PLC *Professional Loss Control, Inc.*

STRUCTURAL STEEL ANALYSIS

for

LIMERICK GENERATING STATION

Unit 1 Reactor Building El. 201'

Safeguard System Access Area Room 200

Fire Area 42A

December 20, 1983

P. O. Box 446 • Oak Ridge, Tennessee 37830 • (615) 482-3541

LIMERICK GENERATING STATION

1. AREA DESCRIPTION

The area under consideration is the Safeguard System Access Area, Room 200, on the 201' elevation of the Unit 1 Reactor Building (Fire Area 42A). The bounding walls of the area are of reinforced concrete construction with an average thickness of 2.5 ft. The total surface area for heat transfer is 8611 ft^2 (see Attachment A for sketch and calculation of surface areas).

2. COMBUSTIBLE LOADING

Combustible loading in the area consists of the cable insulation located in cable trays. The total surface area of the cable trays is 684 ft^2 with an average combustible loading of 3.5 lbs/ft^2 of cable tray surface area. There are no combustible liquids in the area.

3. VENTILATION PARAMETERS

There are four doors which enter the area. All doors measure 3' wide by 7' high. Two doors are located on the south wall, one door on the east wall and one door on the north wall.

4. CASES EXAMINED

Three cases were examined. Case number one considered all cables in the area burning simultaneously with one door open. Case number two considered all cables burning simultaneously with two doors open. Case number three considered all cables burning simultaneously with three doors open.

5. RESULTS

Case number one considered all cables burning simultaneously with a 3' x 7' door open. This resulted in a ventilation controlled fire with a heat output of 4504 kW, and a duration of 95 minutes. The gas temperature at this time would be 642°F which is below the critical temperature of the structural steel (see Attachment B).

Case number two considered all cables burning simultaneously with two 3' x 7' doors open. This resulted in a ventilation controlled fire with a heat output of 9008 kW and a duration of 46 minutes. The gas temperature at this

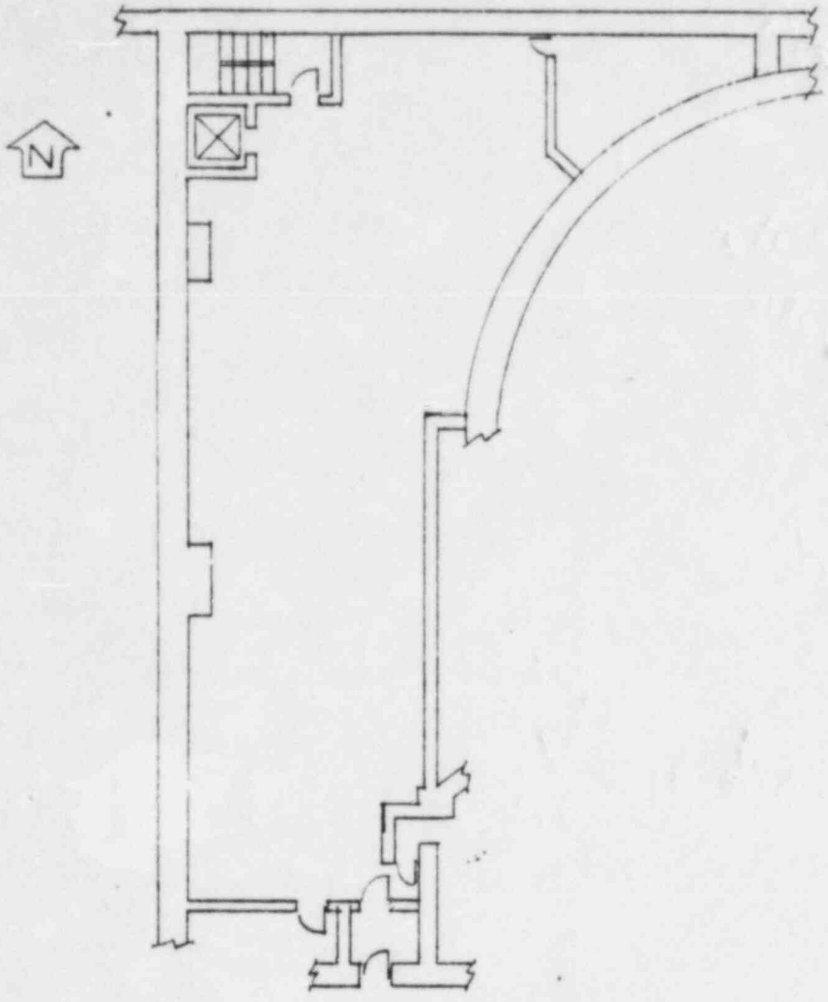
time would be 865°F which is below the critical temperature of the structural steel (see Attachment B).

Case number three considered all cables burning simultaneously with three 3' x 7' doors open. This resulted in a fuel controlled fire with a heat output of 12,078 kW and a duration of 3.5 lbs/ft^2 ÷ $\frac{.1 \text{ lbs}}{\text{min/ft}^2}$ = 35 minutes.

The gas temperature at this time would be 1000°F which is below the critical temperature of the structural steel (see Attachment B).

The position of cable trays relative to strucutral steel members were examined throughout the area in order to assess the potential for localized heating. Cable tray ICCTA is located within 12 inches of member types W30X99, W33X152, W27X84, W24X76, W24X68, W27X114, W21X44, and W21X55.

Attachment C contains the results of calculations performed to determine the respnse of the structural steel members to localized heating. These calculations are conservative because they assume that the entire length of the structural steel member is subjected to 1300°F when, in actuality, only a small section of the steel would be subjected to localized heating. As can be seen from the results, none of the members exceeded the single point failure temperature of 1300°F during the 35 minute exposure period (time required for tray to burn to completion).



Unit 1 Reactor Building El. 201'
Safeguard System Access Area Room 200

Surface Area Calculation

Walls		
North wall	(61' x 15')	894 ft^2
East wall	[(71' + 59') x 15']	1929 ft^2
South wall	(29' x 15')	393 ft^2
West wall	(123' x 15')	1765 ft^2
Ceiling		3630 ft^2
Total Surface Area for Heat Transfer		8611 ft^2

ATTACHMENT A

CASE NUMBER: 1
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: ONE DOOR OPEN ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	21.0	7.0	8611	4504

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
5	203
10	257
15	299
20	334
25	365
30	393
35	418
40	442
45	464
50	486
55	506
60	525
65	544
70	561
75	579
80	595
85	611
90	627
95	642

CASE NUMBER: 2
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: TWO DOORS OPEN ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	42.0	7.0	8611	9008

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
2	239
4	307
6	359
8	403
10	442
12	478
14	510
16	540
18	569
20	595
22	621
24	645
26	669
28	691
30	713
32	734
34	754
36	774
38	793
40	812
42	830
44	848
46	865

CASE NUMBER: 3
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: THREE DOORS OPEN ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	63.0	7.0	8611	12078

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
5	424
10	568
15	680
20	774
25	856
30	931
35	1000

CASE NUMBER: 1
BUILDING: UNIT 1 REACOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W21x44

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 44
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 4.94

TIME (min)	STEEL TEMPERATURE (deg.F)
5.00	614
10.00	918
15.00	1088
20.00	1182
25.00	1234
30.00	1263
35.00	1280

CASE NUMBER: 2
BUILDING: UNIT 1 REACOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W21x55

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 55
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 5.01

TIME (min)	STEEL TEMPERATURE (deg.F)
5.00	511
10.00	795
15.00	977
20.00	1093
25.00	1167
30.00	1215
35.00	1246

CASE NUMBER: 3
BUILDING: UNIT 1 REACOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W24x68

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 68
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 6.06

TIME (min)	STEEL TEMPERATURE (deg.F)
5.00	502
10.00	783
15.00	965
20.00	1083
25.00	1159
30.00	1209
35.00	1241

CASE NUMBER: 4
BUILDING: UNIT 1 REACOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W24x76

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 76
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 6.09

TIME (min)	STEEL TEMPERATURE (deg.F)
5.00	458
10.00	724
15.00	907
20.00	1031
25.00	1116
30.00	1174
35.00	1214

CASE NUMBER: 5
BUILDING: UNIT 1 REACOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W27x84

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 84
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 6.78

TIME (min)	STEEL TEMPERATURE (deg.F)
5.00	461
10.00	728
15.00	911
20.00	1035
25.00	1119
30.00	1177
35.00	1216

CASE NUMBER: 6
BUILDING: UNIT 1 REACOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W27x114

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 114
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 6.89

TIME (min)	STEEL TEMPERATURE (deg.F)
5.00	362
10.00	586
15.00	756
20.00	886
25.00	985
30.00	1060
35.00	1117

CASE NUMBER: 7
BUILDING: UNIT 1 REACOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W30x99

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 99
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 7.37

TIME (min)	STEEL TEMPERATURE (deg.F)
5.00	430
10.00	686
15.00	866
20.00	994
25.00	1084
30.00	1147
35.00	1192

CASE NUMBER: 8
BUILDING: UNIT 1 REACOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' SAFEGUARD SYSTEM ACCESS AREA
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W33x152

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 152
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 8.27

TIME (min)	STEEL TEMPERATURE (deg.F)
5.00	333
10.00	541
15.00	704
20.00	832
25.00	932
30.00	1011
35.00	1073

ATTACHMENT C