

STRUCTURAL STEEL ANALYSIS

for

LIMERICK GENERATING STATION

Unit 1 Reactor Building El. 177'

RHR Heat Exchanger and Pump Room - Room 103

Fire Area 31

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## LIMERICK GENERATING STATION

### 1. AREA DESCRIPTION

The area under consideration is the RHR Heat Exchanger and Pump Room, Room 103, on the 177' elevation of the Unit 1 Reactor Building (Fire Area 31) (see Attachment A for sketch of area). The bounding walls of the area are of reinforced concrete construction with an average thickness of 3 ft. The total surface area for heat transfer is 9068 ft<sup>2</sup> (see Attachment A for calculation of areas).

### 2. COMBUSTIBLE LOADING

Combustible loading in the area consists of 72 gallons of lubricating oil contained in the RHR pump motors. For the analysis this quantity was doubled to account for possible maintenance activities in the area. There are two cable trays in the room - one located along the east wall, the other along the west wall. The total surface area of the cable trays is 58 ft<sup>2</sup> with an average combustible loading of 1.5 lbs/ft<sup>2</sup> of cable tray surface.

### 3. VENTILATION PARAMETERS

There are four doors which enter the area. Two watertight doors measuring 3' wide by 5'10" high enter the area on the 177' elevation and two steam-tight doors measuring 3' wide by 7' high enter the area on the 201' elevation.

### 4. CASES EXAMINED

Two cases were examined, each assuming a lube oil fire involving 144 gallons of lubricating oil. Case number one assumed the lube oil fire with one steamtight door open and case number two assumed both steamtight doors open.

### 5. RESULTS

Case number one considered only one 3' x 7' door open which corresponds to a ventilation controlled heat output of 4504 kW. At this heat output the fire would consume the 144 gallons of lube oil in 85 minutes. The gas temperature at this time would be 584°F, which is below the critical temperature of the structural steel (see Attachment B).

The ventilation controlled burning rate of 4504 kW is equivalent to the heat output from a pool fire with an area of 14 ft<sup>2</sup> (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 supporting the intermediate grating at the 201' elevation, Hesketad's relations will be used:

Virtual point source determination:

$$Z_0 = -1.02D + .083 Q^{.4} = 1.09 \text{ m}$$

Plume temperature at bottom of structural steel supporting intermediate grating.

$$\Delta T_0 = 9.1[T_\infty / (gc_p^2 \rho_\infty^2)]^{.333} Q_c^{.667} (Z - Z_0)^{-1.67}$$

$$\Delta T_0 = 348^\circ\text{K temperature rise}$$

$$T = 695^\circ\text{F temperature of fire plume}$$

The plume temperature is below the critical temperature of the structural steel.

Case number two considered both 3' x 7' doors open which corresponds to a ventilation controlled burning rate of 9008 kW. At this heat output the fire would consume the 144 gallons of lube oil in 44 minutes. The gas temperature at this time would be 809°F which is below the critical temperature of the structural steel (see Attachment B).

The ventilation controlled burning rate of 9008 kW is equivalent to the heat output from a pool fire with an area of 28 ft<sup>2</sup> (pool diameter of approximately 6 ft). In order to assess the effect of the plume of heated gases above the pool fire on the structural steel supporting the intermediate grating at the 201' elevation, Hesketad's relations will be used:

Virtual point source determination:

$$Z_0 = -1.02D + .083 Q^{.4} = 1.32 \text{ m}$$

Plume temperature at bottom of structural steel supporting intermediate grating.

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

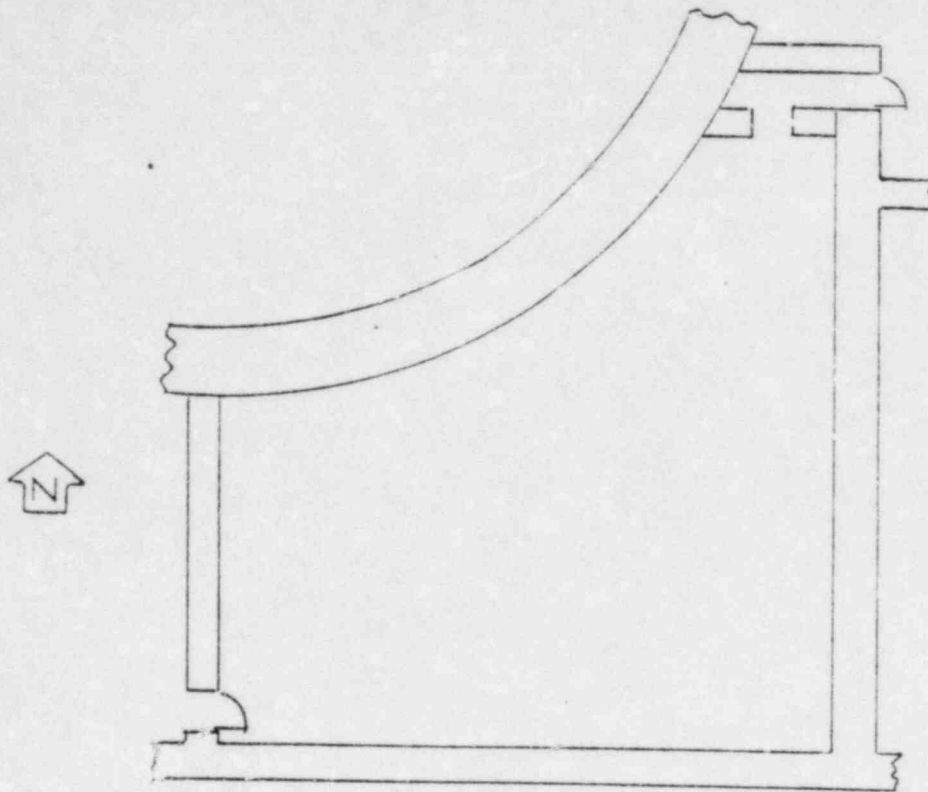
$\Delta T_0 = 597^\circ\text{K}$  temperature rise

$T = 1194^\circ\text{F}$  temperature of fire plume

The plume temperature is below the critical temperature of the structural steel.

The plume temperature is below the critical temperature of the structural steel for both cases. It is concluded that there is no problem due to localized heating of the structural steel as a result of the maximum pool fire that can be supported by the available airflow into the room through two open doors.

The cable trays in this area were positioned such that they did not present a localized heating exposure to the structural steel.



Unit 1 Reactor Building El. 177'  
RHR Heat Exchanger and Pump Room 103

Surface Area Calculation

Walls

North wall	(52' x 40')	2080 ft <sup>2</sup>
South wall	(52' x 40')	2080 ft <sup>2</sup>
East wall	(56' x 40')	2240 ft <sup>2</sup>
West wall	(29' x 40')	1160 ft <sup>2</sup>
		<hr/>
		7560 ft <sup>2</sup>

Ceiling for area is at elevation 217'

<u>Ceiling</u>	(29' x 52')	<hr/>
		1508 ft <sup>2</sup>
Total Surface Area for Heat Transfer		<hr/>
		9068 ft <sup>2</sup>

ATTACHMENT A

CASE NUMBER: 1  
 BUILDING: UNIT 1 REACTOR BUILDING  
 ELEVATION AND AREA DESCRIPTION: 177' RHR HX & PUMP ROOM 103  
 CASE DESCRIPTION: ONE 3'x7'DOOR OPEN LUBE OIL FIRE

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CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	21.0	7.0	9068	4504

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FIRE IS VENTILATION CONTROLLED

FIRE DURATION  
(min)

GAS TEMPERATURE  
(deg.F)

5	197
10	248
15	287
20	321
25	350
30	376
35	401
40	423
45	445
50	465
55	484
60	502
65	520
70	537
75	553
80	569
85	584

CASE NUMBER: 2  
 BUILDING: UNIT 1 REACTOR BUILDING  
 ELEVATION AND AREA DESCRIPTION: 177' RHR HX & PUMP ROOM 103  
 CASE DESCRIPTION: TWO 3'x7' DOORS OPEN LUBE OIL FIRE

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CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	42.0	7.0	9068	9008

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FIRE IS VENTILATION CONTROLLED

FIRE DURATION  
(min)

GAS TEMPERATURE  
(deg.F)

4	295
8	387
12	457
16	517
20	569
24	616
28	660
32	701
36	739
40	775
44	809