Howard Street Tunnel Fire Simulations

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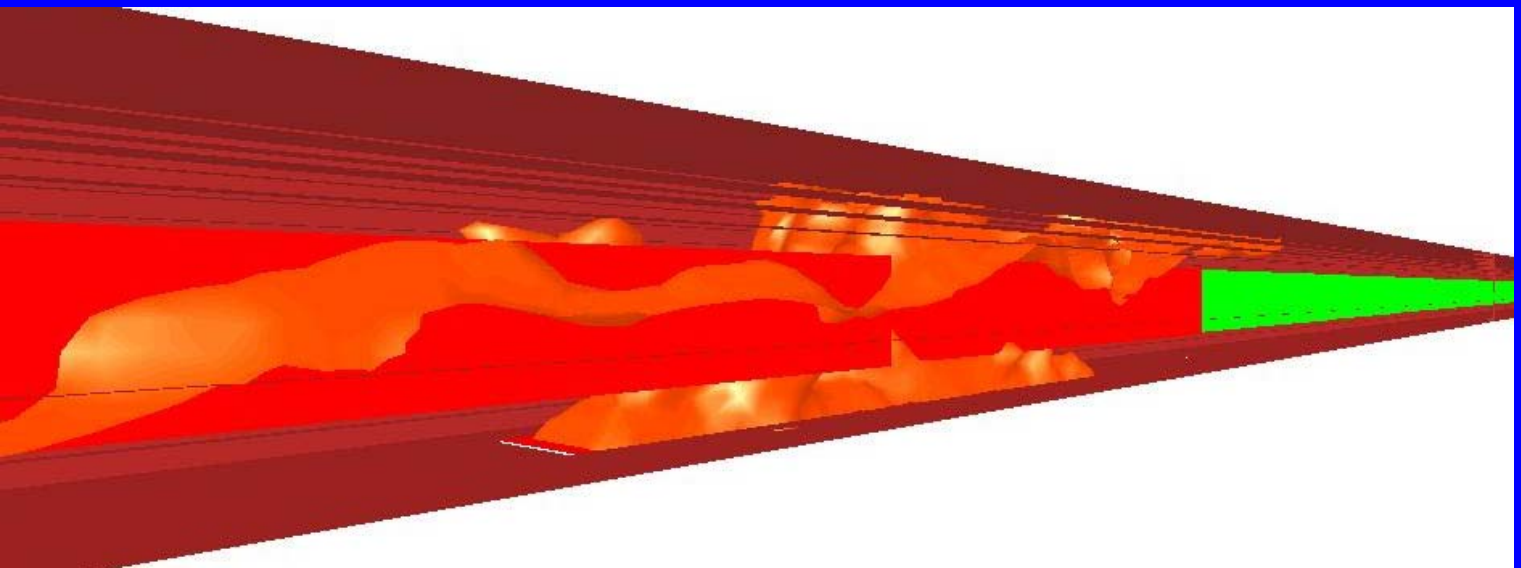
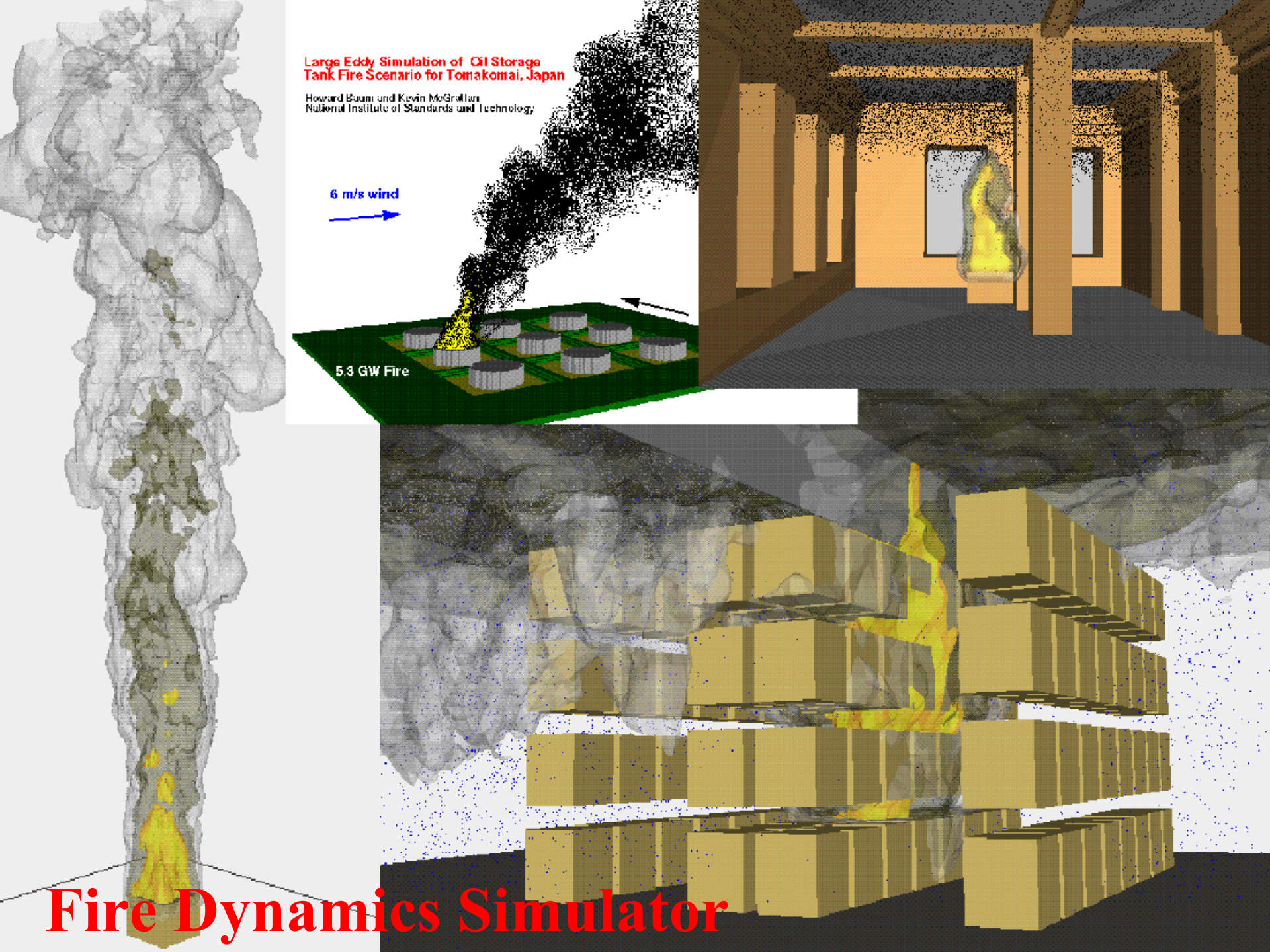
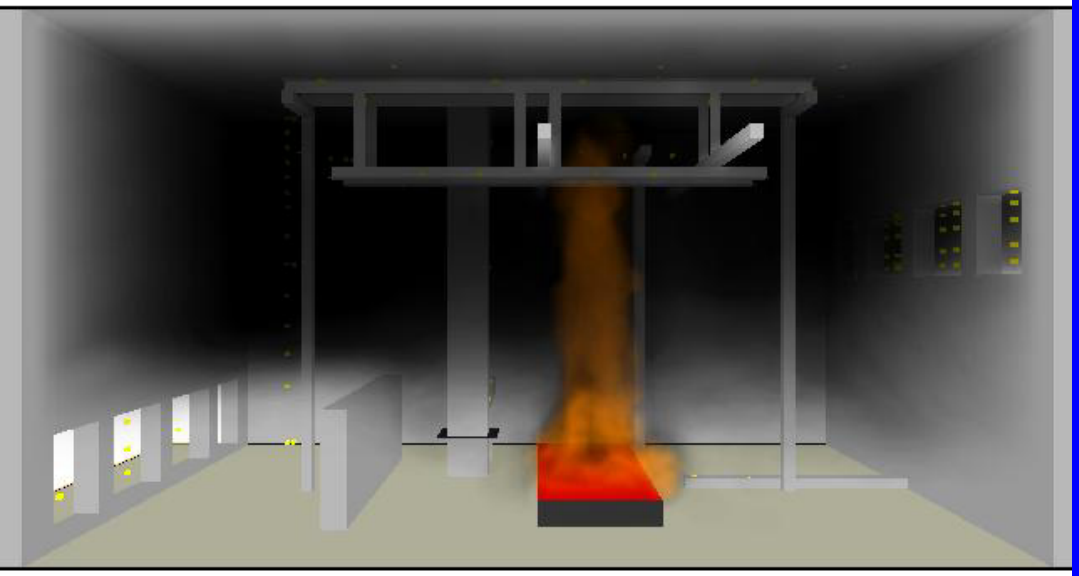




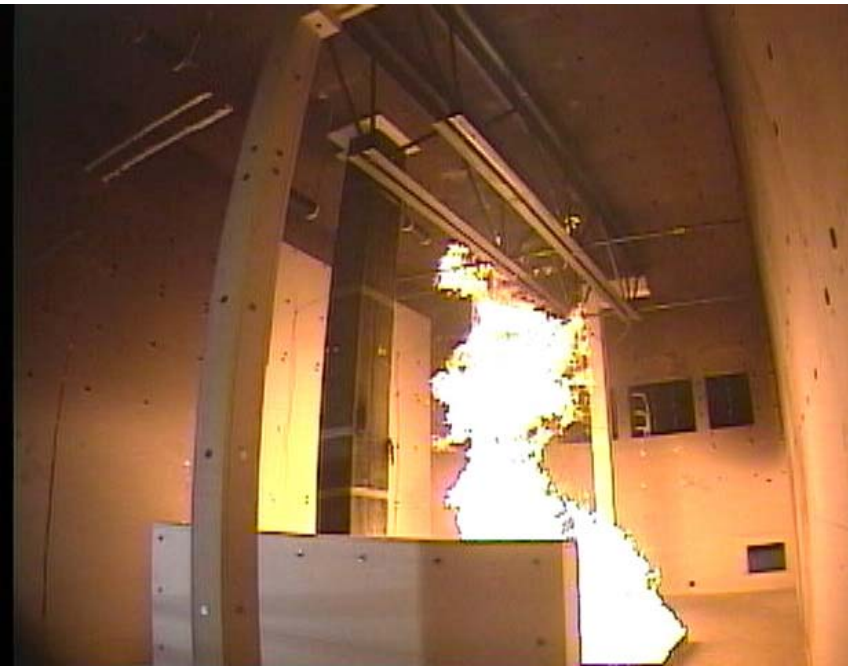
Fire Dynamics Simulator

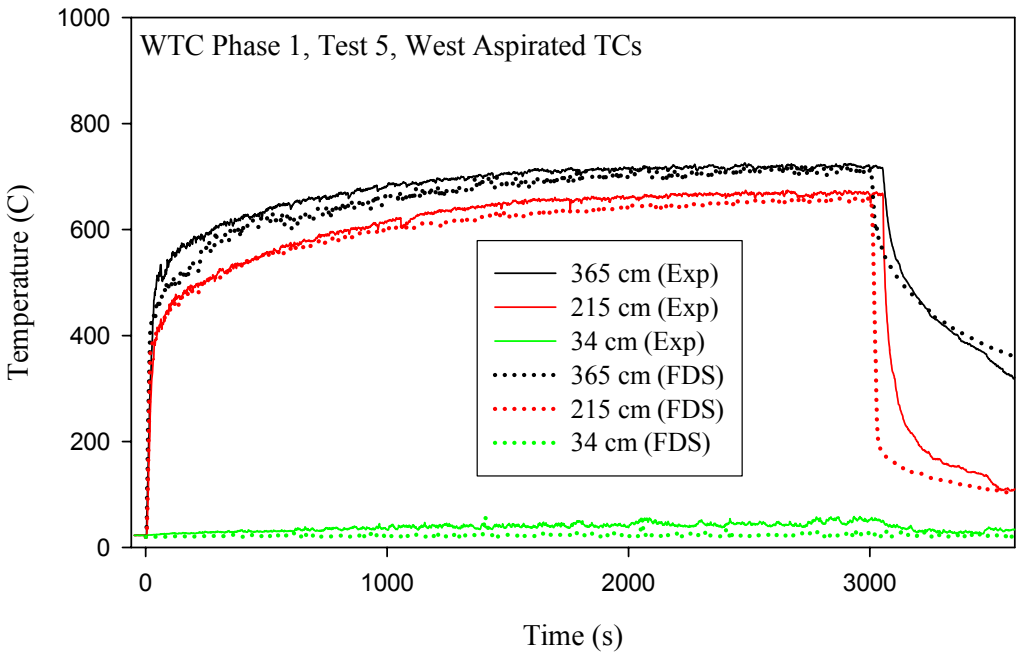
NIST Smokeview 4.0 Alpha - Apr 17 2003



FDS Validation Experiment

3 MW Fire, 23'x12'x12' Compartment, 1 hour burn



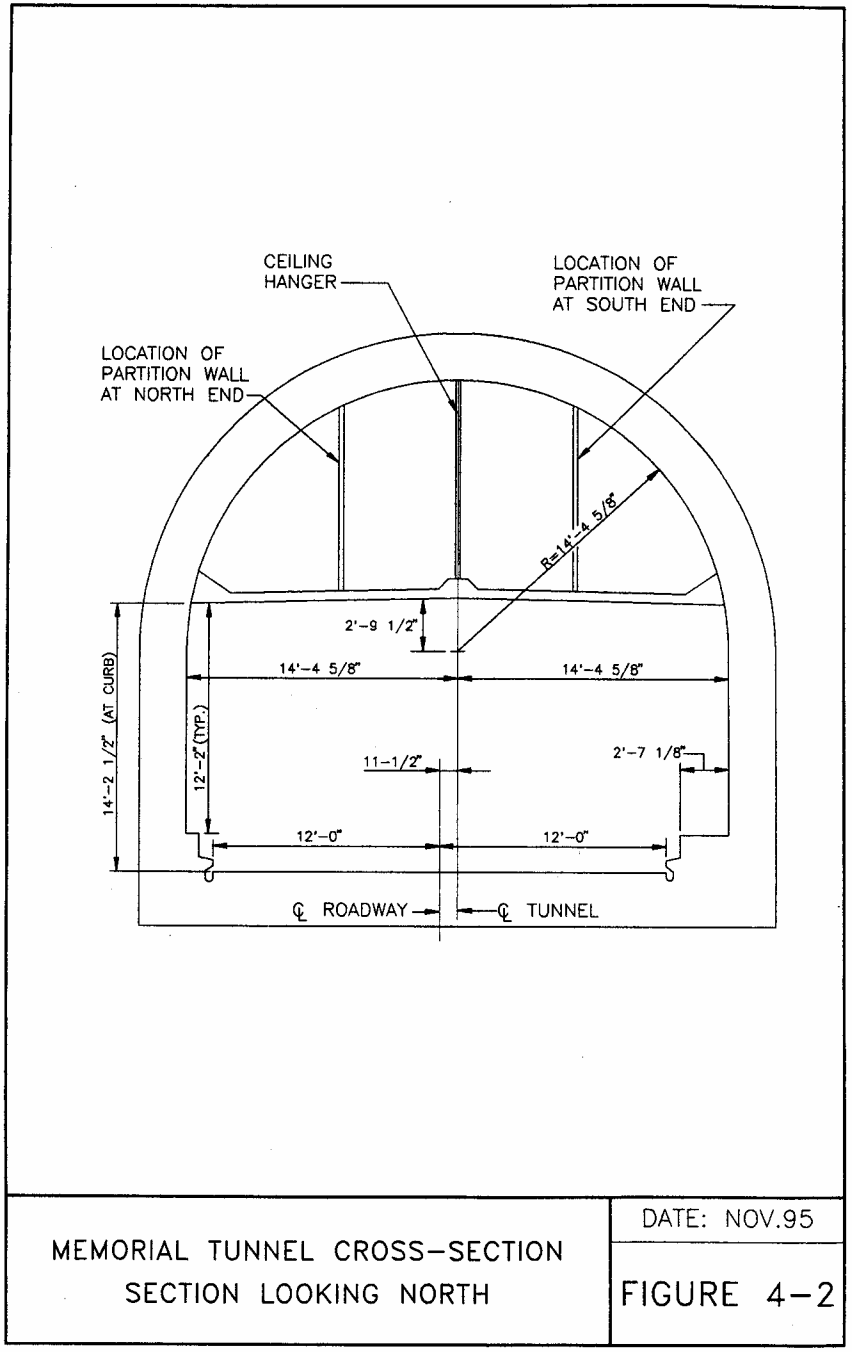


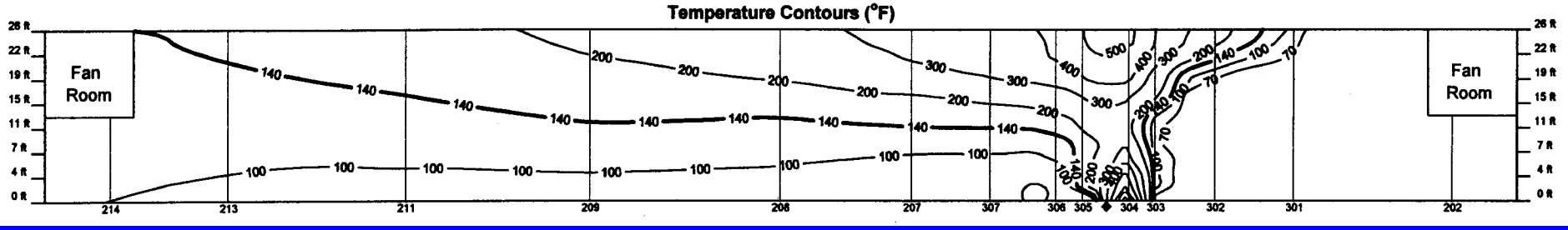
Validation of FDS model based on fire tests done in the mid 1990s inside a decommissioned highway tunnel in West Virginia, sponsored by the Mass. Highway Dept and Fed. Highway Admin.

Memorial Tunnel:

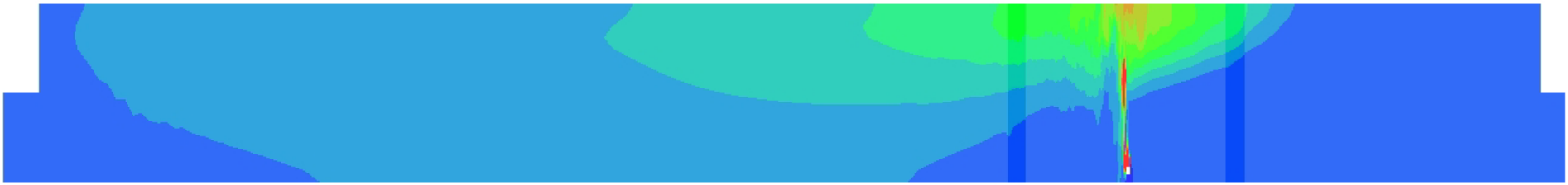
853 m (2,800 ft) long
7.9 m (26 ft) high
3.2 % grade

2 fire tests with natural ventilation, 20 and 50 MW



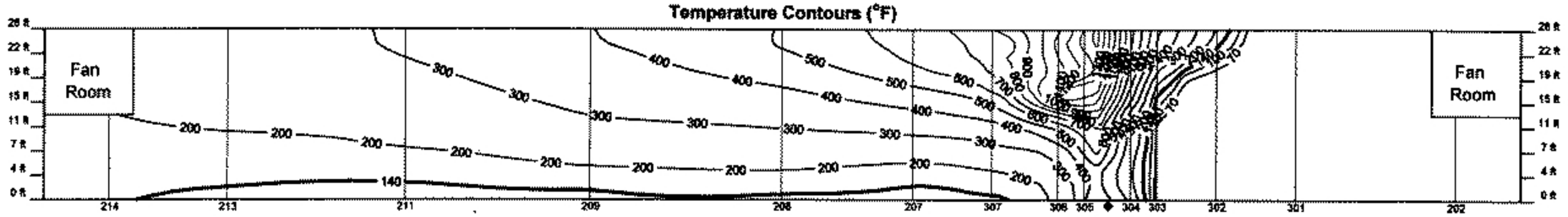


Memorial Tunnel, 20 MW fire, 16 min past ignition

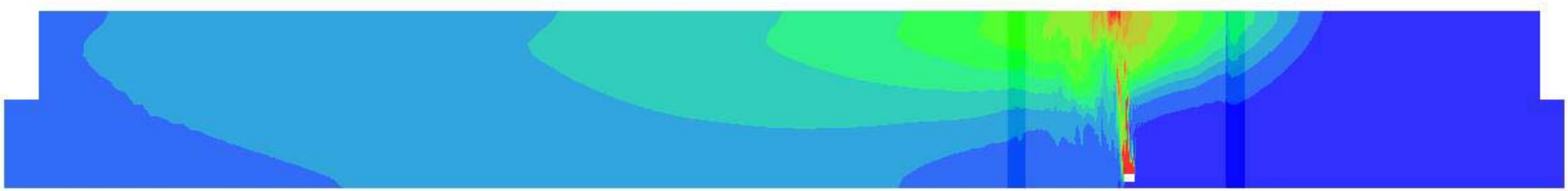


Numerical Simulation

Peak Temperatures near ceiling: 320 C (600 F)



Memorial Tunnel, 50 MW fire, 14 min past ignition



Numerical Simulation

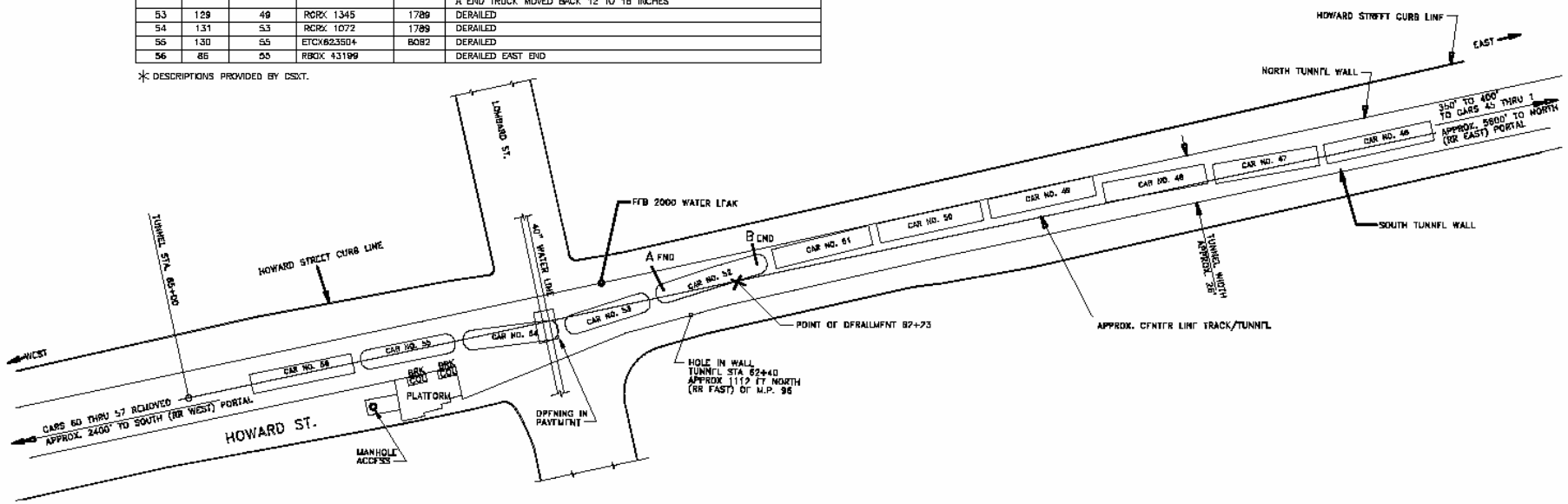
Peak Temperatures near Ceiling: 800 C (1,500 F)

Howard Street Tunnel Fire

- 2.7 km (1.7 mi) long
- 0.8 % grade at Lombard
- 6.4 m (21 ft) high
- 9.9 m (32 ft) wide
- Longer but smaller in cross section compared to Memorial Tunnel

DERAILED CAR INFORMATION *					
CAR NUMBER	WEIGHT (TONS)	CAR LENGTH (FT.)	CAR DESCRIPTION	HAZ. MAT. CODE	DERAILED STATUS
46	105	58	CSXT140140		DERAILED TO SOUTH SIDE
47	110	58	CSXT140092		DERAILED TO SOUTH SIDE
48	108	57	AN 5701		DERAILED, NOT SURE OF POSITION OF TRUCKS, TRAILING END STARTING TO LEAN TO NORTH WALL.
49	108	59	CSXT136353		DERAILED LEANING ON NORTH WALL
50	111	58	CSXT140341		DERAILED LEANING ON NORTH WALL
51	104	55	CSXT158745		DERAILED LEANING ON NORTH WALL
52	123	63	SRIX 30015	2057	DERAILED, B END TRUCK BACK UNDER CAR ABOUT 1/3 OF CAR LENTH. A END TRUCK MOVED BACK 12 TO 18 INCHES
53	129	49	RCRX 1345	1789	DERAILED
54	131	53	RCRX 1072	1789	DERAILED
55	130	55	ETCX823504	8082	DERAILED
56	86	55	RBOX 43199		DERAILED EAST END

* DESCRIPTIONS PROVIDED BY CSXT.



DERAILMENT SKETCH

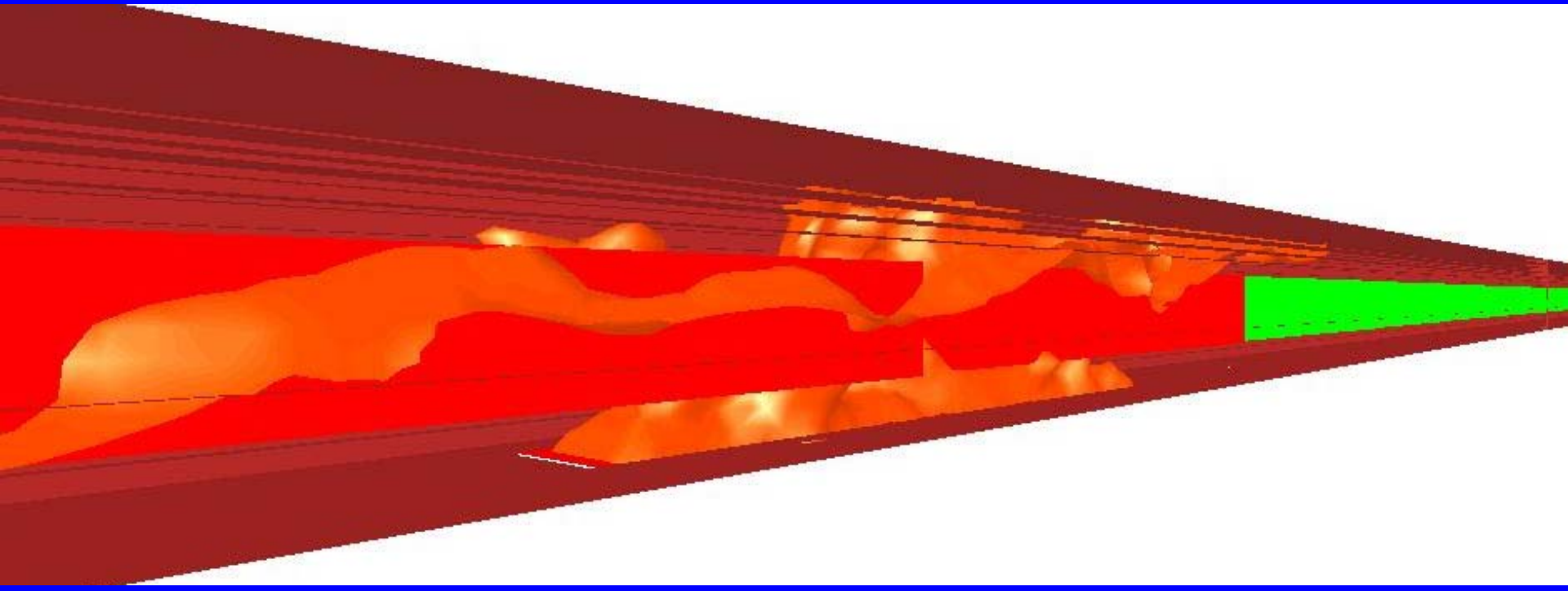
NOTES:

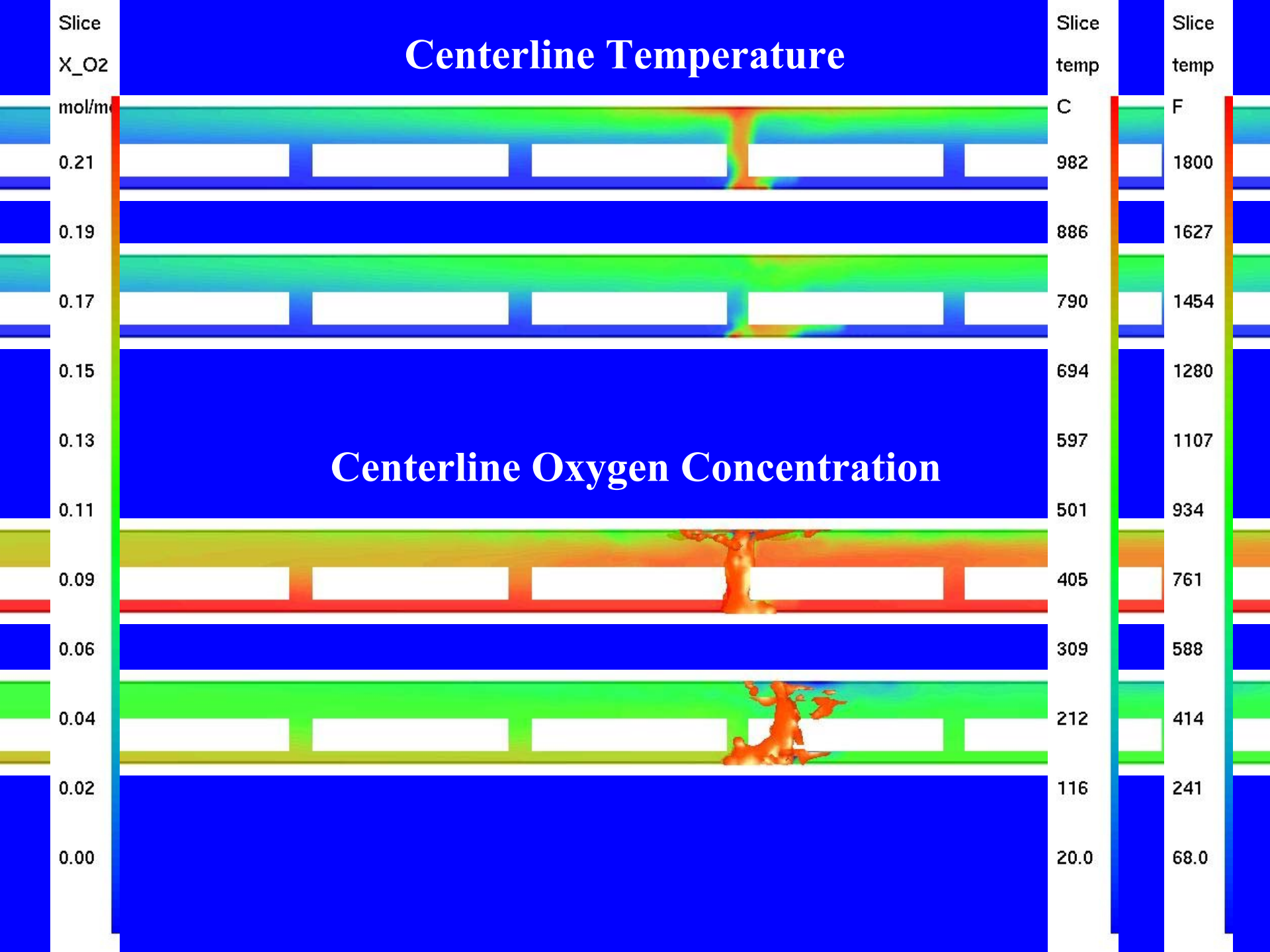
DIMENSIONS SHOWN ARE APPROXIMATE.

THE TRAIN POSITION, AS REPORTED ON THE CSXT TRAIN DOCUMENTATION, INCLUDES THREE LOCOMOTIVES, 60 CARS TOTAL.

TUNNEL STA. 0+00 AT NORTH (RR EAST) PORTAL.

SOURCE: NTSB AND CSX TRANSPORTATION




Centerline Temperature
Centerline Oxygen Concentration
Slice
X_O2
mol/m
0.21
0.19
0.17
0.15
0.13
0.11
0.09
0.06
0.04
0.02
0.00
Slice
temp
C
982
886
790
694
597
501
405
309
212
116
20.0
Slice
temp
F
1800
1627
1454
1280
1107
934
761
588
414
241
68.0

Conclusions

- A series of calculations were conducted revealing average tunnel temperatures similar to temperatures measured in large open fires.

- Peak gas temperatures 1000 C (1800 F) in flames; 500 C (900 F) over the length of a few rail cars.

- Peak wall temperatures 800 C (1500 F) under direct flame impingement; 400 C (750 F) over the length of a few rail cars.

- Parameter studies indicate only minor changes in temperature with changes in various tunnel/fire properties

Previous Experimental Studies

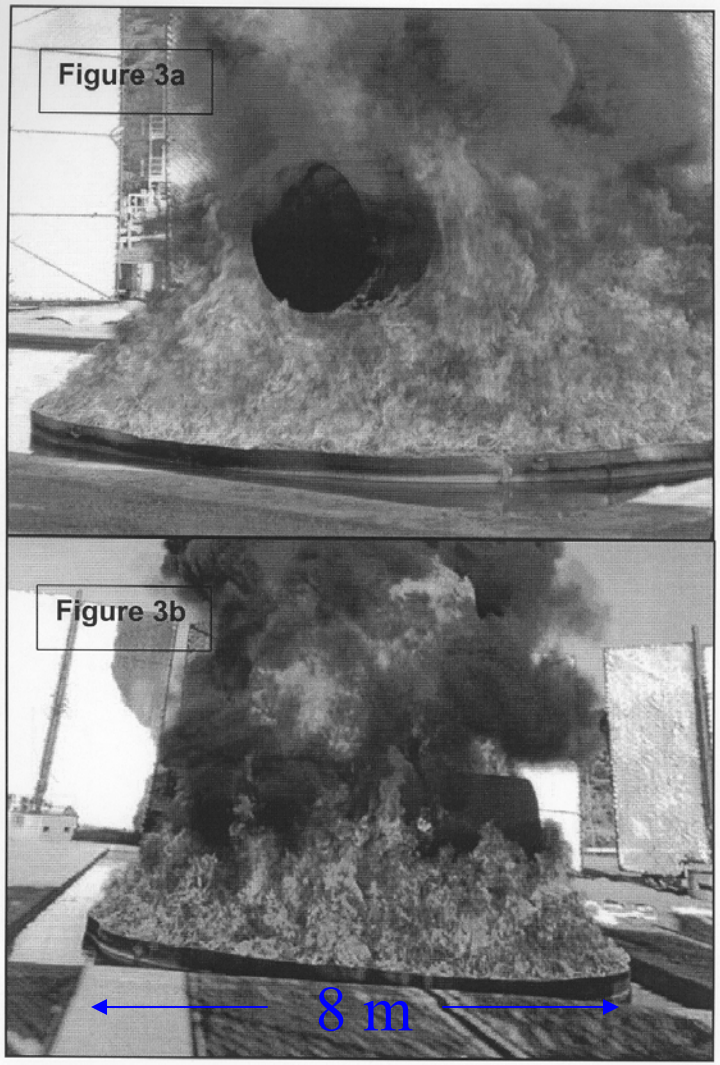


Figure 3 Photos taken during the fire

- 2001 Sandia study on temperature of a massive cylindrical object engulfed in a large outdoor hydrocarbon pool fire.

- The inner surface temperature and the flame emissive power was measured at several locations.

Previous Experimental Studies

- measurements showed that near-steady temperatures were achieved in ~ 25 min.

- the peak inner surface temperature was nearly 1050 °C.

- the temperature varied as a function of location within the cask and the wind direction.

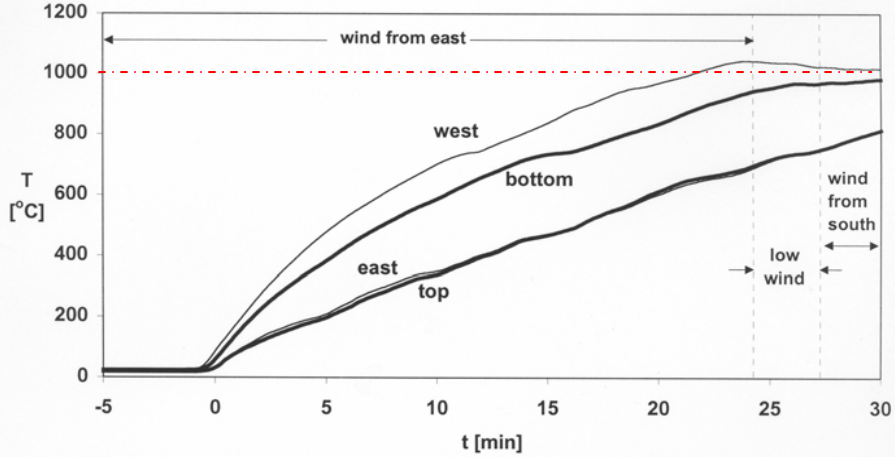


Figure 5. Measured inner surface temperature versus time at x = 1.96 m.

How hot do fires get?

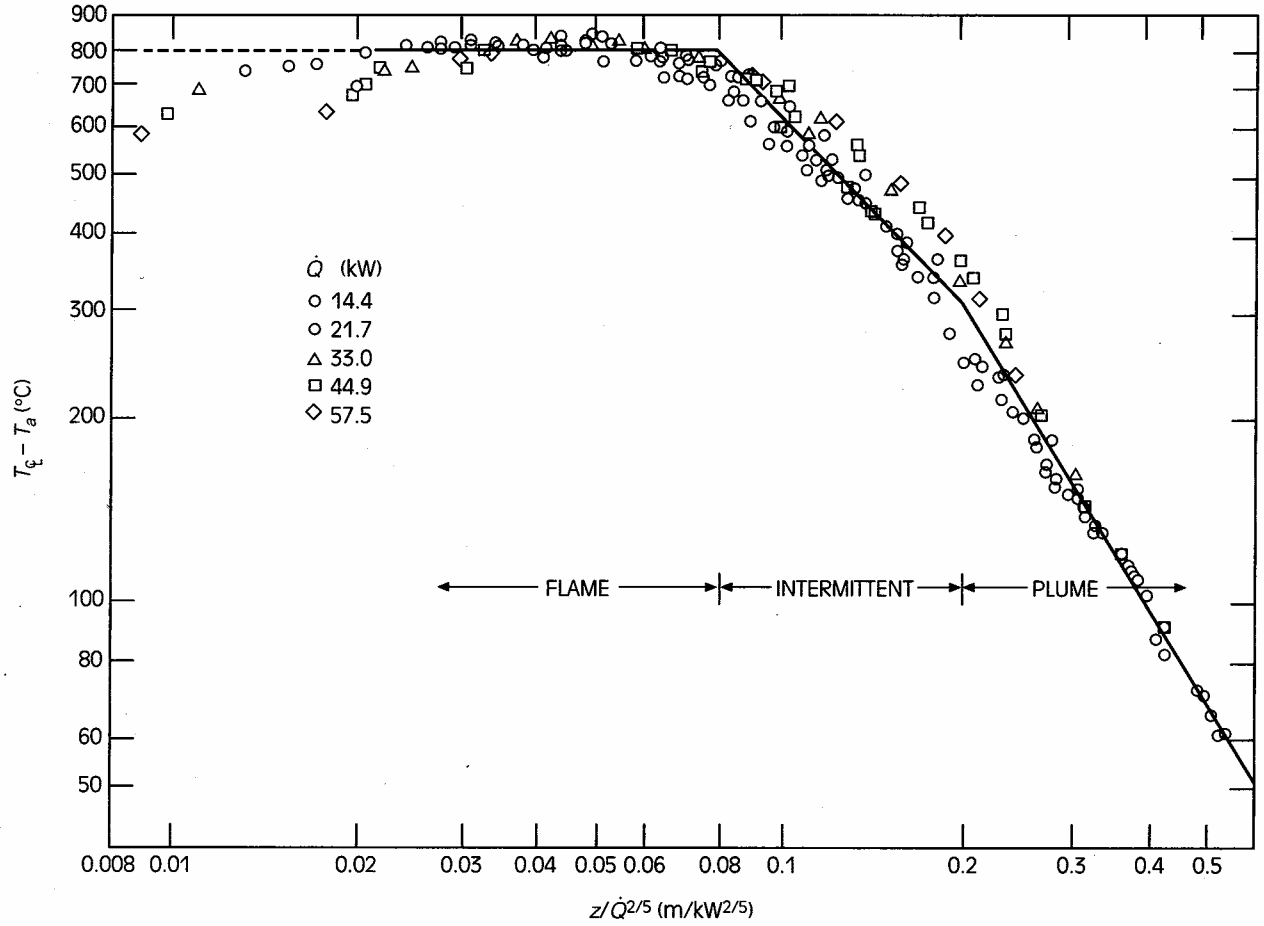


Figure 7-10 *Centerline fire plume temperatures. After McCaffrey, Ref. 1.*