

PLC *Professional Loss Control, Inc.*

STRUCTURAL STEEL ANALYSIS
for
LIMERICK GENERATING STATION

UNIT 1 Reactor Building El. 177'
HPCI Pump & Turbine Room Room 109
Fire Area 34

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LIMERICK GENERATING STATION

1. AREA DESCRIPTION

The area under consideration is the High Pressure Coolant Injection (HPCI) Pump and Turbine Room, Room 109 on the 177' elevation of the Unit 1 Reactor Building (Fire Area 34). Bounding walls in the area are of reinforced concrete construction with an average thickness of 3 ft. The total surface area for heat transfer is 4760 ft² (see Attachment A for sketch and calculation of areas).

2. COMBUSTIBLE LOADING

Combustible loading in the area consists of 155 gallons of lubricating oil contained in the HPCI turbine. For the analysis this quantity was doubled to account for possible maintenance activities in the area. A single cable tray having 18 ft² of surface area and an average combustible loading of 1.5 lbs/ft² of cable tray surface is located near the east wall of the room.

3. VENTILATION PARAMETERS

Two watertight doors each measuring 3' wide by 5'10" high enter the room. One door is located in the north wall, the other in the south wall.

4. CASES EXAMINED

A lube oil fire was assumed in the area involving 310 gallons of lubricating oil. One door entering the area was assumed to be open. This is an opening area of 17.5 ft² which results in a ventilation controlled maximum heat output of 3426 kW.

5. RESULTS

With one door open, the resulting ventilation controlled heat output of 3426 kW will consume the 310 gallons of fuel in 238 minutes. Due to the excessive fuel quantity, the fire duration was taken to 180 minutes which resulted in a gas temperature of 1149°F (see Attachment B) which is above the critical temperature of the structural steel.

The ventilation controlled burning rate of 3426 kW is equivalent to the output from a pool fire with an area of 11 ft² (pool diameter of approximately 4 ft). In order to assess the effect of the plume of heated gases above the pool fire on the structural steel located above the fire, Heskestad's relations will be used:

Virtual point source determination:

$$Z_0 = -1.020 + .083 Q^{.4} = 1.01 \text{ m}$$

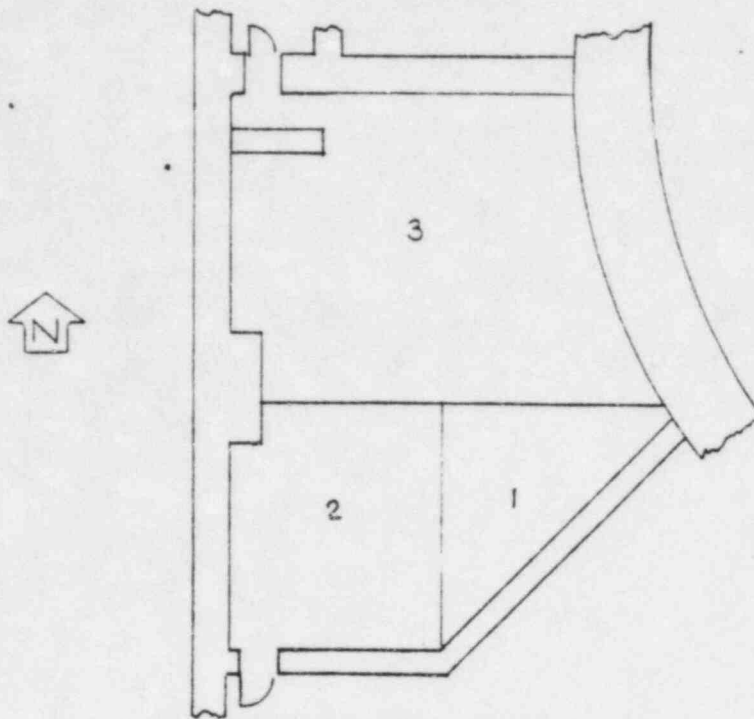
Plume temperature at bottom of steel supporting the room ceiling:

$$T_0 = 9.1 (T_{\infty} / (g c_p^2 \cdot 2))^{.333} Q_c^{.667} (Z - Z_0)^{1.67}$$

$$T_0 = 282^\circ\text{K temperature rise}$$

$$T = 576^\circ\text{F temperature of fire plume}$$

The temperature is below the critical temperature for the structural steel. It can be concluded that there is no problem due to localized heating as a result of the maximum pool fire that can be supported by the available air flow into the room through a single door. The cable tray in this area is positioned such that it does not present a localized heating exposure to structural steel. However, the structural steel in the area will fail due to the overall gas temperature reached if the fire is permitted to burn for 3 hours.



UNIT 1 Reactor Building El. 177'
HPCI Pump & Turbine Room 109

Surface Area Calculation

Walls

North wall	(30' x 23')	690 ft ²
East wall	(28' x 23')	644 ft ²
South wall		1058 ft ²
West wall	(46' x 23')	1058 ft ²
		<hr/>
		3450 ft ²

Ceiling

Area 1	1/2(20' x 20')	200 ft ²
Area 2	(20' x 18') - 160 ft ² (Hatch)	200 ft ²
Area 3	(35' x 26')	910 ft ²
		<hr/>
		1310 ft ²

Total Surface Area for Heat Transfer	4760 ft ²
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CASE NUMBER: 1
 BUILDING: UNIT 1 REACTOR BUILDING
 ELEVATION AND AREA DESCRIPTION: 177' HPCI PUMP AND TURBINE ROOM
 CASE DESCRIPTION: ONE DOOR OPEN LUBE OIL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	17.5	5.8	4760	3417

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	326
20	431
30	512
40	580
50	640
60	694
70	744
80	790
90	833
100	875
110	914
120	951
130	987
140	1022
150	1055
160	1087
170	1118
180	1149