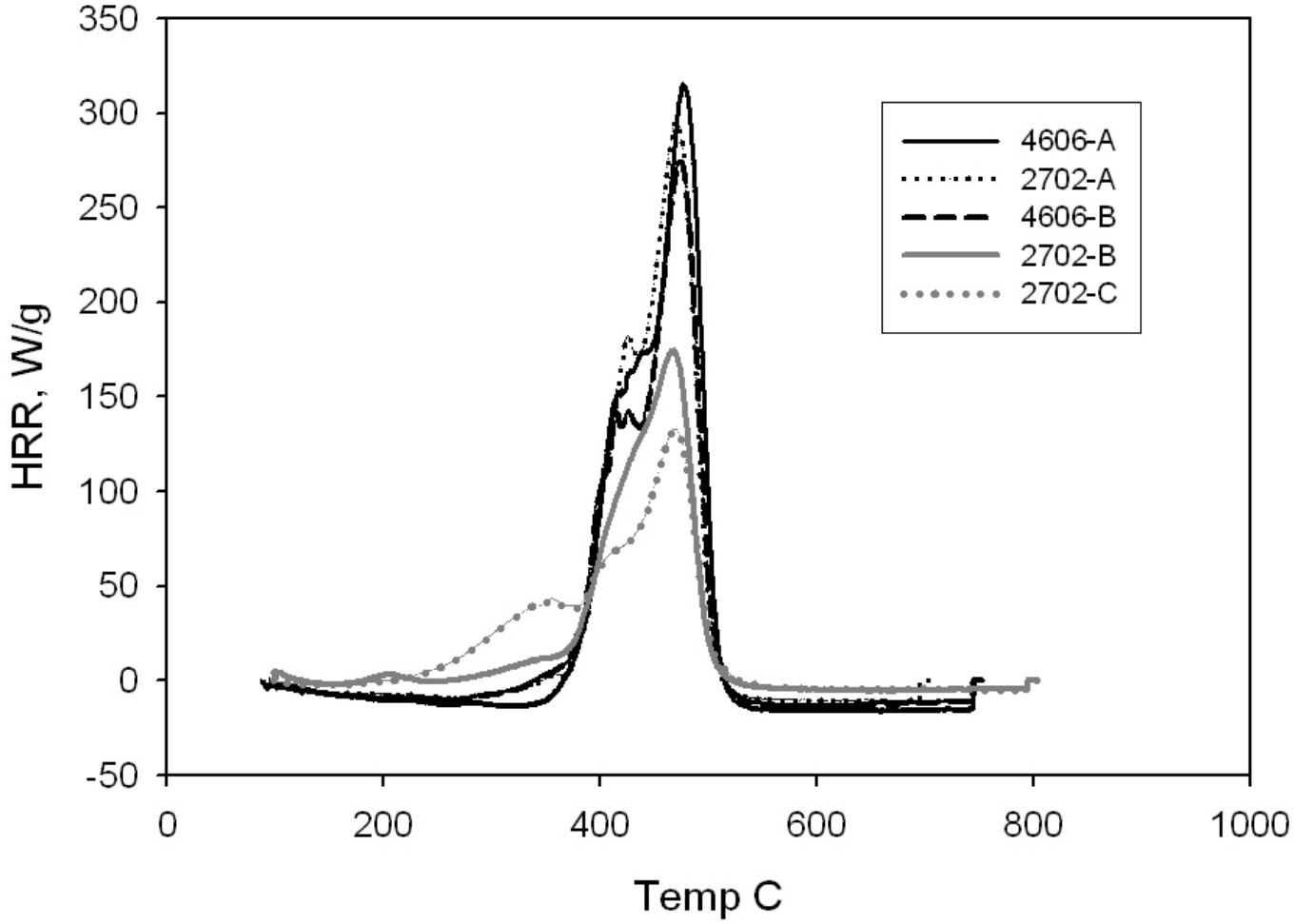
Sample weight = 3 to 8 mg

Sample Area = 3.85×10^{-5} m^2

VISUAL AND GRAVIMETRIC RANKING OF FILM CONTAMINATION

SAMPLE DESIGNATION	VISUAL RANKING OF CONTAMINATION (1-5)		AREAL WEIGHT OF CONTAMINATION (g/m^2)
4606-A	1	low	0 ±3
2702-A	2	↓	11 ±16
4606-B	3	moderate	23 ±15
2702-B	4	↓	44 ±13
2702-C	5	high	135 ±24

SPECIFIC HEAT RELEASE RATE DECREASES WITH CONTAMINATION LEVEL



ANALYSIS OF FIRE HAZARD OF CONTAMINATION

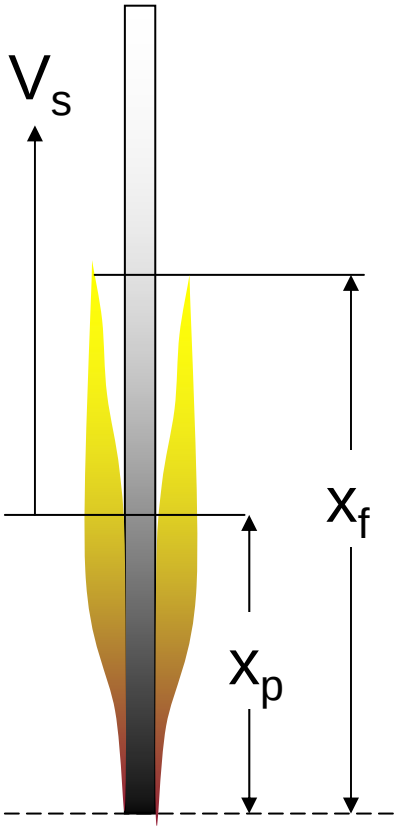
HEAT RELEASE RATE (W/m^2) = (Specific heat release rate of film + contamination (W/g)) X (Areal weight of film + contamination (g/m^2))

FIRE LOAD (J/m^2) = (Heat of combustion of film + contamination (J/g)) X (Areal weight of film + contamination (g/m^2))

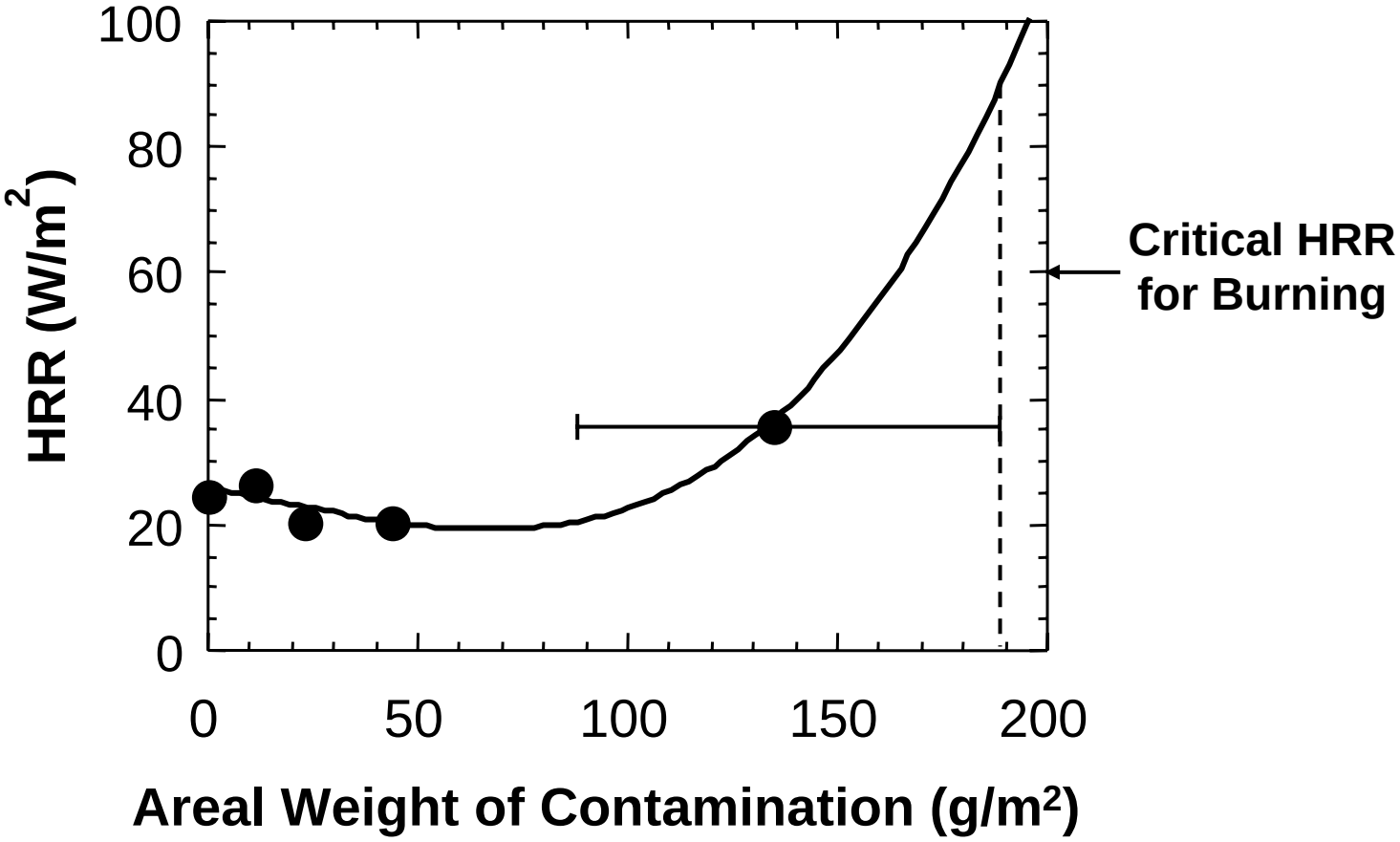
FLAME SPREAD VELOCITY AND HRR

$$V_s = \frac{d\,x_p}{d\,t} = \frac{x_f - x_p}{t_{ign}}$$

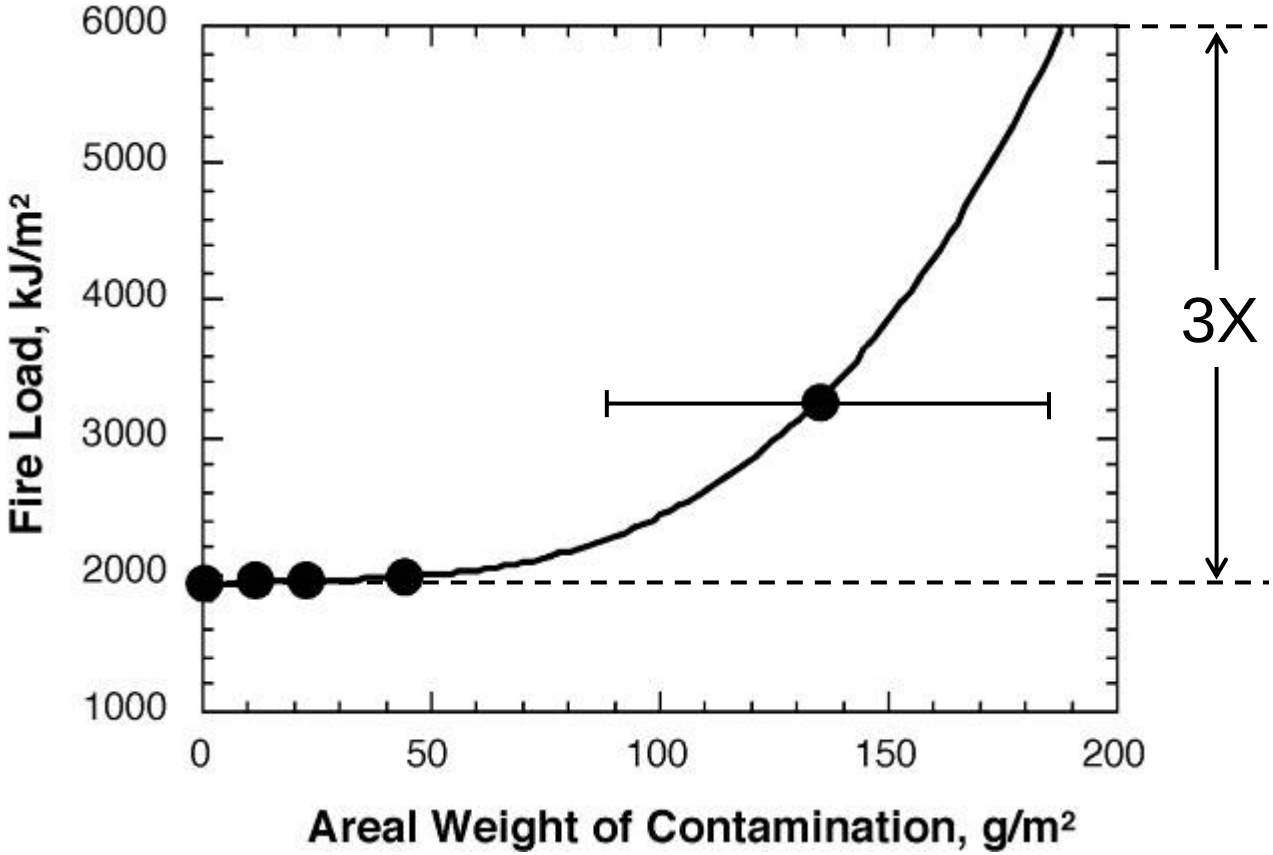
$$\propto HRR^n$$



AREAL HEAT RELEASE RATE VERSUS CONTAMINATION LEVEL



FIRE LOAD TRIPLES AT HIGHEST CONTAMINATION LEVEL



CONCLUSIONS

- Contamination has lower heat of combustion than film because of inert (glass & mineral) particulates.

- Fire load (heat per unit area) ***triples*** at highest contamination level (180 g/m^2) measured in study.