PLC *Professional Loss Control, Inc.*

STRUCTURAL STEEL ANALYSIS

for

LIMERICK GENERATING STATION

Unit 1 Reactor Building

RCIC Pump Room 108

Fire Area 33

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LIMERICK GENERATING STATION

1. AREA DESCRIPTION

The area under consideration is the RCIC Pump Room, Room 108, on the 177' elevation of the Unit 1 Reactor Building (Fire Area 33) (see Attachment A for sketch of area). The bounding walls in the area are of reinforced concrete construction with an average thickness of 2.5 ft. The total surface area for heat transfer is 3820 ft^2 (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

Combustible loading in the area consists 80 gallons of lubricating oil contained in the RCIC turbine. For the analysis this quantity was doubled to account for possible maintenance activities in the area. A single cable tray having 38 ft^2 of surface area with an average combustible loading of 3.6 lbs/ft^2 of cable tray surface area is located along the west wall of the room.

3. VENTILATION PARAMETERS

There are three doors which enter this area. Two watertight doors, each measuring 3' wide by 5'10" high, one door is located in the north wall, the other in the east wall. One 3' wide by 7' high door is located at the entrance to stairwell No. 3.

4. CASES EXAMINED

Three cases were examined each assuming a lube oil fire involving 160 gallons of lubricating oil. Case number one assumed one 3' x 5'10" door open, case number two assumed one 3' x 7' door open, and case number three assumed two 3' x 5'10" doors open. All cases assumed that the pre-action sprinkler system does not operate and that no actions are taken by plant personnel to extinguish the fire.

5. RESULTS

Case number one considered only one 3' x 5'10" door open, which corresponds to a ventilation controlled heat output of 3426 kW. At this heat output

the fire would consume the 160 gallons of lube oil in approximately 125 minutes. .The gas temperature at this time would be 1193°F which is above the critical temperature of the structural steel (see Attachment B).

The ventilation controlled burning rate of 3426 kW is equivalent to the heat output from a pool fire with an area of 11 ft^2 (pool diameter of approximately 4 ft). In order to assess the effect of the plume of heated gases above the pool fire in the structural steel supporting the ceiling, Hesketad's relations will be used:

Virtual point source determination:

$Z_o = -1.02D + .083\ Q^{.4} = 1.01$ m

Plume temperature at bottom of structural steel supporting intermediate grating.

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

ΔT_o = 283°K temperature rise

T = 577°F temperature of fire plume

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

Case number two considered one 3' x 7' door open which corresponds to a ventilation controlled burning rate of 4504 kW. At this burn rate the 160 gallons of lube oil would be consumed in 50 minutes. The gas temperature at this time would be 1004°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^2 (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:

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

Plume temperature at bottom of structural steel supporting ceiling:

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

ΔT_o = 348°K temperature rise

T = 695°F temperature of fire plume

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

Case number 3 considered two 3' x 5'10" doors open which corresponds to a ventilation controlled heat output of 6851 kW. At this heat output the fire would consume the 160 gallons of lube oil in approximately 31 minutes. The gas temperature at this time would be 1189°F which is above the critical temperature for the structural steel (see Attachment B).

The ventilation controlled burning rate of 6851 kW is equivalent to the heat output from a pool fire with an area of 21 ft^2 (pool diameter of approximately 5 ft). In order to assess the effect of the plume of heated gases above the pool fire on the structural steel supporting the ceiling, Hesketad's relations will be used:

Virtual point source determination:

$Z_o = -1.02D + .083 Q^{.4} = 1.23$ m

Plume temperature at bottom of structural steel supporting ceiling:

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

ΔT_o = 482°K temperature rise

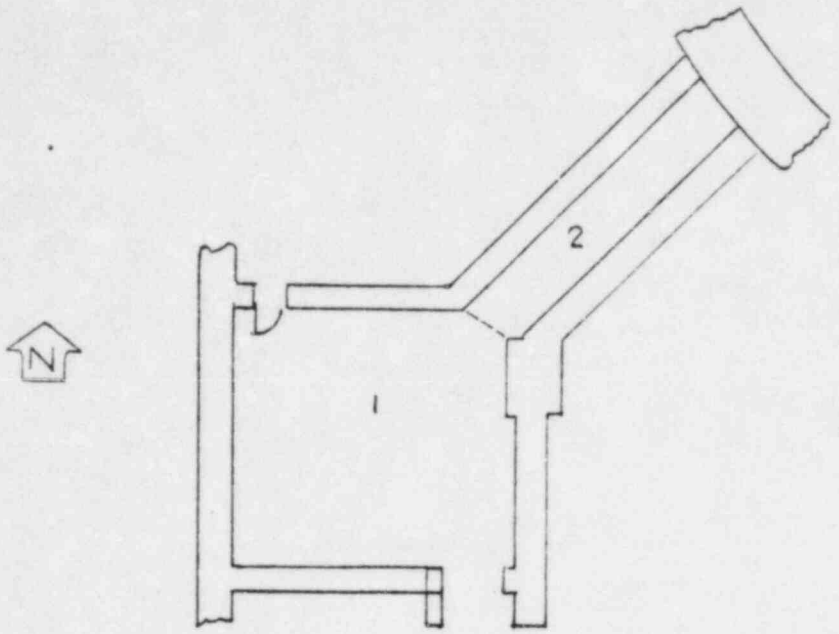
T = 935°F temperature of fire plume

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

The plume temperature for all three cases examined is below the critical temperature of the structural steel. 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 air flow into the room.

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

Even though there are no localized heating problems, two of the cases examined did result in an overall gas temperaure which was above the critical temperature of the structural steel.



Unit 1 Reactor Building El 177'
RCIC Pump Room - Room 108

Surface Area Calculation

Walls		
North wall	(48' x 23')	1104 ft^2
South wall	(50' x 23')	1150 ft^2
East wall	(20' x 23')	460 ft^2
West wall	(21' x 23')	483 ft^2
		3197 ft^2

Ceiling		
Area 1	(23' x 21')	483 ft^2
Area 2	(5' x 28')	140 ft^2
Total Surface Area for Heat Transfer		3820 ft^2

ATTACHMENT A

CASE NUMBER: 1
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 177' RCIC PUMP ROOM 106
CASE DESCRIPTION: ONE 3'x5'10 DOOR OPEN LUBE OIL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	17.5	5.8	3820	3426

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
5	297
10	390
15	461
20	521
25	574
30	621
35	665
40	706
45	745
50	781
55	816
60	849
65	880
70	911
75	940
80	969
85	996
90	1023
95	1049
100	1075
105	1099
110	1124
115	1147
120	1170
125	1193

CASE NUMBER: 3
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 177' RCIC PUMP ROOM 108
CASE DESCRIPTION: TWO 3'x5'10 DOORS OPEN LUBE OIL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	35.0	5.8	3820	6851

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
1	275
2	357
3	421
4	474
5	521
6	564
7	603
8	640
9	674
10	707
11	737
12	767
13	795
14	823
15	849
16	874
17	899
18	923
19	946
20	969
21	991
22	1013
23	1034
24	1055
25	1075
26	1095
27	1114
28	1133
29	1152
30	1171
31	1189

CASE NUMBER: 2
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 177' RCIC PUMP ROOM 108
CASE DESCRIPTION: ONE 3'x7' DOOR OPEN LUBE OIL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	21.0	7.0	3820	4504

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
5	368
10	489
15	583
20	662
25	731
30	794
35	852
40	906
45	957
50	1004