

PLC *Professional Loss Control, Inc.*

STRUCTURAL STEEL ANALYSIS

for

LIMERICK GENERATING STATION

Unit 1 Reactor Building El. 201'

Cooling Water HX Area Room 207

Fire Area 41

December 20, 1983

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LIMERICK GENERATING STATION

1. AREA DESCRIPTION

The area under consideration is the Cooling Water Heat Exchanger Area Room 207 on the 201' elevation of the Unit 1 Reactor Building (Fire Area 41). 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 8985 ft² (see Attachment A for sketch and calculation of surface areas).

2. COMBUSTIBLE LOADING

Combustible loading in this area consists of cable insulation located in cable trays. The total surface area of cable trays is 702 ft² with an average combustible loading of 3.5 lbs/ft² of cable tray surface area. There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

There are two doors which enter this area. Both measure 3' wide by 7' high. One door is located in the east wall and the other is located in the west wall and enters stair No. 2.

4. CASES EXAMINED

Two cases were examined, each assuming that all the cable trays in the area were burning simultaneously. Case number one assumed one door open while case number two assumed both doors open.

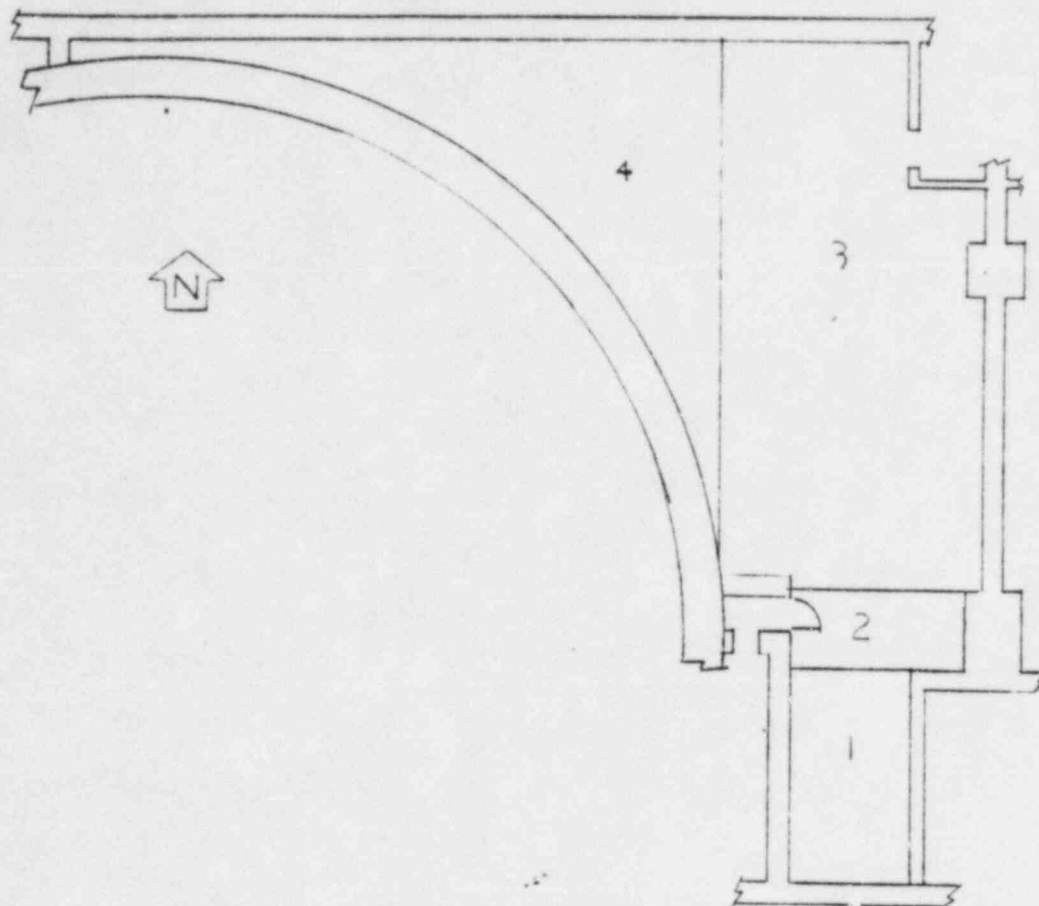
5. RESULTS

Case number one assumed all cables burning simultaneously with one 3' x 7' door open. This resulted in a ventilation controlled fire with a burning rate of 4504 kW and a duration of 90 minutes. The gas temperature at this time would be 601°F which is below the critical temperature of the structural steel (see Attachment B).

Case number two assumed all cables burning simultaneously with both 3' x 7' doors open. This resulted in a ventilation controlled fire with a burning rate of 9008 kW and a duration of 45 minutes. The gas temperature at this time would be 820°F which is below the critical temperature of the structural steel (see Attachment B).

The position of cable trays relative to structural members were examined throughout the area in order to assess the potential for localized heating. Cable tray 1DCQA is located within 12 inches of member types W27X84, W21X44, W18X40 and W27X102.

Attachment C contains the results of calculations performed to determine the response 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 a temperature of 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'
Cooling Water Heat Exchanger Area Room 207

Surface Area Calculation

Walls

| | | |
|------------|--------------|----------------------------|
| North wall | (95' x 15') | 1425 ft ² |
| East wall | (132' x 15') | 1980 ft ² |
| South wall | (33' x 15') | 495 ft ² |
| West wall | (105' x 15') | 1575 ft ² |
| | | <u>5475 ft²</u> |

Ceiling

| | | |
|--------|--------------------------|----------------------------|
| Area 1 | (12' x 48') | 576 ft ² |
| Area 2 | (19' x 11') | 209 ft ² |
| Area 3 | (29' x 74') - (18' x 8') | 2002 ft ² |
| Area 4 | 1/2(48')(32') | 768 ft ² |
| | | <u>3555 ft²</u> |

Total Surface Area for Heat Transfer 9030 ft²

CASE NUMBER: 1
 BUILDING: UNIT 1 REACTOR BUILDING
 ELEVATION AND AREA DESCRIPTION: 201' COOLING WATER HX AREA ROOM 207
 CASE DESCRIPTION: ONE DOOR OPEN ALL CABLES BURNING

| CEILING/WALL THICKNESS (ft) | CEILING/ WALL MATERIAL | Ao (ft2) | Ho (ft) | Aw (ft2) | Q (kW) |
|-----------------------------------|---------------------------|-------------|------------|-------------|-----------|
| 3.0 | CONCRETE | 21.0 | 7.0 | 9030 | 4504 |

FIRE IS FUEL CONTROLLED

| FIRE DURATION (min) | GAS TEMPERATURE (deg.F) |
|------------------------|----------------------------|
| 5 | 197 |
| 10 | 249 |
| 15 | 288 |
| 20 | 322 |
| 25 | 351 |
| 30 | 378 |
| 35 | 402 |
| 40 | 425 |
| 45 | 446 |
| 50 | 466 |
| 55 | 486 |
| 60 | 504 |
| 65 | 522 |
| 70 | 539 |
| 75 | 555 |
| 80 | 571 |
| 85 | 586 |
| 90 | 601 |

CASE NUMBER: 2
 BUILDING: UNIT 1 REACTOR BUILDING
 ELEVATION AND AREA DESCRIPTION: 201' COOLING WATER HX AREA ROOM 207
 CASE DESCRIPTION: TWO DOORS OPEN ALL CABLES BURNING

| CEILING/WALL THICKNESS (ft) | CEILING/ WALL MATERIAL | Ao (ft2) | Ho (ft) | Aw (ft2) | Q (kW) |
|-----------------------------------|---------------------------|-------------|------------|-------------|-----------|
| 3.0 | CONCRETE | 42.0 | 7.0 | 9030 | 9008 |

FIRE IS FUEL CONTROLLED

FIRE DURATION
(min)

GAS TEMPERATURE
(deg.F)

| | |
|----|-----|
| 5 | 322 |
| 10 | 425 |
| 15 | 504 |
| 20 | 571 |
| 25 | 630 |
| 30 | 683 |
| 35 | 732 |
| 40 | 778 |
| 45 | 820 |

CASE NUMBER: 1
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' COOLING WATER HX AREA ROOM 207
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W18x40

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 40
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 4.38

| TIME (min) | STEEL TEMPERATURE (deg.F) |
|---------------|------------------------------|
| 5.00 | 601 |
| 10.00 | 903 |
| 15.00 | 1075 |
| 20.00 | 1172 |
| 25.00 | 1227 |
| 30.00 | 1259 |
| 35.00 | 1277 |

CASE NUMBER: 2
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' COOLING WATER HX AREA ROOM 207
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: 3
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' COOLING WATER HX AREA ROOM 207
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: 4
BUILDING: UNIT 1 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 201' COOLING WATER HX AREA ROOM 207
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE W27x102

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (deg. F): 1300
WEIGHT OF STEEL MEMBER (lbs./ft): 102
SURFACE OF STEEL MEMBER HEATED (sq.ft./ft): 6.95

| TIME (min) | STEEL TEMPERATURE (deg.F) |
|---------------|------------------------------|
| 5.00 | 395 |
| 10.00 | 635 |
| 15.00 | 811 |
| 20.00 | 941 |
| 25.00 | 1036 |
| 30.00 | 1106 |
| 35.00 | 1158 |