PHILADELPHIA ELECTRIC COMPANY

PEACH BOTTOM ATOMIC POWER STATION
UNITS 2 & 3

STRUCTURAL STEEL SURVIVABILITY EVALUATION

APPENDIX 2

SEPTEMBER 16, 1983

Structural Steel Survivability Evaluation

A. Introduction:

Appendix R Section III G.2.A States:

"Separation of cables and equipment and associated non-safety circuits of redundant trains by a fire barrier having a 3-hour rating. Structural steel forming a part of or supporting such fire barriers shall be protected to provide fire resistance equivalent to that required of the barrier."

The goal of our evaluation was to verify that unprotected structural steel supporting plant fire barriers is capable of maintaining structural integrity during worst case expected fire conditions thereby providing a "fire resistance equivalent to that required of the barrier."

B. Description:

The structural slabs at Peach Bottom are typically composite construction, i.e. structural steel beams or girders supporting, and interconnected to, a reinforced concrete slab. The structural supports are either partial or total composite construction. All members are end-restrained.

Fire barriers supporting or located above safe shutdown areas were evaluated. Any additional barriers identified during our plant upgrade modifications (re-routing cable etc.) will be evaluated using the same methodology.

The following items supporting the evaluation are attached:

1. Methodology for Evaluation of Fire Resistance of Structural Steel
2. Summary of Assumptions
3. Summary of Conservatisms
4. Calculation Summary
5. Structural Steel Analysis Calculations for 31 Plant Areas

C. Acceptance Criteria:

A critical steel temperature of 1477 F was used in the evaluation. This temperature is based on published test data and is an average of the temperatures recorded for tests performed on various beam/slab assemblies. Additional industry standards (AISC, A151) researched refer to the general temperature acceptance criteria of ASTM standard E119; however, the temperatures derived through actual testing better

represent end restraint conditions and composite construction at Peach Bottom. It has been demonstrated that unrestrained beam/slab assemblies have lower fire endurance than restrained assemblies, and composite action will prolong fire endurance. The beam sizes and slab thicknesses for the assemblies tested are typically smaller than those existing at Peach Bottom. Applying the test data is conservative since the larger steel members and thicker slabs at Peach Bottom have additional heat capacity.

The 1477 F temperature is applicable to partial composite construction, but has been used as the acceptance criteria for all structural steel members. It is therefore conservative when evaluating full composite beam/slab assemblies.

The critical steel temperatures were determined by testing beam/slab assemblies that were loaded to approximately 50%-60% of yield stress. The structural members at Peach Bottom were designed to an allowable value of 60% of yield stress but include a specified live load. Actual stresses will be significantly lower than 60% of yield stress.

D. Summary:

Thirty-one areas have been evaluated, in cases such as the Battery Rooms and Switchgear Rooms one calculation was run to represent all cases since these rooms are very similar. Where Unit 2 was similar to Unit 3 the worst case combustible loading was used to represent both. Gas temperatures were computed representing consumption of all combustibles in the defined areas. Local hot spot heat fluxes were evaluated for areas where particular trays were in close proximity to exposed structural members. When computed gas temperatures were below the acceptance criteria, steel temperatures were not computed. Steel temperatures were computed for areas where the gas or local temperatures were above the acceptance criteria.

The calculations included conversatisms identified in the methodology as well as the following:

1. Openings defined for ventilation controlled fires were typically based on architectural layout and in many cases electrically supervised fire barrier doors or watertight doors were assumed to be open when a fire started. Several cases were refined to reflect realistic conditions and in such cases gas temperatures representing one or two doors open for a ventilation controlled fire were calculated.

2. The localized temperatures which were computed did not take into effect conduction down the length of a beam. Generally the localized effect was only for a width of 2-3 feet, while the gas temperature in the room was several hundred degrees lower that the hot spot.

3. The calculation results were run for fire duration or a minimum of 3 hours. Credit is warranted for manual suppression by the fire brigade inside a 30 minute timespan.

Calculated gas and local temperatures for twenty-seven of thirty-one areas met the acceptance criteria. The following problem areas were identified:

1. Turbine Building - Elevation 116' - Common Area-Calculation #24. This area exhibited a gas temperature of 404 F after 3 hours however a single tray produced localized temperatures which were above the acceptance criteria in 35-40 minutes. We propose to encapsulate the entire tray in a 3-hour fire resistant material.

2. Battery Rooms - Calculation #31.

   The battery rooms presented the most severe fire conditions. The structural steel acceptance temperatures were reached very rapidly. The case of one door open produced a gas temperature of 1578 F within 30 minutes. This is 100 F above the acceptance criteria. We propose no modifications for this area for the following reasons:

   a. The existing batteries with polystyrene cases are being replaced with new batteries having polycarbonate cases. U.L. testing of polycarbonate sheets yielded a flame spread rating of 10. This replacement will significantly reduce the hazard associated with the battery cases. The Unit 2 battery cases will be changed out during the spring 1984 refueling outage. The Unit 3 battery cases will be changed out at the next refueling outage scheduled for January 1985.

   b. The battery rooms are provided with automatic smoke detection.

   c. Due to fire barrier maintenance and security the Battery Room doors are maintained closed, therefore the 1 door open fire scenario is extremely conservative.

   d. The availability of manual suppression equipment and rapid fire brigade response will greatly reduce any possibility of a serious fire.

3. Cable Spreading Room - Calculation #23. The Cable Spreading Room is a critical area and the ceiling is a fire barrier however, due to alternative shutdown it will no longer be a safe shutdown barrier. The Cable Spreading room exhibited gas temperatures of 1100 F with two doors open and 586 F with one door open, neither of which should be the case due to security control of access, self closing doors and fire barrier maintenance. Localized temperatures were marginally above the acceptance criteria. One of five cases examined was 10 F above the acceptance temperature and a second was 22 F above. We propose no modifications since 1) the two door open fire scenario is extremely conservative, and 2) there are 23 smoke detectors and an automatic carbon dioxide system that will provide quick detection and suppression to mitigate a problem.

4. Computer Room - Calculation #25. This area is similar to the Cable Spreading Room. The gas temperature only reached 185 F, however one local condition resulted in temperatures 8 F above the acceptance criteria at the 175 minute mark of the fire. Again, the barrier under consideration is not a safe shutdown barrier but is in a critical area. We propose no modifications because of the existance of smoke detection, a manual carbon dioxide system and the expected rapid response of the fire brigade.

Conclusion:

After completion of the modifications as stated above the structural steel of the analyzed fire barriers will provide a fire resistance equivalent to that required of the barrier.

7/5

Methodology

for

Evaluation of Fire Resistance of Structural Steel

INTRODUCTION

A simple yet reliable procedure for evaluating the fire effects of structural steel is proposed using well established and accepted current methodology and available fire test data. The problem of evaluating the response to fire exposure of structural steel has two distinct parts: identifying (quantifying) the fire exposure and assessing the effects on the steel. The approach described below successfully treats the problem in a systematic method making use of simple and conservatively realistic fire models and heat transfer calculations.

FIRE MODELING

Many models of varying complexity have been developed to predict the growth, spread, peak temperature and/or time temperature history of a fire. The more complex models which deal with the fire from ignition to decay require significant input data about both the fuel and room geometry. The complexity of these models and the need for making assumptions where test data is not available make the application and subsequent review of the result difficult for engineers not extremely familiar with the models.

If realistic but conservative assumptions are made and available test data are used, simplified approximations of fire behavior can be made which

provide good estimates of peak temperature and/or time temperature history of the fire. The first step in this process is to determine the controlling mode of combustion. Coulbert[1] identifies five (5) modes which he calls "energy release criteria" as follows:

1. Flame Spread Rate
2. Fuel Surface Area Limit
3. Ventilation Limit
4. Enclosure Volume
5. Fuel Load

For the purposes of the procedure described below, these constraints are used as follows:

1. Flame Spread Rate - based on test data on cable fires from Sandia Laboratories, FMRC/EPRI, and real cable fires such as Browns Ferry and San Onofre, flame spread rates can be used to estimate the time to a fully developed fire. For the purposes of this procedure, a fully developed fire is assumed to occur immediately.
2. Fuel Surface Area Limit - based on FMRC/EPRI data realistic prediction of fuel surface area combustion rates can be applied to numbers of cable trays involved to establish a heat release rate for fuel surface controlled fires. The extent (size) of the fire is selected based on the location and amount of fixed combustibles in an area (i.e., cable insulation).
3. Ventilation Limit - the ventilation available through openings can be determined to assess the heat release rate for ventilation controlled fires.

4. Enclosure Volume - should all natural and forced ventilation be terminated, this limit criteria determines fire duration based on available O_2 to support combustion. A relationship between size (heat release rate) and duration can be calculated for a fixed volume.

5. Fuel Load - with ventilation supplied, this criteria determines fire duration.

Fuel Controlled Fire

For fuel surface controlled fires, a realistic empirical method has been developed by the National Bureau of Standards[3] for estimating room temperature. This method calculates an upper level gas layer temperature based on correlation of more than 100 sets of test data to basic plume theory. Plume theory relates the ceiling layer temperature rise, T, to the heat release rate Q and the height above the fire H as follows:

$$\Delta T \propto Q^{2/3} \cdot H^{-1/3}$$

Using the premise that in a developing, fuel controlled fire, the fire behavior was similar to a plume the authors sought a power law relationship relating ΔT to heat released and heat loss in the following form:

$$\Delta T = C \left(\frac{Q}{\sqrt{g}\, C_p\, \rho\, T_o\, A_o \sqrt{H_o}} \right)^N \cdot \left(\frac{h_k\, A_w}{\sqrt{g}\, C_p\, A_o \sqrt{H_o}} \right)^M$$

Correlating this form to 112 separate experiments on a variety of fuels, the authors propose the convenient form:

$$\Delta T = 480\ X_1^{2/3}\ \cdot\ X_2^{-1/3}$$

$$\text{Where } X_1 = \frac{Q}{\sqrt{g}\ C_p\ \rho\ T_o\ A_o\sqrt{H_o}} \quad \text{and} \quad X_2 = \frac{h_k\ A_w}{\sqrt{g}\ \rho_o\ C_p\ A_o\sqrt{H_o}}$$

Q is established by evaluating the number of cable trays involved and related tray surface area. Next h_k must be evaluated. The value of h_k will be determined by the wall materials and thickness, and the fire development time. For a long slow developing fire in a thin walled enclosure, h_k is best approximated by steady state conduction through the wall and ceiling, $h_k = \frac{k}{\delta}$. For a fast developing short duration fire in a thick walled enclosure, h_k is best approximated using the thermal inertia (assumption of semi-infinite solid), $h_k = \sqrt{\frac{\rho C_p K}{t}}$. The semi-infinite solid approach is most appropriate for nuclear power plant enclosures because of the massive barriers. Q and h_k are inputed with the ventilation opening data to calculate X_1 and X_2 and subsequently ΔT.

Ventilation Controlled Fires

For ventilation limited fires, a simplification of the methods proposed by Babrauskas and Williamson[4] as modified by Berry[5] will be used. The conservative assumption allowing the simplification are as follows:

1. Convective and Radiative loss through openings in the enclosure are negligible (see Berry[5]).
2. Heat loss through the walls will be dominated by the thermal inertia of the barriers, $\rho\ C_p\ k$ (assumption of semi-infinite slab approximation).

The heat balance equation can be described as follows:

$Q = 1580\ A_o\sqrt{H_o}$ = heat release rate (kw)

$Q = \sigma A_t\ \eta\ (T_g^4 - T_w^4)$ = radiant heat transferred to boundary

$Q = \frac{\sqrt{\pi\ \rho\ C_p\ k}}{2\sqrt{t}}\ A_t\ (T_w - T_o)$ = conductive heat loss through boundary

To get T_g as a function of t these equations can be solved to yield the following expression:

$$T_g = \left[\frac{Q}{\alpha A_t \eta} + \left(T_o + \frac{Q\sqrt{t}}{A_t K}\right)^4\right]^{1/4}$$

where $Q = 1580\ A_o\sqrt{H_o}$

$K = 1/2\sqrt{\pi\ k\ \rho\ C_p}$

η = function of emissivity of fire gases and boundary walls

A_t = total heat loss surface area of boundary

This relationship is similar in form to that developed by Harmathy[6] except the heat release rate is defined by the ventilation factors. A time temperature history can be calculated for $0<t<\tau$ where τ = duration.

Fire Duration

The fire duration is determined either by the limit of fuel loading or enclosure volume. For a fuel loading limited fire, the duration is calculated taking the amount of combustibles and dividing by the heat release rate:

For enclosure volume limited fire, the duration is calculated by taking the available oxygen for combustion and dividing by the heat release rate:

$$\tau = \frac{\text{Constant (Volume of Enclosure)}}{Q}$$

Computer Calculation

The steps outlined below describe how the program calculates the controlling mode of combustion and fire exposure to the steel. These steps are also shown in Figure 1.

Step 1 Input Data

Data is developed for input based on the following:

Q_{as} - the fuel surface area limited heat release rate is estimated taking the surface area of cable trays involved using natural breaks in continuity of combustibles as the limit on fire extent. The free burning heat release rate is applied to this area to calculate Q_{as}.

The best available data on free burning cable trays containing neoprene jacket cables appears in the FMRC/EPRI([2]) test reports. For these cables a mass burning rate of 6.7 kg/min was measured for an array of 12 cable trays, each 8' long and 18" wide. This reduces to a surface controlled burning rate of 0.1 lb/min ft^2 of cable tray or a heat release rate of 1000 BTU/min ft^2 (190 KW/m^2). These results are realistic and compare favorably with other test data on solid fuels such as wood cribs. This unit heat release will be used in the modeling method described below.

A_w - The heat loss surface area consists of all wall and ceiling surfaces. The conservative assumption of negligible heat loss through the floor is applied by excluding the floor area in A_w.

A_o - The area of openings is taken from drawings. Various combinations of door openings or other openings in walls can be applied to determine worst case ventilation conditions.

H_o - The height of the openings is taken from drawings.

V_e - The volume of the enclosure is calculated using the geometry of the sealed enclosure. In the case of Reactor Buildings, previously established building volumes are used.

τ Fuel Load - The duration of the fire based on fuel load in the involved cable tray or τ Fuel load = $\frac{\text{combustible per ft}^2 \text{ tray}}{\text{.1 lb per min per ft}^2 \text{ tray}}$ = minutes

Step 2 Calculate Q vent = $1580\ A_o\sqrt{H_o}$

Step 3 Compare Q vent to Q_{as}

If Q vent $>$ Q_{as} the fire is fuel surface controlled: go to Step A4

If Q_{as} $>$ Qvent the fire is ventilation controlled: go to Step B4

Step A4 Calculate enclosure volume limited duration

$$\tau_{vol} = \frac{29\ V_e(m^3)}{Q_{as}(kw)} \text{ in minutes}$$

Step A5 Use lower of τfuel load or τ_{vol}.

Step A6 Calculate $\Delta T = 480\ (X_1)^{2/3}\ X_2^{-1/3}$ (°C) and convert to °F

Step A7 Compare $\Delta T + T_o$ to T_{cr} for steel

If $\Delta T + T_o < T_{cr}$ steel passes

If $\Delta T + T_o > T_{cr}$ steel fails

Step B4 Calculate enclosure volume limited duration

$$\tau_{vol} = \frac{29\ V_e\ (m^3)}{Qvent\ (kw)} \text{ in minutes}$$

Step B5 Use lower of τfuel load or τ_{vol}

Step B6 Calculate $T_g = \left[\frac{Q}{\sigma A_t \eta} + \left(To + \frac{Q\sqrt{t}}{A_t K}\right)^4\right]^{\frac{1}{4}}$ for $0<t<\tau$

Step B7 Compare T_{max} to T_{cr} for steel

If $T_{max} < T_{cr}$ steel passes

If $T_{max} > T_{cr}$ calculate time to T_{cr} using $\Delta T = 231 \frac{U}{G} (\bar{T}-T_1) \Delta t$

per Stanzak

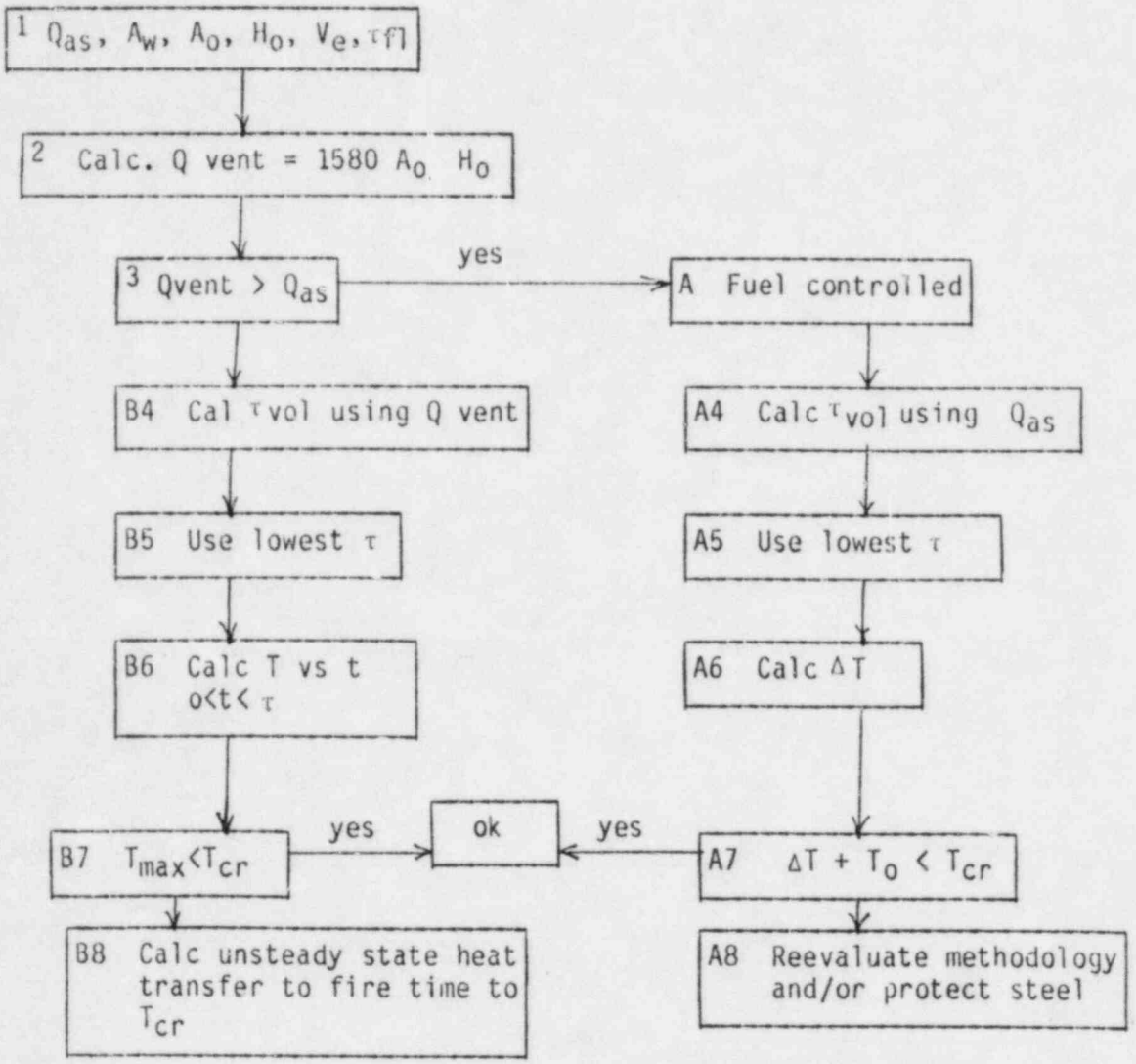
1 Q_{as}, A_w, A_o, H_o, V_e, τ_{fl}
2 Calc. Q vent = 1580 A_o H_o
3 Qvent > Q_{as}
yes
A Fuel controlled
B4 Cal τ_{vol} using Q vent
A4 Calc τ_{vol} using Q_{as}
B5 Use lowest τ
A5 Use lowest τ
B6 Calc T vs t
$o<t<\tau$
A6 Calc ΔT
B7 $T_{max}<T_{cr}$
yes
ok
yes
A7 $\Delta T + T_o < T_{cr}$
B8 Calc unsteady state heat transfer to fire time to T_{cr}
A8 Reevaluate methodology and/or protect steel

Figure 1

RESPONSE OF STEEL

The evaluation of the steel is a two part problem. The first part is to establish a T_{cr}(critical temperature) where the strength of the steel is reduced to the point of failure. This can be determined from references in the literature or can be calculated given the static loading using a procedure outlined by Stanzak[7]. The second part is to compare the fire temperature with the T_{cr} for the steel. In the case of the hot layer temperature calculated for the fuel controlled fire, the accpetance criteria will be $T_g < T_{cr}$. In the case of the ventilation controlled fire, the unsteady state heat transfer calculation outlined by Stanzak[7] will be used to determine the steel temperature. This equation is as follows:

$$\Delta T_{steel} = 231 \frac{U}{G} (\bar{T}_g - T_i) \Delta t$$

where $\frac{U}{G}$ is the surface area to mass ratio of the steel

$\bar{T}_g$ is the average fire temperature in time interval

T_i is steel temperature at the start of interval

Δt is time interval in minutes

References

1. Clifford D. Coulbert, "Energy Release Criteria for Enclosure Fire Hazards Analysis--Part I," Fire Technology, Volume 13, No. 3., August 1977.

2. FMRC, "Categorization of Cable Flammability, Intermediate Scale Fire Tests of Cable Tray Installations," Electric Power Research Institute, EPRI NP-1881, August 1982.

3. B.J. McCaffrey, et. al., "Estimating Room Temperature and the Likelihood of Flashover Using Fire Test Data Correlations," Fire Technology, Volume 17, No. 2, May 1981.

4. V. Babrauskas and R.B. Williamson, Post-Flashover Compartment Fires, University of California, Berkeley, Report No. UCB FRG 75-1, December 1975.

5. D.L. Berry, E.E. Minor, "Nuclear Power Plant Fire Protection--Fire Barriers (Subsystem Study Task 3)," Sand 78-1990, NUREG/CR-0468, Sandia National Laboratories, September 1979.

6. T.Z. Harmathy, "A New Look at Compartment Fires, Part II," Fire Technology, Volume 8, No. 4, November 1972.

7. W.W. Stanzak (translator), "The Calculation of the Fire Resistance of Steel Construction," National Research Council of Canada, Technical Translation 1425, March 1971.

Summary of Assumptions

NBS

The application of the NBS empirical method for hot layer gas temperature is based on the following assumptions:

1. The correlation holds for upper layer gas temperatures up to approximately 600 °C (1100°F).
2. The wall thermal penetration time t_p is greater than the characteristic fire growh time, t_c. For the large concrete barriers t_p is calculated to be 7 to 10 hours. This verifies the semi-infinite solid heat transfer assumption.
3. Heat loss area for the boundries is taken to be the walls and ceiling. Heat loss through the floor is considered negligible.

Ventilation Controlled Method

The application of the ventilation controlled fire method is based on the following assumptions:

1. Convective or radiative heat losses through openings in the enclosure are negligible.
2. Heat transfer through the boundries is calculated using the semi-infinite solid assumption.
3. Heat loss through the floor is considered negligible.

General Assumptions for Input Data

1. The development of input data requires assumption regarding the size and duration of a fuel surface area controlled fire. The size of the fire, Q_{as}, is estimated by evaluating natural breaks in continuity of combustibles. Where these natural breaks exist, a heat release rate involving the number and size of trays is calculated. The duration of the fire is based on the cable loading in the involved trays and the mass burning rate as determined by test.

2. The heat of combustion of the hypalon jacketed cable is assumed to be 9950 Btu/ft. The literature values for the XLPE/Cl.S.PE from the EPRI small scale test (EPRI NP-1200) range from 6000 to 7500 Btu/ft.

Summary of Conservativisms

1. No convective heat loss for ventilation controlled fires.
2. No radiation heat losses through openings.
3. No conductive heat losses through floor.
4. Cable heat release rates are based on large scale tests using conservative heat of combustion.
5. Fuel surface area controlled fires are taken as conservatively large fires.

Special cases:

A special case exists in large open areas with ill defined ventilation openings. For large open areas, the NBS empirical methodology has not been verified. In such cases the heat balance equations used for ventilation controlled fires are applied by redefining the heat release rate, Q, as a fuel surface area limited fire.

Another special case exists where no natural break in combustibles exists and ventilation openings are ill defined. In this case the heat balance equations used for ventilation controlled fires are applied as above with the heat release rate, Q, established by a conservative initial fire, the spread of that fire for the duration or burnout of the initial fire. For example, assuming some spread of a cable fire down a group of trays, (i.e. 7-10 ft/hour based on tests and fire loss data), the fire will spread from its initial size to a steady state size reached when the initial fire burns out. The time of the initial burnout is the weight of combustibles per unit area of tray divided by the rate of combustion (i.e. if the weight of combustibles is 5 lb/ft^2 of tray, and the rate of combustion is 0.1 $lb/min/ft^2$ the initial burnout will occur at about 50 minutes). The steady state size would be defined based on the cable tray configuration.

The above two special cases will apply to some of the open areas in the Reactor Building. The sample calculation describes a typical example of this approach.

CALCULATION SUMMARY

Calculation Numbers	Area	Gas Temperature (Acceptance Criteria 1477 F)	Local Effects
1	Radwaste Bldg. El. 88' Unit 2 RCIC Pump Room	769	No
2	Radwaste Bldg. El. 91'6" Standby Gas Treatment Room	136	No
3	Radwaste Bldg. El. 91'6"-135' Unit 3 RHR Heat Exchanger and Pump Room	917	No
4	Unit 2 Reactor Bldg. El. 91'6" + 116' Torus Area	94	No
5	Unit 2 Reactor Bldg. El. 91'6" + 116' RHR Heat Exchanger and Pump Room	961	No
6	Unit 2 Reactor Bldg. El 91'6" + 116' RHR Heat Exchanger and Pump Room	1077	No
7	Unit 2 Reactor Bldg. El. 116' North Vacuum Breaker Area	715	No
8	Unit 2 Reactor Bldg. El. 116' South Vacuum Breaker Area	723	No
9	Unit 2 Reactor Bldg. El. 135' North of Reactor Center Line	705	No
10	Radwaste Bldg. El. 135' Medical Station and Corridor	930	No
11	Radwaste Bldg. El. 150' Radwaste H&V Equipment Compartment	246	No
12	Unit 2 Reactor Bldg. El. 165' MG Set Vent Supply Fans	No Combustibles	No
13	Unit 3 Reactor Bldg. El. 165' MG Set Vent Supply Fans	No Combustibles	No
14	Unit 2 Reactor Bldg. El. 195' West of Reactor Center Line	145	No
15	Unit 2 Reactor Bldg. El. 195' East of Reactor Center Line	366	No
16	Unit 2 Reactor Bldg. El. 195' + 214' Ventilating Equip. Area + Fan Room	625	No
17	Radwaste Bldg. El. 116' Unit 3 Cooling Water Equipment Room	975	No
18	Radwaste Bldg. El. 135' Personnel Decontaminatin Station	600	Yes, see calculation

CALCULATION SUMMARY

Calculation Numbers	Area	Gas Temperature (Acceptance Criteria 1477 F)	Local Effects
19	Radwaste Bldg. El. 135' Unit 2 Reactor Recirc Pump MG Set Room	1200	No
20	Turbine Bldg. El. 135' Switchgear Room	1438	No
21	Unit 2 Reactor Bldg. El. 165' South of Column Line 10	1027	No
22	Radwaste Bldg. El. 165' Remote Shutdown Panel Area	802	No
23	Turbine Bldg. El. 150' Cable Spreading Room	1099	Yes, see calculation
24	Turbine Bldg. El. 116' Common Equipment Area	405	Yes, see
25	Turbine Bldg. El. 150' Computer Room	184	Yes, see calculation
26	Pump Structure El. 112'	994	No
27	Diesel Generator Bldg. El. 127' Diesel Generator Room	1433	No
28	Diesel Generator Bldg. El. 127' Fuel Transfer Room	1404	No
29	Radwaste Bldg. El. 88' Unit 2 Reactor Sump Room	1150	No
30	Radwaste Bldg. El. 88' HPCI Pump Room	1278	No
31	Turbine Bldg. El. 135 Battery Room	3550	No

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 2

Radwaste Building El. 88'

RCIC Pump Room

Room 7 Fire Zone 60

September 12, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Radwaste Building El. 88' RCIC Pump Room (Room 7, Fire Zone 60) (see Attachment A for the area under consideration.) Bounding walls of the area are reinforced concrete with an average thickness of 2.5 ft. Total surface area of boundary walls and ceiling is 4164 ft^2 (387 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

The combustible loading used for the calculations in the area consist of 399 lbs of cable insulation and 5 gallons of oil the total surface area of cable trays is 152 ft^2 with an average cable combustible loading of 2.6 lbs/ft^2.

3. VENTILATION PARAMETERS

Two doors serve this area each measuring 3' x 7'. One door is located in the east wall and the other in the west wall. These two openings allow a ventilation opening of 42 ft^2.

The total volume of air available in the room for combustion is 2289 m^3. The curve in figure 1 shows the duration of a fire at a given heat output with the available air in the room. The curve indicates that there is only enough air to burn all the cable insulation, but not enough to consume all the cable and oil without additional ventilation.

4. CASES EXAMINED

The limiting factor which will determine the combustion of all materials in the room is ventilation (see Figure 1). With two doors open the maximum heat release rate fire in the room is 9008 kW. This size fire is represented when all the cables in the room are burning simultaneously (2687 kW) and an oil spill fire of 20 ft^2 (6321 kW) is burning at the same time. An oil fire of this size consumes 2.5 gpm of oil. At this rate the 5 gallons of oil would be consumed in 2 minutes, assuming an adequate surface area of oil is exposed. After this time the fire would be limited by the fuel surface area of the cable trays. The maximum heat

release fire would then be 2687 kW until all the cable was consumed. This would take another 24 minutes. The overall fire duration would be 26 minutes (see Attachment B).

The second case considers the localized heating of steel members in the centerline of the oil spill fire plume.

5. RESULTS

The case examined a 9008 kW fire (cable and oil) for 2 minutes and then continued with a 2687 kW fire for another 24 minutes until the remaining cable was consumed. The results indicate that the maximum ceiling gas temperature reached during the 26 minute duration of the fire is 769°F (see Attachment C). This temperature is not sufficient to fail the structural steel in the area.

There are no cables located within 3 feet of any structural steel, therefore, localized heating from a cable fire is not a factor.

The second case looked at localized heating of steel members when located in the centerline of the oil fire plume. These calculations show that at a ceiling height of 27 ft, using the oil fire described, the plume centerline temperature would be 514°F. This temperature indicates that the critical steel temperature will not be exceeded due to localized heating.

A detailed analysis of the steel will not be performed.

Heat Output Duration for Available Air in Room

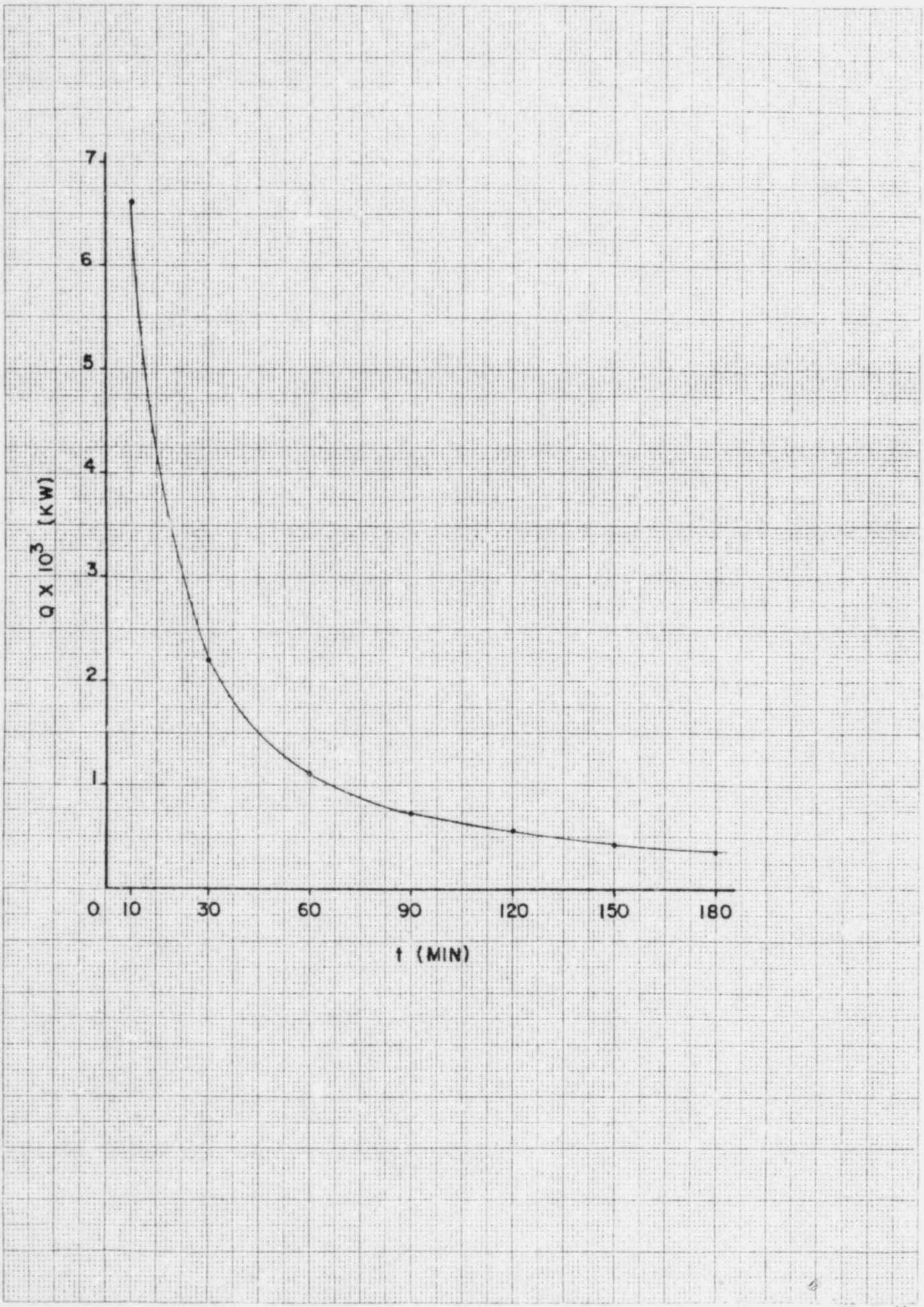

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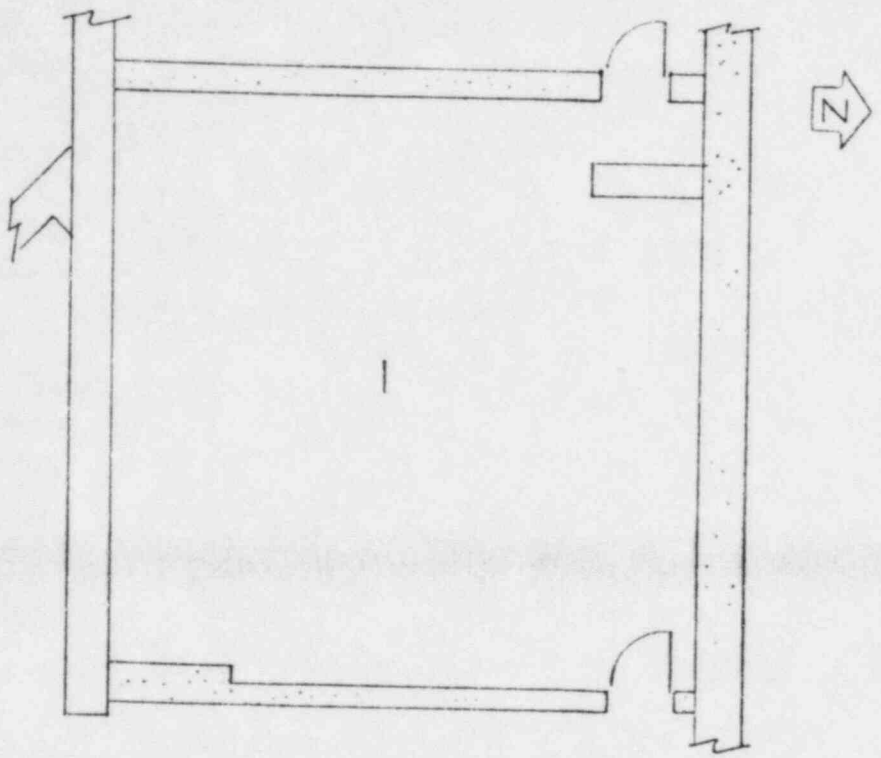
Figure 1



Unit 2 RCIC El. 88'

Surface Area Calculation

Walls

North wall	(27' x 31')	837 ft^2
South wall	(27' x 31')	837 ft^2
East wall	(27' x 30') - (3' x 7' door)	789 ft^2
West wall	(27' x 30') - (3' x 7' door)	789 ft^2
		3252 ft^2

Ceiling

(30' x 31') - (1' x 6' wall) - (2' x 6' wall)	912 ft^2
Total Surface Area for Heat Transfer	4164 ft^2 (387 m^2)

ATTACHMENT A

Cable Trays

Cable trays considered to be burning simultaneously:

Horizontal Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
ZA2MA200	14	24	28
ZA2MA210	24	24	48
ZB2MA020	32	24	64
ZA2MA220	2	24	4
ZA2MA030	2	24	4
Vertical Tray No.			
ZA2MV780	2	24	4
			152

$$\text{Heat Release} = \frac{152\ ft^2}{10.75\ ft^2/m^2} \times 190\ kW/m^2 = 2687\ kW$$

$$\text{Fire Duration of Cables} = 2.6\ lb/ft^2 \div \frac{0.1\ lb}{min\ ft^2} = 26\ \text{minutes}$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: RADWASTE UNIT 2
ELEVATION AND AREA DESCRIPTION: 88' EL. RCIC PUMP ROOM
CASE DESCRIPTION: TWO DOORS CABLE 5 GAL OIL

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	42	7	4164	9008

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
1	316
2	416

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	42	7	4164	2687

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
3	488
4	518
5	541
6	560
7	577
8	593
9	607
10	620
11	632
12	644
13	655
14	666
15	676
16	686
17	695
18	704
19	713
20	722
21	730
22	738
23	746
24	754
25	762
26	769

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Units 2, 3

Radwaste Building El. 91'6"

Standby Gas Treatment Room

September 12, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Units 2, 3 West end of the Radwaste Building at the 91'6" elevation (Room 33, Fire Zone 70) (see Attachment A for sketch of area). Bounding walls of area are reinforced concrete with an average thickness of 3 ft. Total surface area of the bounding walls and ceiling 11,795 ft^2. (See Attachment A for a calculation of heat loss surface area.)

2. COMBUSTIBLE LOADING

The combustibles in this area consist of cable insulation and filter material. The filter material has been neglected in this analysis because it will not contribute to the heating of the room since it is enclosed. The heat release of the cable insulation will be the largest source of heating in the room.

The total surface area of cables in this area is 98 ft^2 with an average combustible loading of 1.51 lb/ft^2. A listing of the cable trays under consideration is included in Attachment B. There are no significant combustible liquids in this area.

3. VENTILATION PARAMETERS

There are two openings considered in this study. They are both doors with an opening size of 3' x 7' for a total ventilation area of 42 ft^2. One door is located at the far northeast corner. The other door leads to a stairway through the east wall of the area.

The total volume of air available for combustion within the room is 1592 m^3. The curve in figure 1 shows the fire duration (min) for a given heat output (kW) given only the volume of air in the room for combustion.

4. CASES EXAMINED

With the light combustible loading in this area, the assumption that all cables are burning simultaneously presents the worst case fire. With all cables burning, a surface area of 98 ft^2 would be involved.

This corresponds to a heat output of approximately 1732 kW. The duration of such a fire will be

$$1.51 \text{ lbs/ft}^2 \div \frac{0.1 \text{ lbs}}{\text{min ft}^2} = 15 \text{ minutes}$$

Figure 1 shows that the volume of air in the area will not have an effect on the fire duration since there is sufficient air in the room only to support a 3000 kW fire for 15 minutes. The fire will be fuel controlled.

5. RESULTS

With the worst case assumption that all the cable trays in the area are burning simultaneously with ventilation openings of 42 ft^2, the fire was determined to be fuel controlled. The gas temperature at the ceiling would be 136°F (see Attachment C) which is not sufficient to fail the structural steel in the area.

There are no cables located within 3 feet of any structural steel, therefore, localized heating is not a factor. The critical steel temperature will not be exceeded so a detailed analysis of the steel will not be performed.

Heat Output Duration for Available Air in Room

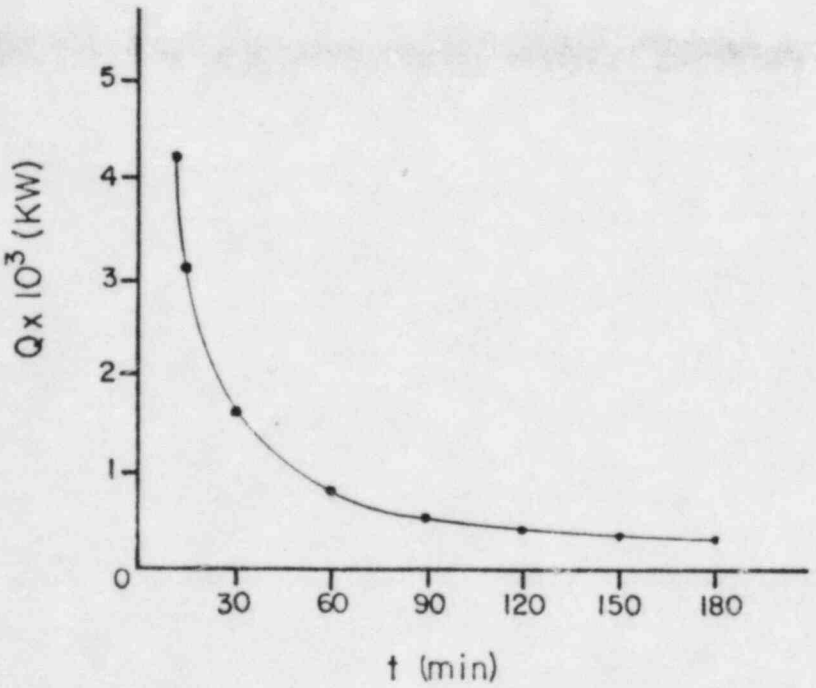
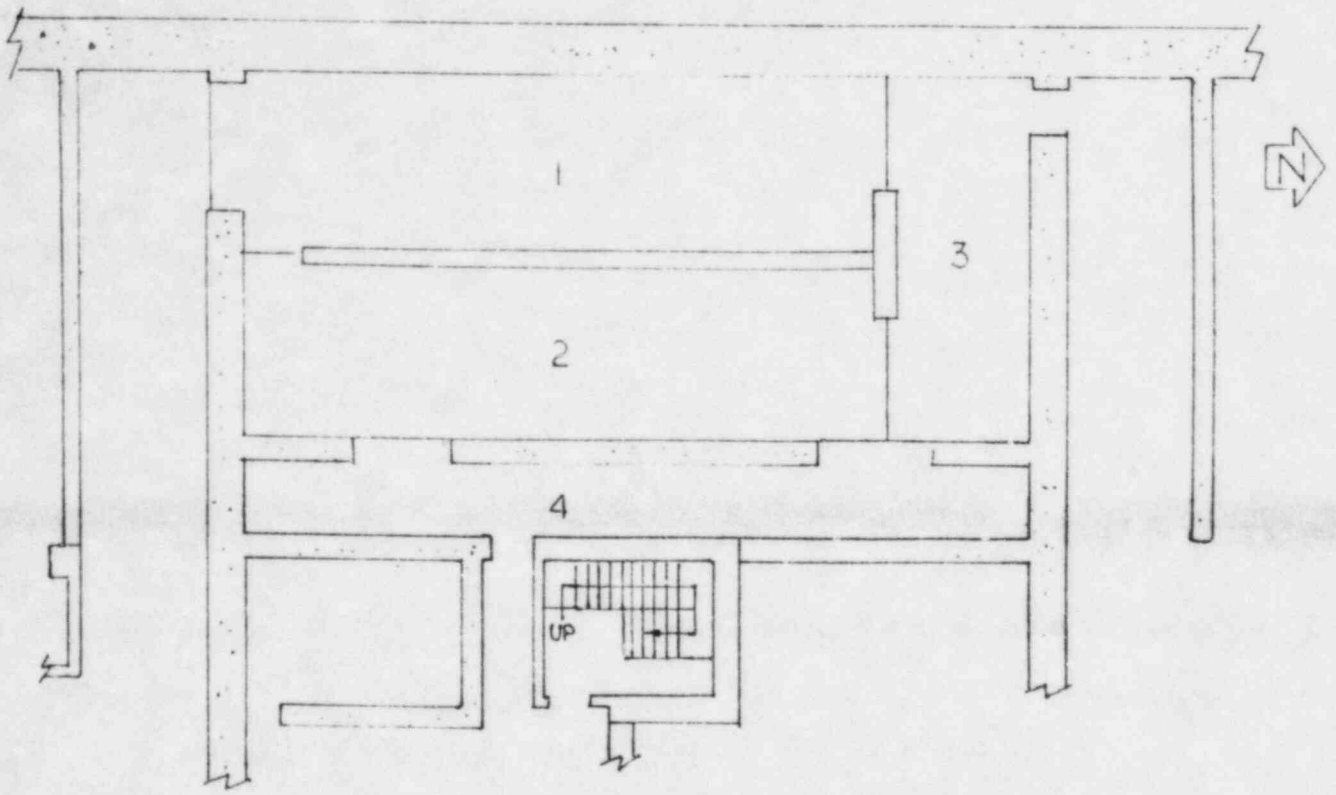


Figure 1



Units 2 & 3 SGT Room El. 91'6"

Surface Area Calculation

Walls		
North wall area 1	(23.5' x 5')	117.5 ft^2
South wall area 1	(23.5' x 5')	117.5 ft^2
East wall area 1	(23.5' x 50')	1175.0 ft^2
West wall area 1	(23.5' x 56')	1316.0 ft^2
North wall area 2	(23.5' x 5')	117.5 ft^2
South wall area 2	(23.5' x 14')	329.0 ft^2
East wall area 2	(23.5' x 38')	893.0 ft^2
West wall area 2	(23.5' x 48')	1128.0 ft^2
North wall area 3	(23.5' x 30') - (3' x 7' door)	684.0 ft^2
South wall area 3	(23.5' x 12')	282.0 ft^2
East wall area 3	(23.5' x 8')	188.0 ft^2
West wall area 3	(23.5' x 12')	282.0 ft^2
North wall area 4	(23.5' x 6')	141.0 ft^2
South wall area 4	(23.5' x 6')	141.0 ft^2
East wall area 4	(23.5' x 65') - (3' x 7' door)	1506.5 ft^2
West wall area 4	(23.5' x 42')	987.0 ft^2
		9405.0 ft^2

Ceiling		
Area 1	(14' x 55') + (2' x 10') + (1' x 14') + (1' x 5')	809.0 ft^2
Area 2	(14' x 55') + (1' x 5')	775.0 ft^2
Area 3	(30' x 12') + (10' x 1') + (10' x 1')	380.0 ft^2
Area 4	(6' x 65') + (2' x 9') + (2' x 9')	426.0 ft^2
		2390.0 ft^2

Total Surface Area for Heat Transfer 11,795 ft^2 (1097 m^2)

ATTACHMENT A

Cable Trays

Cable trays considered to be burning simultaneously:

Horizontal Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
ZA2PA30	33	24	66
ZA2PA40	16	24	32
Vertical Tray No.			
None			-
			98 ft^2

$$\text{Heat Release} = \frac{98\ ft^2}{10.75\ ft^2/m^2} \times 190\ kW/m^2 = 1732.1\ kW$$

$$\text{Combustible Loading} = \frac{148\ lb\ cable}{98\ ft^2} = 1.51\ lb/ft^2$$

$$\text{FL (min)} = 1.51\ lb/ft^2 \div \frac{.1\ lb/ft^2}{min} = 15\ minutes$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: RADWASTE UNIT 2
ELEVATION AND AREA DESCRIPTION: 91.6' EL. STANDBY GAS TREATMENT ROOM
CASE DESCRIPTION: TWO DOORS OPEN AND ALL CABLES

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	42	7	11795	1732

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
1	89
2	95
3	101
4	105
5	109
6	112
7	115
8	118
9	121
10	124
11	126
12	129
13	131
14	133
15	136

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 3

Radwaste Building El. 91'6" to 135'

RHR Heat Exchanger and Pump Room

Room 106 Fire Zone 12A

September 12, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 3 Radwaste Building El. 91'6" to 135' RHR Heat Exchanger and Pump Room (Room 156, Fire Zone 12A) (see Attachment A for sketch of area under consideration). Bounding walls of area are reinforced concrete with an average thickness of 2.5 ft. Total surface area of bounding walls and ceiling is 5330 ft^2 (495 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

The combustible loading used for the calculations in the area consists of 131 lbs of cable insulation material and 56 gallons of oil. The total surface area of cable trays is 65 ft^2 with an average cable combustible loading of 2.0 lbs/ft^2.

3. VENTILATION PARAMETERS

Two doors serve this area each measuring 3' x 7'. One door is located in the east wall leading into the stairway. The other door is in the north wall leading into the RHR corner room of Reactor Building Unit 3. These two openings allow a ventilation opening of 42 ft^2.

The total volume of air available in the room for combustion is 2666.5 m^3. The curve in figure 1 shows the duration of a fire at a given heat output with the available air in the room. The curve indicates that there is not sufficient air in the room to consume all the combustible material, therefore, the fire will be ventilation controlled.

4. CASES EXAMINED

The limiting factor for a fire in this area is the ventilaton rate for the room. This is controlled by the 42 ft^2 of the ventilation openings available in this area. This corresponds to a maximum fire with a 9008 kW heat release rate. The case that is examined here is a 9008 kW fire. Assuming all the cables are burning simultaneously, the cable insulation would contribute 1149 kW and the oil fire 7859 kW for a period of 20 minutes. An oil fire of this size represents 2.9 gpm of oil burning.

At this rate 59.6 gallons of oil would have been consumed, however, only 56 gallons of oil are available. To make this evaluation conservative we assume 59 gallons of oil are available and the fire duration will be 20 minutes involving both cable and oil.

The second case to be examined is localized heating of the steel members assuming the steel is in the centerline of the oil fire plume during the above mentioned fire scenario.

5. RESULTS

The first case shows that the worst fire will reach a gas temperature of 917°F in the 20 minute fire duration in which all the combustibles are consumed. This temperature is not sufficient to fail the structural steel in the area (see calculations in Attachment C).

There are no cables located within 3 feet of any structural steel, therefore, localized heating is not a factor. The critical steel temperature will not be exceeded so a detailed analysis of the steel will not be performed.

The second case looked at localized heating of steel members when located in the centerline of an oil fire plume. These calculations show that at heights of 24.5 ft and 43.5 ft, where structural steel is located, the plume centerline temperatures are 704°F and 280°F respectively. This represents a steady state pool fire of 7859 kW and 6 ft diameter created by a spill of 3 gpm. These temperatures indicate that the critical steel temperature will not be exceeded due to localized heating.

Heat Output Duration for Available Air in Room

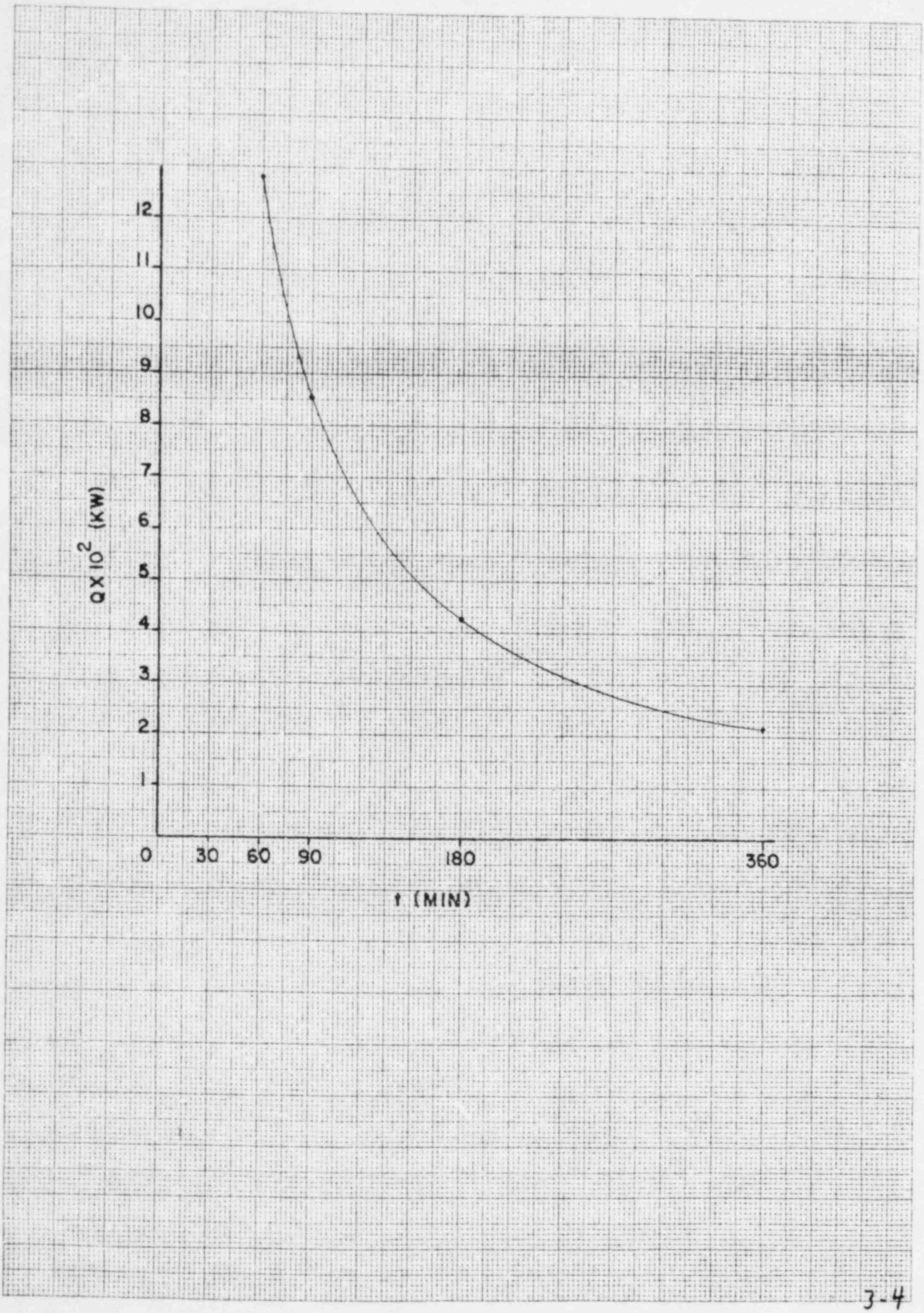
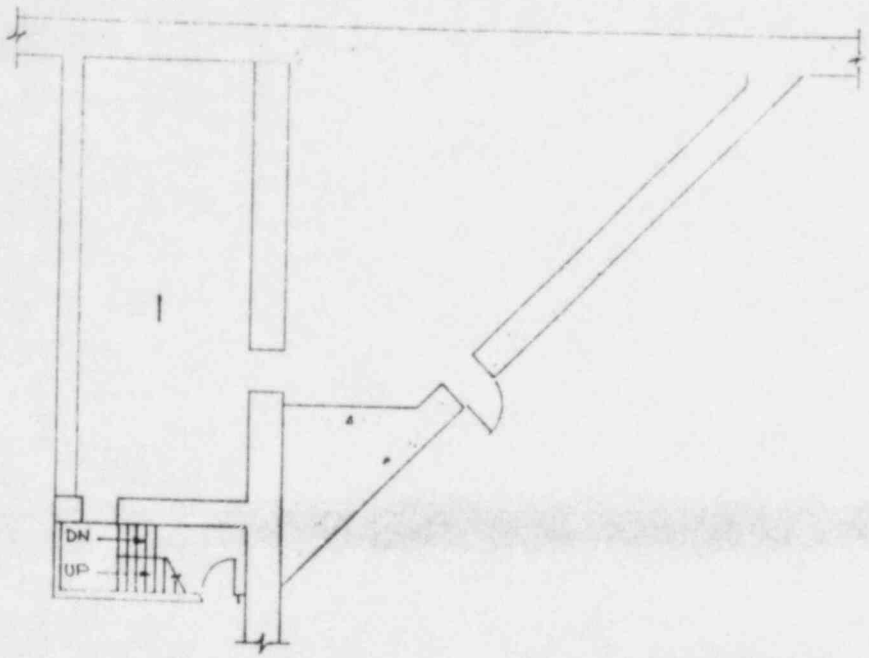


Figure 1



Unit 3 Radwaste Building El. 91'6"
RHR Exchanger and Pump Room Fire Zone 12A

Surface Area Calculation

Walls

North wall	(37' x 42'6") - (3' x 7' door)	1551 ft^2
East wall	(18'3" x 42'6") - (3' x 7' door)	755 ft^2
South wall	(37' x 42'6")	1573 ft^2
West wall	(18'3" x 42'6")	775 ft^2
		4655 ft^2

[Wall height =
135' El.-91'6" El. - (1' floor slab) = 42'6"]

Ceiling

Area 1	(18'3" x 37')	675 ft^2

Total Surface Area for Heat Transfer 5330 ft^2 (495 m^2)

ATTACHMENT A

Cable Trays

Cable trays considered to be burning simultaneously:

Horizontal Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
ZA3GC02	15	12	15
ZA3GC03	10	12	10
Vertical Tray No.			
ZA3GV01	20	24	40
Total Surface Area for Heat Release			65 ft^2

$$\frac{65\ ft^2}{10.75\ ft^2/m^2} \times 190\ kW/m^2 = 1149\ kW$$

$$\text{Fire Duration of Cabling} = 2.0\ lb/ft^2 \div \frac{0.1\ lb}{min\ ft^2} = 20\ \text{minutes}$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: RADWASTE UNIT 3
ELEVATION AND AREA DESCRIPTION: 91.5' EL. RHR HEAT EXCHANGER AND PUMP RO
CASE DESCRIPTION: TWO DOORS

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	42	7	5330	9008

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
1	263
2	341
3	401
4	451
5	495
6	536
7	573
8	607
9	639
10	670
11	699
12	727
13	754
14	779
15	804
16	828
17	851
18	874
19	896
20	917

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 2

Reactor Building El. 91'6" & 116'

Torus Area

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 91'6" & 116' Torus Area (see Attachment A for sketch of area under construction). Bounding walls of area are reinforced concrete with an average thickness of 3.5 ft. Total surface area of bounding walls are ceiling is 43,306 ft^2 (4024 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

Combustible loading in this area consists of the cable trays listed in Attachment B. The total surface area of cable trays is 111 ft^2 with an average combustible loading of 2 lbs/ft^2. There are no combustible liquids in this area.

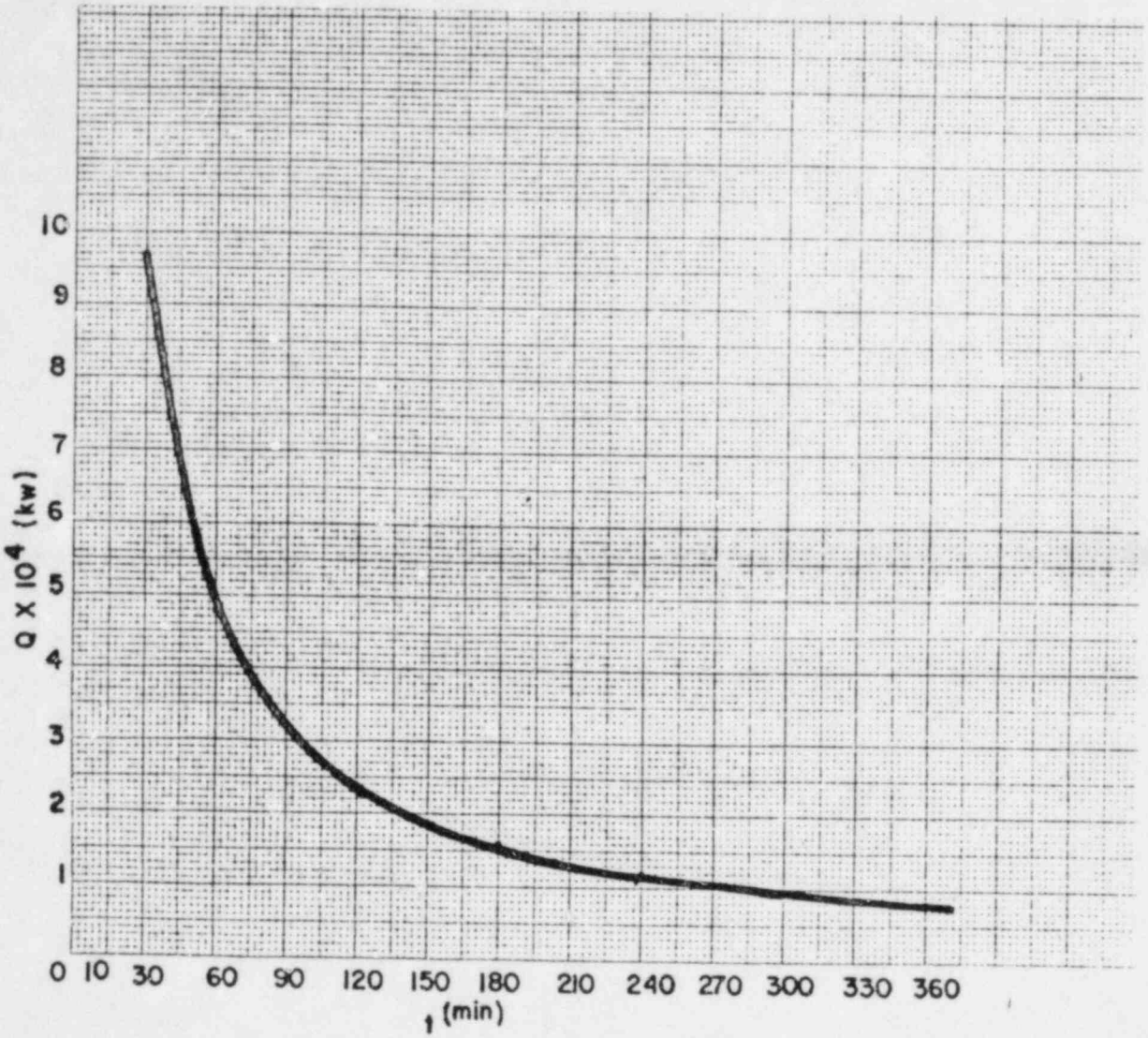
3. VENTILATION PARAMETERS

There are four doors each measuring 3' wide by 7' high entering the torus area. One door entering from each of the corner rooms. A possible limiting factor from the fire duration will be the total volume of air in the Reactor Building available for combustion which is 1×10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

With the light combustible loading in this area the assumption that all cable trays are burning simultaneously would present the worst case. With all cable trays burning a surface area of 111 ft^2 would be involved. This corresponds to a heat output of 1960 kW. With all cables in the area assumed to be burning simultaneously, the duration of the fire would be $3\ lb/ft^2 \div \frac{.1\ lbs}{min\ ft^2}$ = 20 minutes.

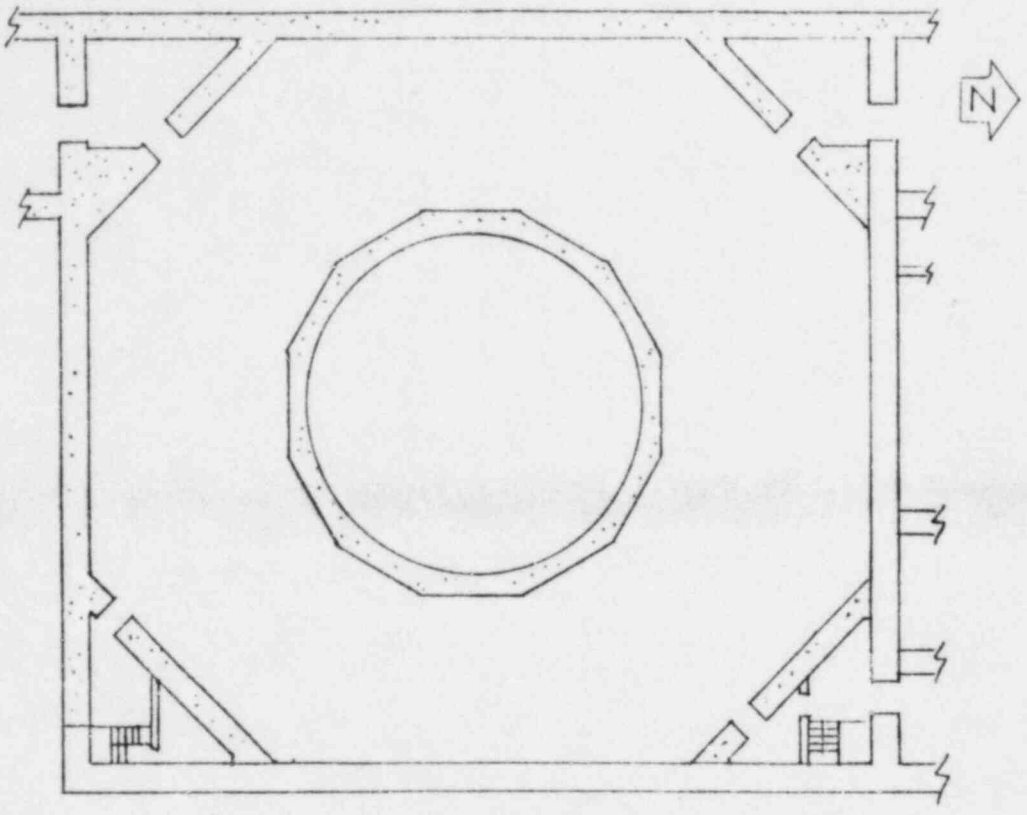
From the graph on the following page, the volume of air in the Reactor Building will not have an effect on the fire duration.



5. RESULTS

The worst case examined is with all cables in the area burning simultaneously with one door open. The gas temperature at the ceiling would be 94°F (see Attachment C). This will not fail the structural steel in the area.

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



Unit 2 Reactor Building Elevation 92'6" & 116'
Torus Area

Surface Area Calculation

Walls

Outer

North wall	(64' + 58.5' + 64')40'	7460 ft^2
East wall	(61' x 40')	2440 ft^2
South wall	(64' + 58.5' + 64')40'	7460 ft^2
West wall	(61' x 40')	2440 ft^2

Inner

North	(15' + 14' + 15' + 13' + 16')40'	2920 ft^2
East	(15' + 14' + 15')40'	1760 ft^2
South	(15' + 14' + 16' + 13' + 15')40'	2920 ft^2
West	(13' + 15' + 14')40'	1680 ft^2
		29,080 ft^2

Ceiling (151' x 148') - 4[1/2(45' x 45')] - $\pi(36)^2$ 14,226 ft^2

Total Surface Area for Heat Transfer 43,306 ft^2 (4023 m^2)

Cable Trays

The following cable trays are located in the area and are assumed to be burning simultaneously:

Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
2B2MH-210	19	12	19
2B2MH-220	23	12	23
2B2MH-230	15	12	15
2B2MH-240	23	12	33
2B2MH-250	21	12	21
			111 ft^2

Calculation of heat release:

$$\frac{111\ ft^2}{10.76\ ft^2/m^2} \times 190\ \frac{kw}{m^2} = 1960\ kw$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 91'6 & 116' TORUS AREA
CASE DESCRIPTION: ONE DOOR OPEN ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.5	CONCRETE	21	7	43386	1960

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
5	83
10	88
15	91
20	94

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 2

Reactor Building El. 91'6" & 116'

RHR Heat Exchanger and Pump Room

(Rooms 2 & 101)

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 91'6" & 116' RHR and Heat Exchanger and Pump Room (Rooms 2 & 101) (see Attachment A for sketch of area under consideration). Bounding walls of area are reinforced concrete with an average thickness of 3 ft. Total surface area of bounding walls and ceiling is 5066 ft^2 (470 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

Combustible loading in the area consists of the cable trays having a surface area of 79 ft^2 with an average combustible loading of 2 lbs/ft^2.

A quantity of 28 gallons of combustible lubricating oil is contained in the RHR pump. An additional 28 gallons of lube oil is assumed to be in the area to account for possible maintenance activities.

3. VENTILATION PARAMETERS

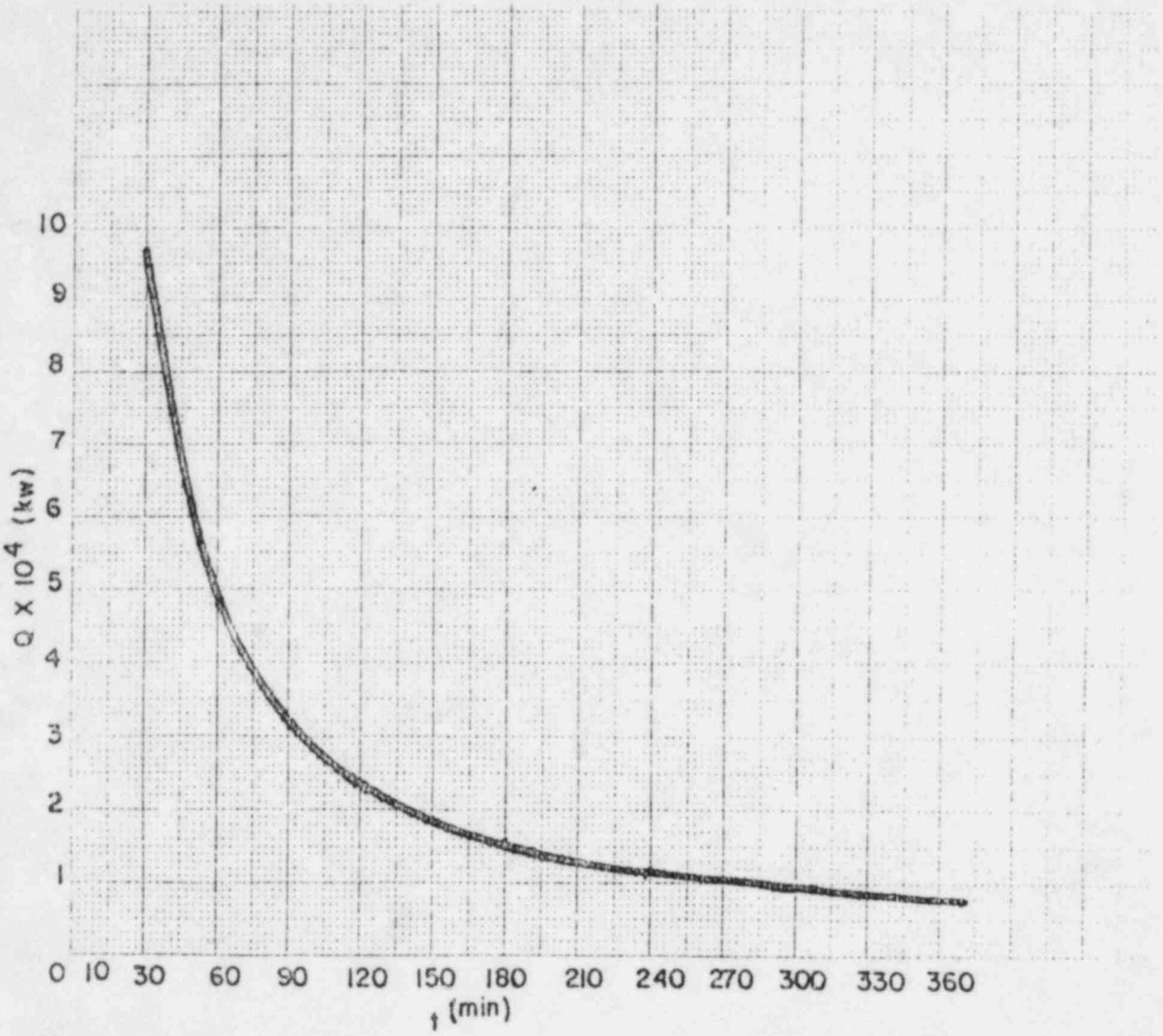
There are two doors which enter this both measuring 3' wide by 7' high. One door enters on the 91'6" elevation, the other enters from the 116' elevation. A possible limiting factor for the fire duration will be the total volume of air in the Reactor Building available for combustion which is 1 x 10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

The limiting factor for a fire in this area is the ventilation rate for the room. With both 3' wide by 7' high doors entering the area considered to be open, the maximum heat output that can occur is given by the equation $Qv = 1580\ Ao\ \sqrt{Ho}$ where:

Ao = total opening area of $\frac{42\ ft^2}{10.76\ ft/m^2} = 3.90 m^2$ and

Ho = height of opening 7 ft x .3048 m/ft = 2.13m



giving a maximum heat output, Qv, of

$$Qv = 1580 \times 3.90 \sqrt{2.13}$$

$$Qv = 9008 \text{ kW}$$

Assuming that all cable trays in the area are burning simultaneously, the resulting heat output is 1400 kW. This leaves 9008 kW - 1400 kW = 7608 kW for the heat output of the lube oil fire. This heat output corresponds to a lube oil burn rate of 2.9 gallons per minute. The duration of the oil fire at this consumption rate will be 20 minutes, totally consuming the 56 gallons of lube oil present. The duration of the cable tray fire would be $2 \text{ lbs/ft}^2 \div \frac{.1 \text{ lbs}}{\text{min ft}^2} = 20$ minutes.

From the graph above, the total volume of air in the Reactor Building will not affect the fire duration.

5. RESULTS

The case described above with a constant heat output of 9008 kW for a duration of 20 minutes with two open doors results in a gas temperature of 961°F (see Attachment B) which is below the critical temperature for the structural steel.

The ventilation controlled burning rate of 9008 kW is equivalent to the heat output from a pool fire with an area of 27.9 ft^2 (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 located on the 116' elevation directly above the fire Heskested's (1) relations will be used:

Virtual point source determination:

$$Zo = -1.02D + .083\ Q^4 = 1.3m$$

Plume temperature at bottom of steel on 116' elevation:

$$\Delta To = 9.1\ (T_\infty / (gCp^2 \rho_\infty^2))^{.333} Qc^{.667} (Z-Zo)^{-1.67}$$

Δ To = 466°K temperature rise

T = 907°F temperature of fire plume

This temperature is below the critical temperature for the structural steel.

For the structural steel on the 135' elevation:

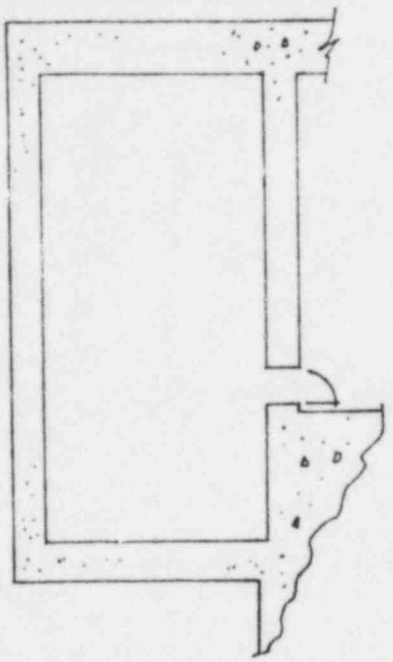
Δ To 148°K temperature rise

T = 335°F temperature of fire plume

This temprature is below the critical temperature for the structural steel.

It can be 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 structural steel.



RHR Heat Exchanger & Pump Room

Surface Area Calculation

Walls

North wall	(37' x 40')	1480 ft^2
East wall	(18' x 40')	720 ft^2
South wall	(37' x 40')	1480 ft^2
West wall	(18' x 40')	720 ft^2
		4400 ft^2

Ceiling (37' x 18') 666 ft^2

Total Surface Area for Heat Transfer 5066 ft^2

ATTACHMENT A

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 91'6 & 116' RHR HT EXCH ROOMS 2 & 101
CASE DESCRIPTION: TWO DOORS OPEN CABLE AND OIL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	42	7	5066	9008

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
5	517
10	701
15	842
20	961

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 2

Reactor Building El. 91'6" & 116'

RHR Heat Exchanger and Pump Room

(Rooms 4 & 103)

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 91'6" & 116' RHR and Heat Exchanger and Pump Room (Rooms 4 & 103) (see Attachment A for sketch of area under consideration). Bounding walls of area are reinforced concrete with an average thickness of 3.5 ft. Total surface area of bounding walls and ceiling is 5489 ft^2 (510 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

Combustible loading in the area consists of the cable trays in Attachment B. The total surface area of cable trays is 92 ft^2 with an average combustible loading of 3.0 lbs/ft^2. A quantity of 28 gallons of combustible lubricating oil is contained in the RHR pump. An additional 28 gallons of lube oil is assumed to be in the area to account for possible maintenance activities.

3. VENTILATION PARAMETERS

Two doors serve this area each measuring 3' wide by 7' high. One door enters from the north west corner of the torus area, the other enters from the Radwaste Building. A possible limiting factor for the fire duration will be the total volume of air in the Reactor Building available for combustion which is 1×10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

The limiting factor for a fire in this area is the ventilation rate for the room. With both 3' wide by 7' high doors entering the area considered to be open, the maximum heat output that can occur is given by the equation $Qv = 1580\ Ao\ \sqrt{Ho}$ where:

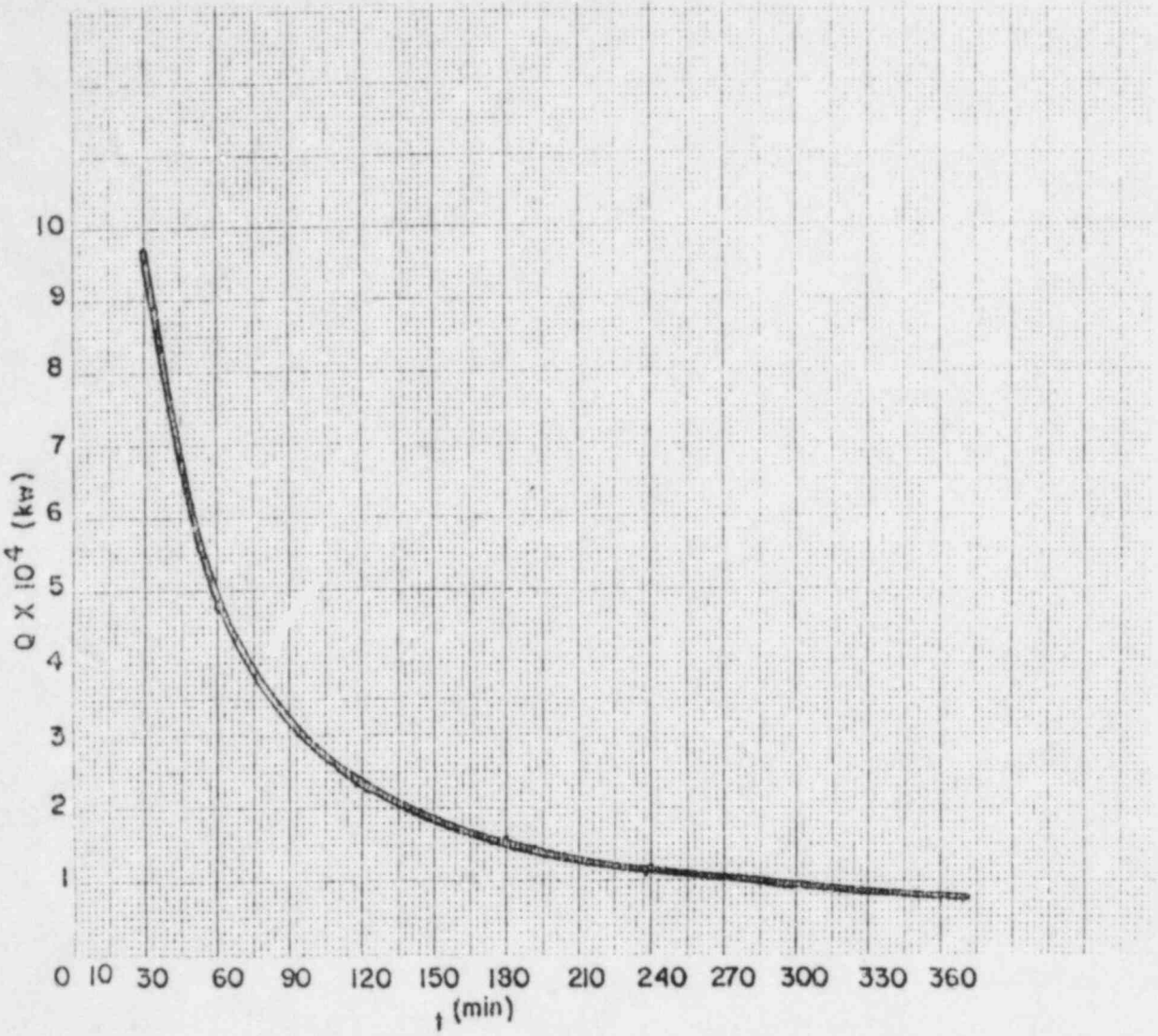
Ao = total opening area of $\frac{42\ ft^2}{10.76\ ft/m^2} = 3.90 m^2$ and

Ho = height of opening 7 ft x .3048 m/ft = 2.13m

given a maximum heat output, Qv, of

$Qv = 1580 \times 3.90 \sqrt{2.13}$

$Qv = 9008$ kW



Assuming that all cable trays in the area are burning simultaneously, the resulting heat output is 1625 kW. This leaves 9008 kW - 1625 kW = 7283 kW for the heat output of the lube oil fire. This heat output corresponds to a lube oil burn rate of 2.8 gallons per minute. The duration of the oil fire at this consumption rate will be 20 minutes, totally consuming the 56 gallons of lube oil present. The duration of the cable tray fire would be 3 $lbs/ft^2 \div \frac{.1\ lbs}{min\ ft^2}$ = 30 minutes.

At the twenty minutes point, the fire would decrease to 1625 kW in heat output. To make this evaluation conservative, the heat output of 9008 kW was used throughout the 30 minute fire duration. From the graph above, the total volume of air in the Reactor Building will not have an effect on the fire duration.

5. RESULTS

The case described above with a constant heat output of 9008 kW for a duration of 20 minutes with two open doors results in a gas temperature of 1077°F (see Attachment C) which is below the critical temperature for the structural steel.

The ventilation controlled burning rate of 9008 kW is equivalent to the heat output from a pool fire with an area of 27.9 ft^2 (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 located on the 116' elevation directly above the fire, Heskested's (1) relations will be used:

Virtual point source determination:

$$Zo = -1.02D + .083\ Q^4 = 1.3m$$

Plume temperature at bottom of steel on 116' elevation:

$$\Delta To = 9.1\ (T_\infty / (gCp^2\ \rho_\infty^2))^{.333} Qc^{.667} (Z-Zo)^{-1.67}$$

Δ To = 466°K temperature rise

T = 907°F temperature of fire plume

This temperature is below the critical temperature for the structural steel.

For the structural steel on the 135' elevation:

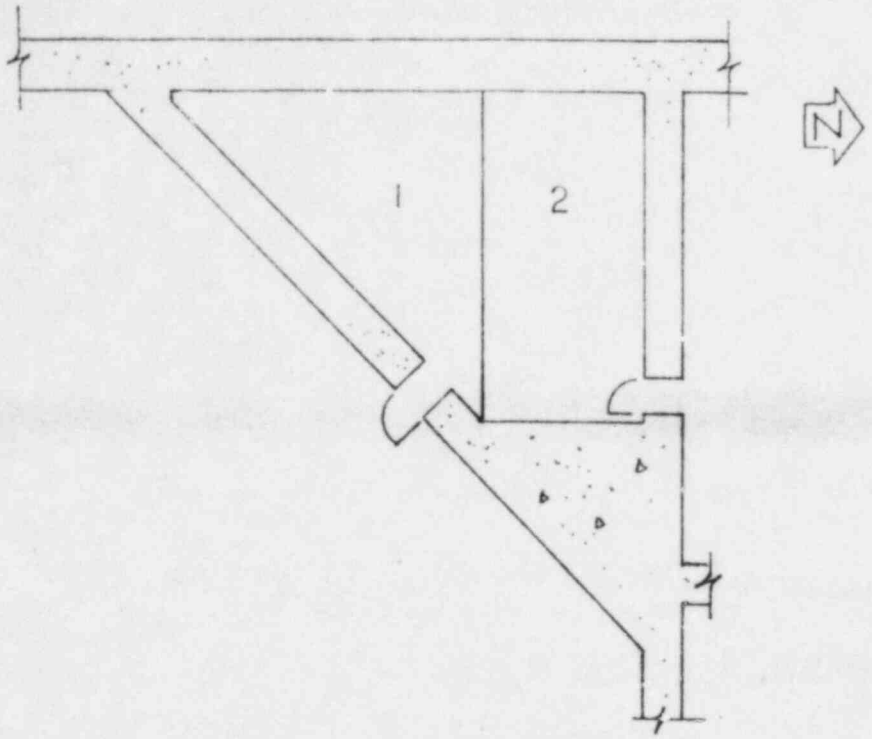
Δ To 148°K temperature rise

T = 335°F temperature of fire plume

This temperature is below the critical temperature for the structural steel.

It can be 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 structural steel.



Unit 2 Reactor Building
RHR Heat Exchanger & Pump Room 4 & Room 103

Surface Area Calculation

Walls

North wall	(27' x 40')	1080 ft^2
East wall	(14' x 40')	560 ft^2
South wall	(38' x 40')	1520 ft^2
West wall	(40' x 40')	1600 ft^2
		4760 ft^2

Ceiling

Area 1	[(27' x 26') ÷ 2]	351 ft^2
Area 2	(14' x 27')	378 ft^2
		729 ft^2

Total Surface Area for Heat Transfer 5489 ft^2

Cable Trays

The following cable trays are located in the area and are assumed to be burning simultaneously:

Room 4

Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
ZB-2KA050	15	12	15
ZB-2KA040	36	12	36
ZB-2KV020	12	24	24
			75 ft^2

Room 103

ZB-2KG040	17	12	17
			92 ft^2

Heat release rate calculated as follows:

$$\frac{92\ ft^2}{10.76\ ft^2/m^2} \times 190\ \frac{kw}{m^2} = 1625\ kW$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 91'6 & 116' RHR AND HEAT EXCHANGER ROOMS
CASE DESCRIPTION: TWO DOORS OPEN CABLE AND LUBE OIL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.5	CONCRETE	42	7	5489	9008

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	653
20	893
30	1077

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

UNIT 2

Reactor Building El. 116'

North Vacuum Breaker Area

September 8, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 116' North Vacuum Breaker Room (see Attachment A for sketch of area under construction).

Bounding walls are of reinforced concrete with an average thickness of 3 ft.

Total surface area of bounding walls and ceiling is 2813 ft^2 (261 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

Combustible loading in this area consists of the cable trays listed in Attachment B. The total surface area of cable trays is 108 ft^2 with an average combustible loading of 3 lb/ft^2. There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

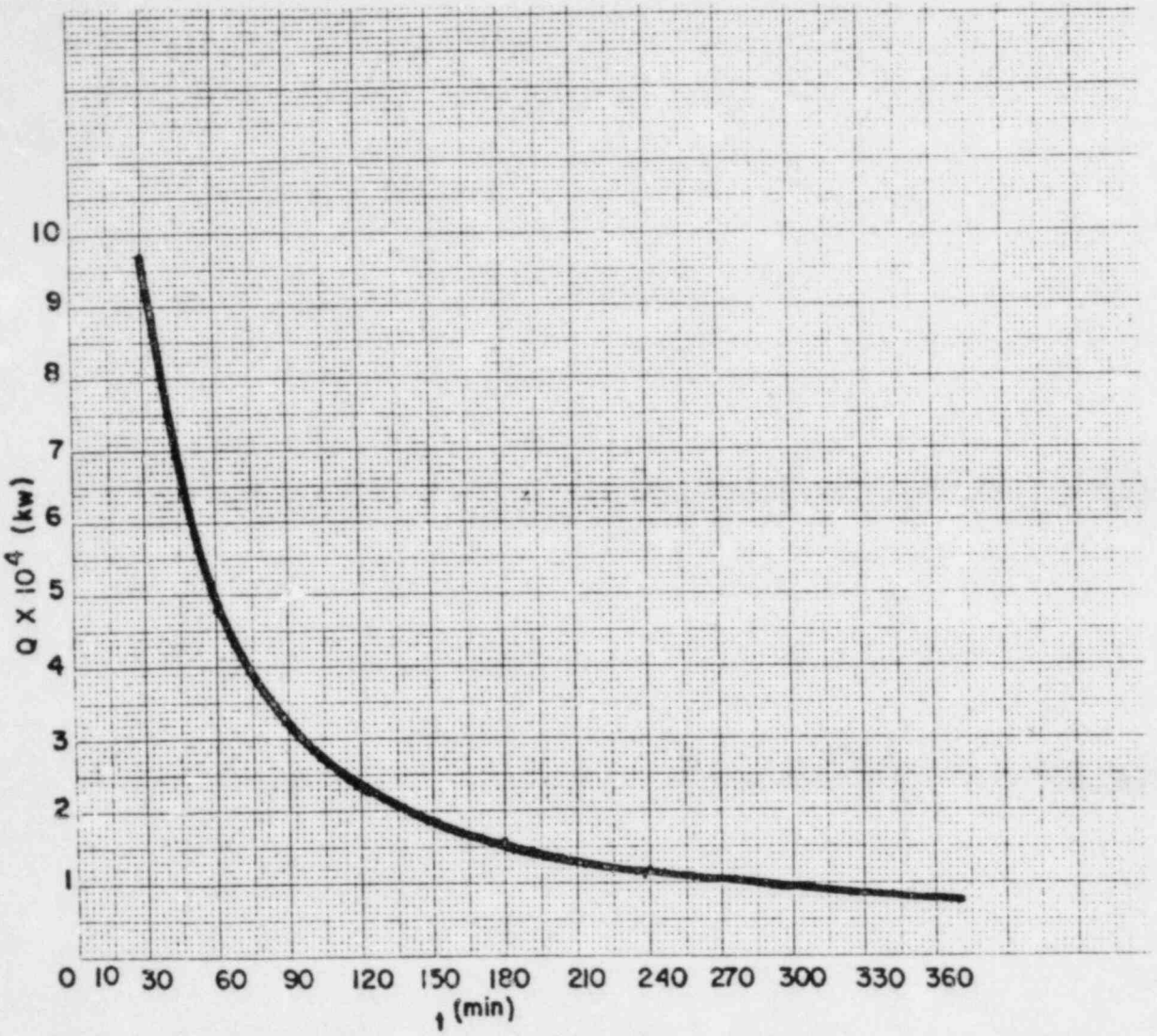
There are two doors leading into this area. Both doors measure 3' wide by 7' high with one door entering from the Turbine Building and the other entering from the stairwell. A possible limiting factor for the fire duration will be the total volume of air in the Reactor Building available for combustion which is 1×10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

With the light combustible loading in this area, the assumption that all cables are burning simultaneously would present the worst case. With all cable trays burning a surface area of 108 ft^2 would be involved. This corresponds to a heat output of approximately 1910 kW. With all cables assumed to be burning simultaneously the duration of the fire would be

$$3\ lb/ft^2 \div \frac{.1\ lb}{min\ ft^2} = 30\ minutes.$$

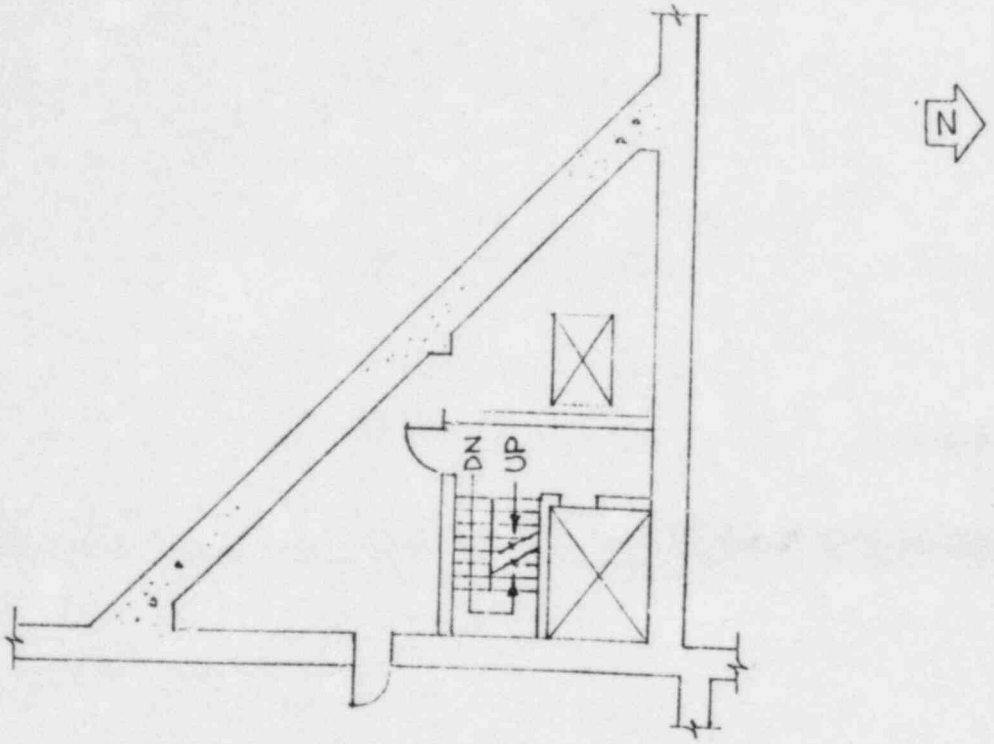
From the chart above, the volume of air in the Reactor Building will not have an effect on the fire duration.



5. RESULTS

The worst case examined is with all cable trays in the area burning simultaneously with one door open measuring 3' wide by 7' high. The National Bureau of Standards method was used for this area because of the relataively small room size. The gas temperature at the ceiling would be 715°F (see Attachment C).

This temperature is not high enough to fail the structural steel in the area. There are no horizontal cable trays within three feet of the ceiling structural steel members. Localized heating of the structural steel to its critical temperature will not occur so a detailed analysis of the steel will not be performed.



Unit 2 Reactor Building Elevation 116'
Vacuum Breaker Area (North)

Surface Area Calculation

Walls

North wall	(21' x 18')	378 ft^2
East wall	(22' x 18')	396 ft^2
SW wall	(53' x 18')	954 ft^2
Stairwell	(17' x 18') + (18' x 18')	630 ft^2
		2358 ft^2
Ceiling	[(39' x 39') ÷ 2] - (17' x 18')	455 ft^2
Total Surface Area for Heat Transfer		2813 ft^2

Cable Trays

The following cable trays are present in the area defined for the source fire and all of the trays are assumed to be burning simultaneously.

Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
ZA2MV230	16	24	32
ZA2MF100	16	12	16
ZC2MH300	12	12	12
ZC2MH310	16	12	16
ZC2MV220	16	24	32
			108 ft^2

Heat release rate calculated as follows:

$$\frac{108\ ft^2}{10.76\ ft^2/m^2} \times 190\ kW/m^2 = 1910\ kW$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 116' NORTH VACUUM BREAKER AREA
CASE DESCRIPTION: ONE DOOR OPEN 3'X 7' ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	21	7	2813	1916

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
30	715

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

UNIT 2

Reactor Building El. 116'

South Vacuum Breaker Area

September 8, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 116' South Vacuum Breaker Room (see Attachment A for sketch of area under construction).

Bounding walls of area are reinforced concrete with an average thickness of 3 ft.

Total surface area of bounding walls and ceiling is 2975 ft^2 (276 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

Combustible loading in this area consists of the cable trays listed in Attachment B. The total surface area of cable trays is 109 ft^2 with an average combustible loading of 3.5 lb/ft^2. There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

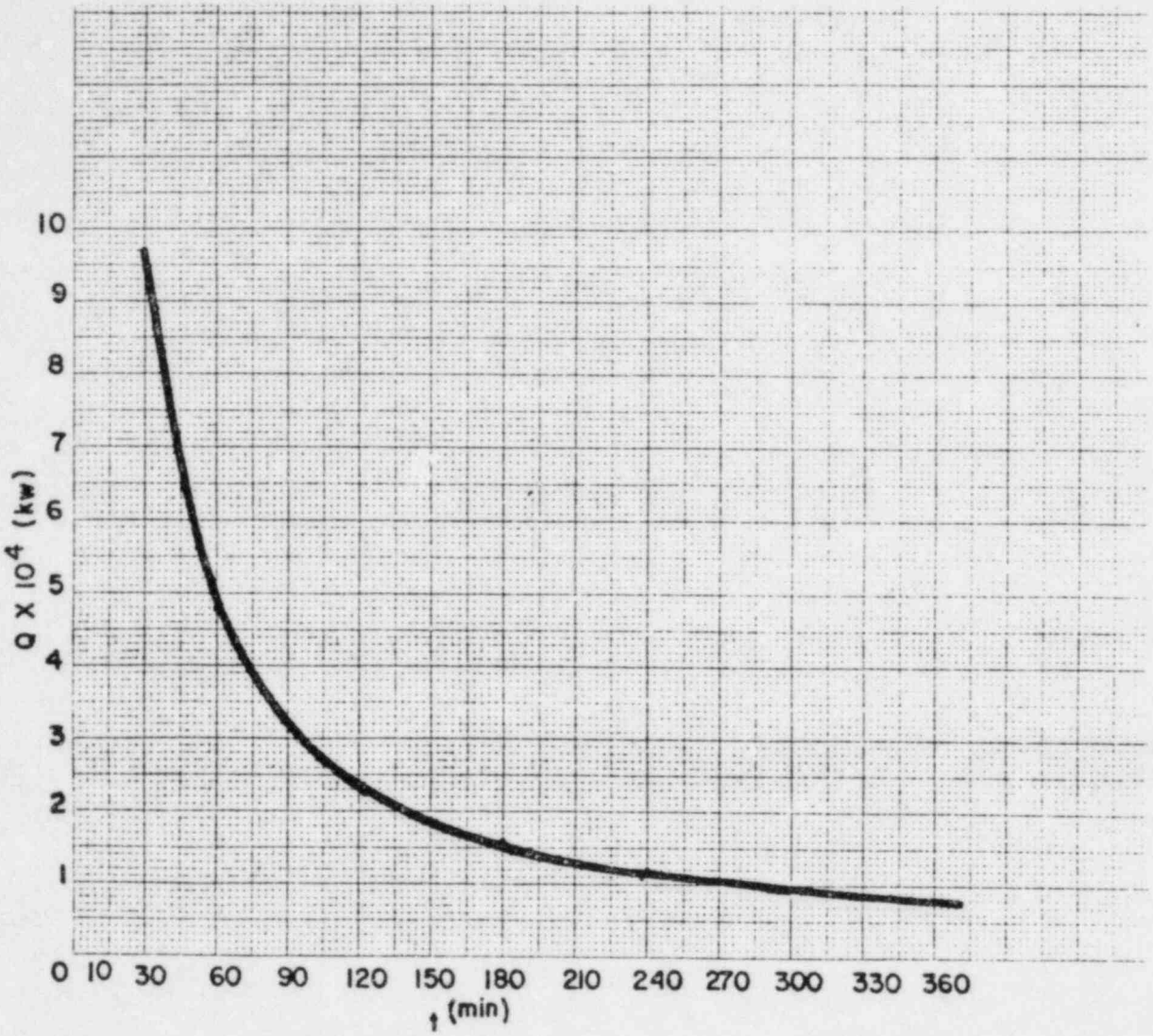
There is one door which measures 3' wide by 7' high leading into this area and is located at the stairwell. A possible limiting factor for the fire duration will be the total volume of air in the Reactor Building available for combustion, which is 1×10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

With the light combustible loading in this area, the assumption that all cables are burning simultaneously would present the worst case. With all cable trays burning a surface area of 109 ft^2 would be involved. This corresponds to a heat output of approximately 1925 kW. With all cables assumed to be burning simultaneously the duration of the fire will be

$$3.5 \text{ lb/ft}^2 \div \frac{.1 \text{ lb}}{\text{min ft}^2} = 35 \text{ minutes.}$$

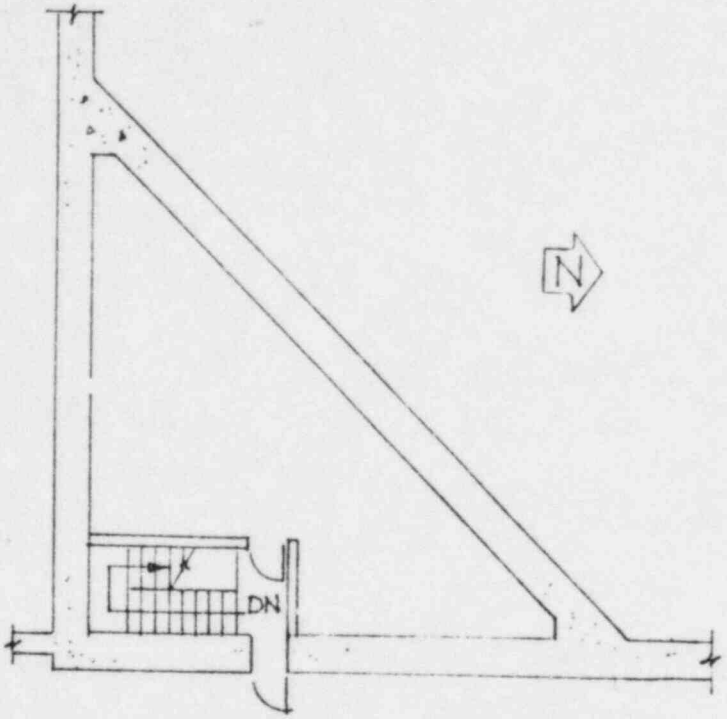
From the chart on the following page, the volume of air in the Reactor Building will not have an effect on the fire duration.



5. RESULTS

The worst case examined is with all cable trays in the area burning simultaneously with a ventilation opening measuring 3 ft wide by 7 ft high. The National Bureau of Standards method was used for this area because of the relataively small room size. The gas temperature at the ceiling would be 723°F (see Attachment C).

This temperature is not high enough to fail the structural steel in the area. There are no cable trays within six feet of the ceiling structural steel members. Localized heating of the structural steel to its critical temperature will not occur so a detailed analysis of the steel will not be performed.



Unit 2 Reactor Building Elevation 116'
Vacuum Breaker Area (South)

Surface Area Calculation

Walls

East wall	(21' x 18')	378 ft^2
South wall	(31' x 18')	558 ft^2
NW wall	(53' x 18')	954 ft^2
Stairwell	(18' x 18') + (8' x 18')	468 ft^2
		2358 ft^2
Ceiling	[(39' x 39') ÷ 2] - (8' x 18')	617 ft^2
Total Surface Area for Heat Transfer		2975 ft^2

ATTACHMENT A

Cable Trays

The following cable trays are located in the area under consideration and are assumed to be burning simultaneously.

Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
ZB2MH190	10	24	20
ZB2MH200	5	24	5
ZB2MV180	8	24	16
ZB2MV210	10	24	20
ZD2MF010	18	24	18
ZD2MF020	6	24	12
ZD2MV200	9	24	18
			109 ft^2

Heat release rate calculated as follows:

$$\frac{109\ ft^2}{10.76\ ft^2/m^2} \times 190\ kW/m^2 = 1925\ kW$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 116' SOUTH VACUUM BREAKER AREA
CASE DESCRIPTION: ONE DOOR OPEN 3'X 7' ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	21	7	2275	1925

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
35	723

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

UNIT 2

Reactor Building El. 135'

North of Reactor Center Line

September 7, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 135', area north of Reactor Center Line column lines 13 to 18 (see Attachment A for sketch of area under consideration).

Bounding walls of area are reinforced concrete with an average thickness of 3 ft.

Total surface area of bounding walls and ceiling is 18,437 ft^2 (1713 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

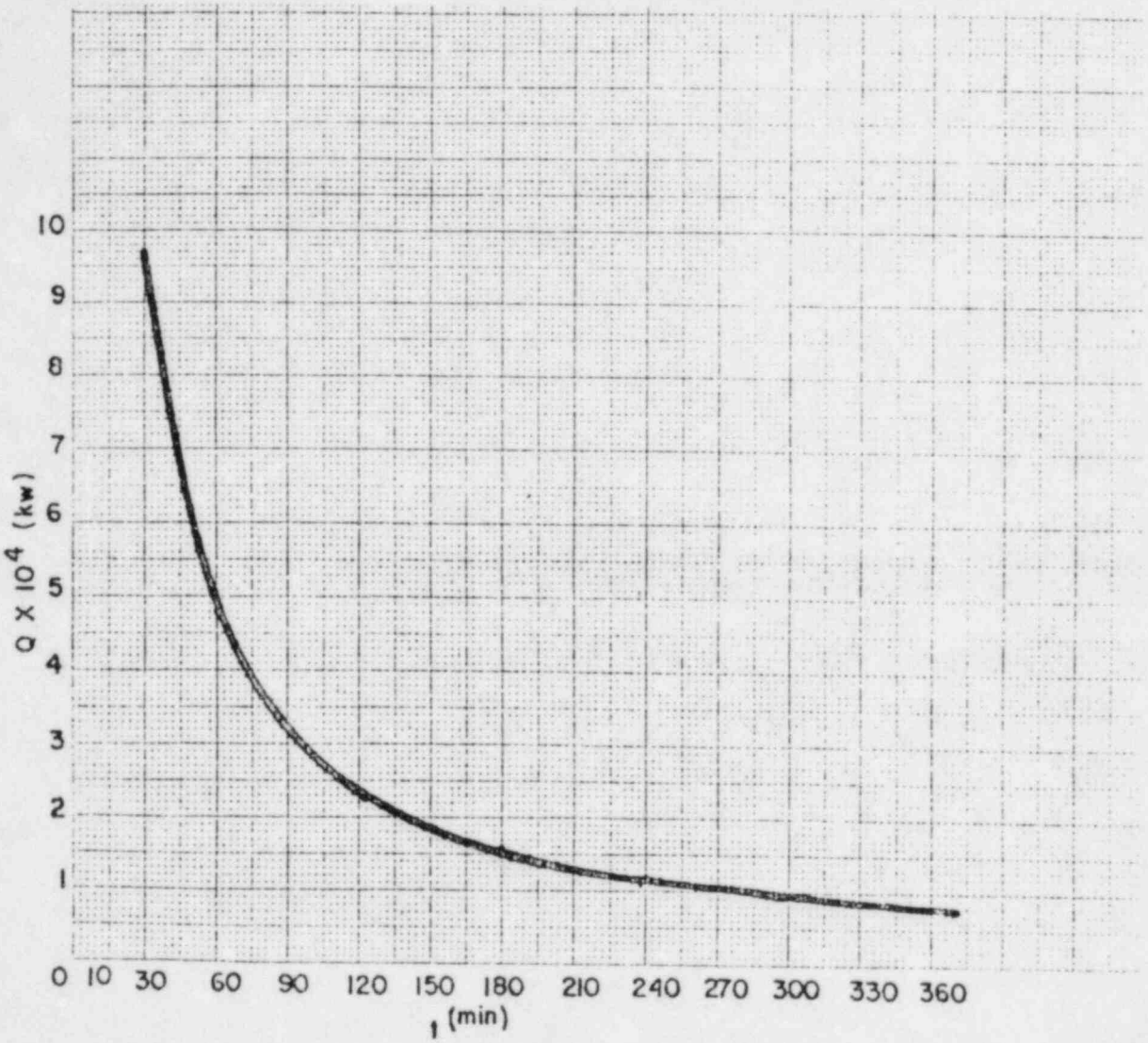
The heaviest concentration of cabling in this area is located in the far northwest corner. Total surface area of cable tray to be considered involved in a fire is 309 ft^2 with an average combustible loading of the cable trays being 4 lbs/ft^2 (see Attachment B for calculation of cable tray area). There are no combustible liquids in the area.

3. VENTILATION PARAMETERS

Two ventilation openings serve this area. The corridor on the west side of the Reactor is 5' wide x 29' high. The east side corridor opening measures 10' wide x 10' high. The total volume of air in the Reactor Building available for combustion is 1×10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

A spreading cable fire was assumed in the area of heaviest cable concentration which is in the northwest corner. The fire is assumed to start at a point source and spread horizontally in each direction at a rate of 10 feet per hour. A constant burning rate is assumed throughout the duration of the fire. The fire is assumed to extend down the tray stacks along the north and west walls a distance of 10 feet before the original source of the fire dies out. An area of 309 ft^2 of cable trays (see Attachment B for a list of cable trays initially burning) will have a heat output of approximately 5500 kW, which is used throughout

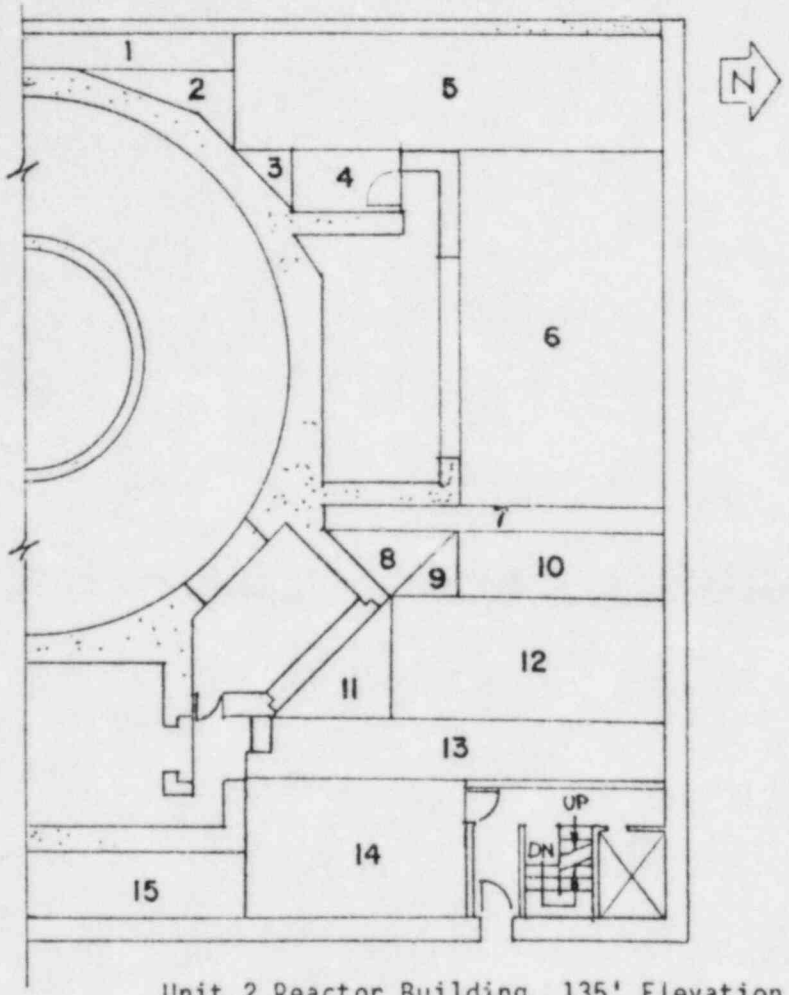


the fire duration. The actual heat output as the fire spreads out of the area originally involved would be less because the concentrations of cabling that would become involved at any one time would be less. From the chart above, the volume of air in the Reactor Building would support combustion for approximately 9 hours.

5. RESULTS

For the above case with two openings having a total area of 245 ft^2 and a constant heat output of 5500 kW, the fire duration was assumed to last 6 hours with no action taken by plant personnel to extinguish the fire. The gas temperature at three hours was 519°F and 705°F at six hours (see Attachment C). These temperatures do not exceed the critical temperature of the steel framing members.

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



Unit 2 Reactor Building 135' Elevation

Surface Area Calculation

Walls

West wall	(76' x 29')	2204 ft^2
North wall	(118' x 29')	3422 ft^2
East wall	(76' x 29')	2204 ft^2
Area around vessel	(7' + 16' + 19')29'	1218 ft^2
Outside Area of Rm 204 (west)	(19' x 29')	551 ft^2
Outside Area of Rm 204 (north)	(45' x 29')	1305 ft^2
Outside Area of Rm 204 (east)	(17' x 29')	493 ft^2
Outside Area of Rm 207 (NW)	(15' x 29')	435 ft^2
Outside Area of Rm 207 (NE)	(20' x 29')	580 ft^2
Outside Area of Rm 207 (east)	(9' x 29')	261 ft^2
Outside Area of Rm 208 (north)	(19' x 29')	551 ft^2
Outside Area of Rm 208 (east)	(26' x 29')	754 ft^2
		13,978 ft^2

ATTACHMENT A

Ceiling

Area 1	26' x 4.5'	117 ft^2
Area 2	1/2(10' x 18')	90 ft^2
Area 3	1/2(6' x 7')	21 ft^2
Area 4	12' x 7'	84 ft^2
Area 5	50' x 17'	850 ft^2
Area 6	22' x 45'	990 ft^2
Area 7	38' x 3'	114 ft^2
Area 8	1/2(11' x 12')	66 ft^2
Area 9	1/2(6' x 9')	27 ft^2
Area 10	23.5' x 9'	212 ft^2
Area 11	1/2(15' x 15')	113 ft^2
Area 12	29.5' x 15'	443 ft^2
		4459 ft^2

Total Surface Area for Heat Transfer 18,437 ft^2 (1713 m^2)

ATTACHMENT A

Cable Trays

The following cable trays are present in the area defined for the source fire and all of the trays are assumed to burn simultaneously.

Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
2KN-024	4	24	8
2KN-026	8	24	16
2KL-024	4	24	8
2KL-026	8	24	16
2KW-024	4	24	8
2KW-026	6	24	12
ZB-2KM-024	4	24	8
ZB-2KM-026	8	24	16
2KP-026	8	24	16
2KV-064	14	18	21
2KN-030	10	24	20
2KN-035	2	24	4
2KL-030	10	24	20
2KL-035	2	24	4
2KW-030	8	24	16
2KW-035	2	24	4
ZB-2KM-030	10	24	20
ZB-2KM-035	2	24	4
2KP-030	10	24	20
2KP-035	2	24	4
2KV-292	7	24	14
2KV-062	9	18	14
2KV-260	16	18	24
2KV-110	12	12	12
			309 ft^2

For a fuel surface area controlled fire involving all of these cable trays, the heat release rate can be calculated as follows:

$$309\ ft^2/10.76\ ft^2/m^2 \times 190\ kW/m^2 = 5456\ kW$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 135' NORTH OF REACTOR CENTER LINE
CASE DESCRIPTION: TWO OPENINGS SPREADING CABLE FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	245	19	18437	5500

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	178
20	221
30	255
40	283
50	308
60	330
70	351
80	370
90	388
100	406
110	422
120	437
130	452
140	467
150	480
160	494
170	507
180	519
190	532
200	544
210	555
220	567
230	578
240	589
250	599
260	610
270	620
280	630
290	640
300	650
310	659
320	669
330	678
340	687
350	696
360	705

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

COMMON AREA

Radwaste Building El. 135'

Medical Station and Corridor

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Medical Station (Room 237) and adjacent Corridor (Room 240) on the 135' elevation of the Radwaste Building. See Attachment A for a sketch of the area under consideration. Bounding walls of the area are reinforced concrete construction with an average thickness of 1 ft. Total surface area of the bounding walls and ceiling is 1237 ft^2 (see Attachment A for a calculation of heat loss surface area).

2. COMBUSTIBLE LOADING

Fixed combustible loading in this area consists of horizontal and vertical cable trays located in the enclosed space above the ceiling. Total surface area of the cable trays is 96 ft^2 with an average combustible loading in the trays being 5.2 lbs/ft^2 of tray surface area. All other cabling in this area is routed in conduit and is not included in the combustible loading.

3. VENTILATION PARAMETERS

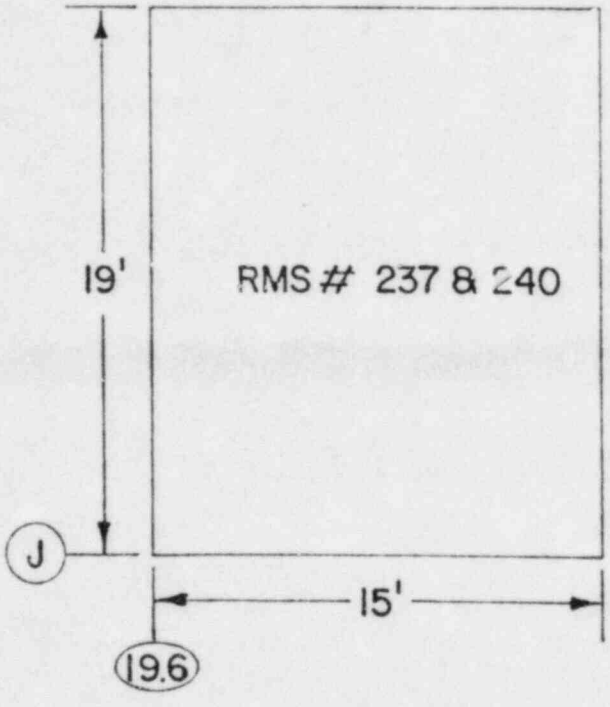
This area is served by two personnel doors, each being 3 ft wide by 7 ft high.

4. CASES EXAMINED

The assumption was made that all of the cabling in this area was burning simultaneously in order to present the worst case. Total surface of the trays is 96 ft^2 which corresponds to a heat output of approximately 1700 kW. With all cables burning at once the duration of the fire will be 5.2 $lbs/ft^2 \div \frac{0.1\ lb}{min\ ft^2}$ = 52 minutes.

5. RESULTS

The only case examined was with cables burning simultaneously with one door open. Since the fire was fuel controlled under this set of circumstances there is no need to examine the case with the second door open. The peak fire temperature reached was 930°F which is below the critical temperature of the structural steel (see Attachment B for results). The cable trays were located far enough below the steel members to prevent localized heating effects.



Medical Station Corridor

Surface Area Calculation

Walls

North wall	(19' x 14')	266 ft^2
South wall	(19' x 14')	266 ft^2
East wall	(15' x 14')	210 ft^2
West wall	(15' x 14')	210 ft^2
		952 ft^2
Ceiling	(19' x 15')	285 ft^2
Total Surface Area for Heat Transfer		1237 ft^2

ATTACHMENT A

CASE NO.: 1
BUILDING: RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: MEDICAL STN. & CORRIDOR, 135' ELEV.
CASE DESCRIPTION: ONE DOOR OPEN, ALL CABLES BURNING

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
1	CONCRETE	21	7	1237	1700

FIRE IS FUEL CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
52	930.231

ATTACHMENT B

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

COMMON AREA

Radwaste Building El. 150'

Radwaste H & V Equipment Compartment

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Radwaste Building H & V Equipment Compartment on the 150' elevation. See Attachment A for a sketch of the area under consideration. Bounding walls of the area are reinforced concrete construction with an average thickness of 2 ft. Total surface area of the bounding walls and ceiling is 13,886 ft^2 (see Attachment A for a calculation of heat loss surface area).

2. COMBUSTIBLE LOADING

Fixed combustible loading in this area consists of horizontal and vertical cable trays. Total surface area of the cable trays is 194 ft^2 with an average combustible loading in the trays being 3.3 lbs/ft^2 of tray surface area. All other cabling in this area is routed in conduit and is not included in the combustible loading.

3. VENTILATION PARAMETERS

There is a 8'3" wide by 12' high opening in to the room located at the south end of the west wall.

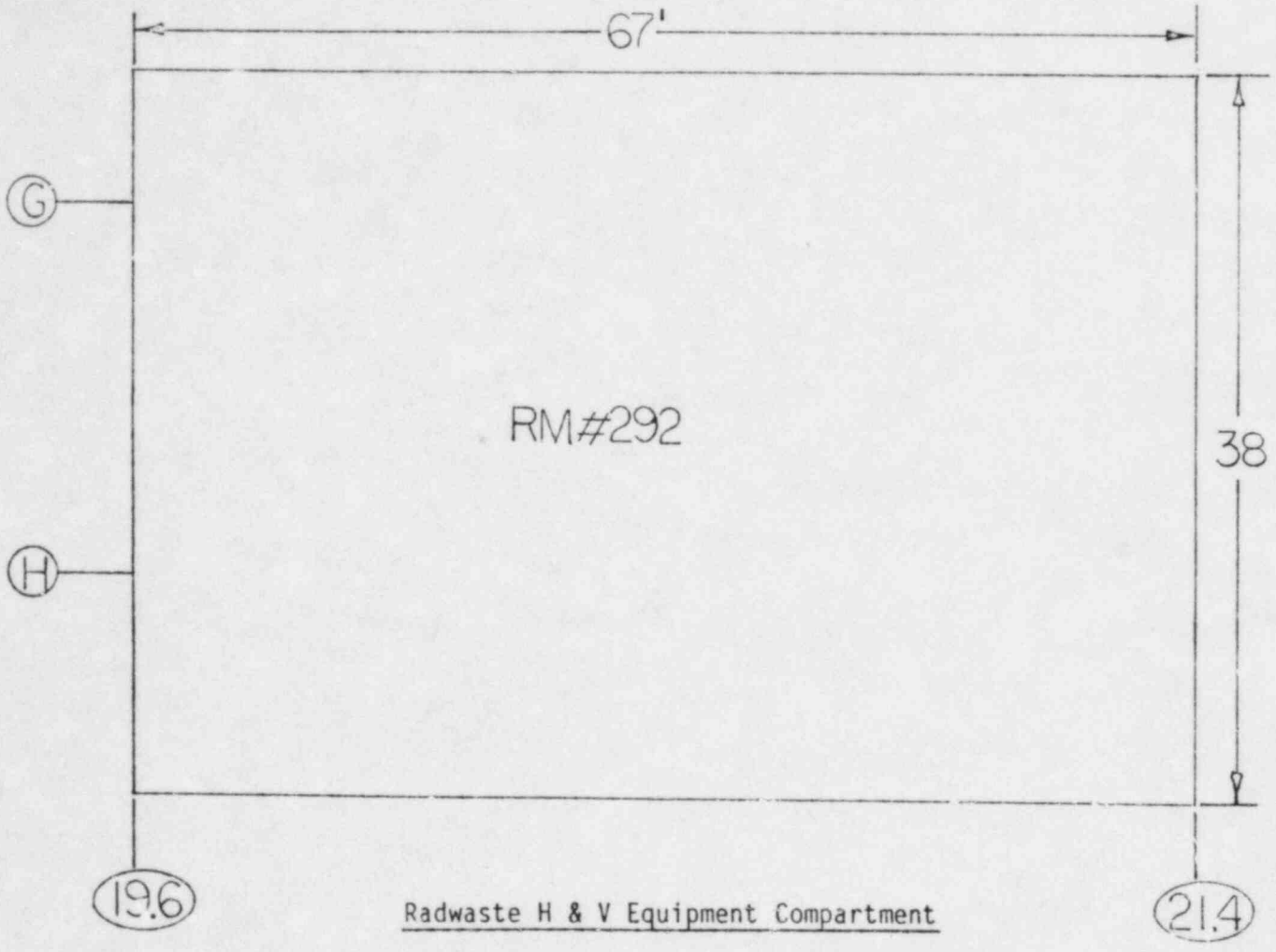
4. CASES EXAMINED

With the light combustible loading in this area, the assumption that all cables were burning simultaneously would present the worst case. Total surface area of the cable trays is 194 ft^2 which corresponds to a heat output of 3425 kW. With all cables burning at once the duration of the fire will be

$$3.3 \text{ lbs/ft}^2 \div \frac{0.1 \text{ lb}}{\text{min ft}^2} = 33 \text{ minutes.}$$

5. RESULTS

Since there is only one opening into this area the ventilation rate is fixed, however, with all cables burning simultaneously the fire is still fuel surface controlled. As can be seen from the results (see Attachment B) the room temperature is well below the critical temperature of the structural steel. The cable trays were located far enough below structural steel members to prevent localized heating effects.



Radwaste H & V Equipment Compartment

Surface Area Calculation

Walls

North wall	(38' x 14')	4732 ft^2
South wall	(38' x 14')	4732 ft^2
East wall	(67' x 14')	938 ft^2
West wall	(67' x 14')	938 ft^2
		11,340 ft^2
Ceiling	(67' x 38')	2546 ft^2
Total Surface Area for Heat Transfer		13,886 ft^2

ATTACHMENT A

CASE NO.: 1
BUILDING: RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: RADWASTE H&V EQMT. CMPT., 150' ELEV.
CASE DESCRIPTION: ALL CABLES BURNING

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
2	CONCRETE	98	12	13886	3425

FIRE IS FUEL CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	159.416
20	195.462
30	223.134
40	246.468

ATTACHMENT B

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 2

Reactor Building El. 165'

MG Set Vent Supply Fans

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Radwaste Building El. 165' MG Set Vent Supply Fans Unit 2 (see Attachment A for sketch of area under consideration). Bounding walls of area are reinforced concrete with an average thickness of 2.5 ft. Total surface area of bounding walls and ceiling is 8164 ft^2 (758 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

All cabling in this area is routed in conduit, there are no cable trays. There are no significant quantities of combustible liquids in this area.

3. VENTILATION PARAMETERS

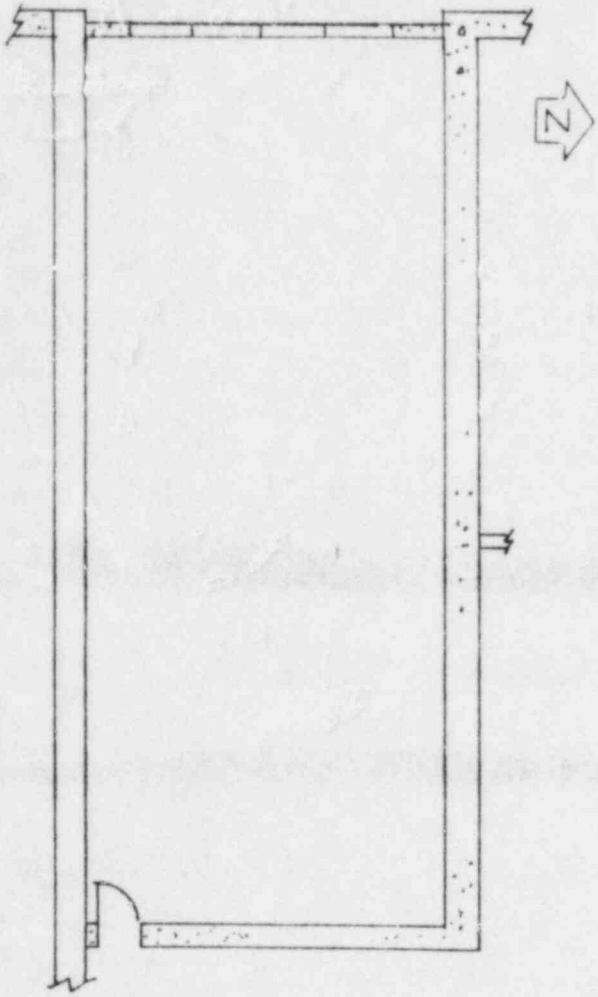
There is one 3' wide by 7' high door serving this area. Along the west wall are louvers measuring approximately 20' square.

4. CASES EXAMINED

With no exposed combustible cabling and no combustible liquids in the area, there is no fuel in the area to support a fire.

5. RESULTS

The structural steel in this area will not fail due to a fire as there is no fuel in the area to support a fire.



Radwaste Building El. 165'
MG Set Vent Supply Fans Unit #2

Surface Area Calculation

Walls

North wall	(73' x 29')	2117 ft^2
East wall	(30' x 29')	870 ft^2
South wall	(73' x 29')	2117 ft^2
West wall	(30' x 29')	870 ft^2
		5974 ft^2

Ceiling (73' x 30') 2190 ft^2

Total Surface Area for Heat Transfer 8164 ft^2

ATTACHMENT A

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 3

Reactor Building El. 165'

MG Set Vent Supply Fans

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Radwaste Building El. 165' MG Set Vent Supply Fans Unit 3 (see Attachment A for sketch of area under consideration). Bounding walls of area are reinforced concrete with an average thickness of 2.5 ft. Total surface area of bounding walls and ceiling is 8164 ft^2 (758 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

All cabling in this area is routed in conduit, there are no cable trays. There are no significant quantities of combustible liquids in this area.

3. VENTILATION PARAMETERS

There is one 3' wide by 7' high door serving this area. Along the west wall are louvers measuring approximately 20' square.

4. CASES EXAMINED

With no exposed combustible cabling and no combustible liquids in the area, there is no fuel in the area to support a fire.

5. RESULTS

The structural steel in this area will not fail due to a fire as there is no fuel in the area to support a fire.

Radwaste Building El. 165'
MG Set Vent Supply Fans Unit #3

Surface Area Calculation

Walls

North wall	(73' x 29')	2117 ft^2
East wall	(30' x 29')	870 ft^2
South wall	(73' x 29')	2117 ft^2
West wall	(30' x 29')	870 ft^2
		5974 ft^2

Ceiling (73' x 30') 2190 ft^2

Total Surface Area for Heat Transfer 8164 ft^2

ATTACHMENT A

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTUM ATOMIC GENERATING STATION

UNIT 2

Reactor Building El. 195'

West of Reactor Center Line

September 7, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 195', area west of reactor centerline from column lines 8 to 18 (see Attachment A for sketch of area under consideration).

Bounding walls of area are reinforced concrete with an average thickness 2.5 ft.

Total surface area of bounding walls and ceiling is 17,010 ft^2 (1581 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

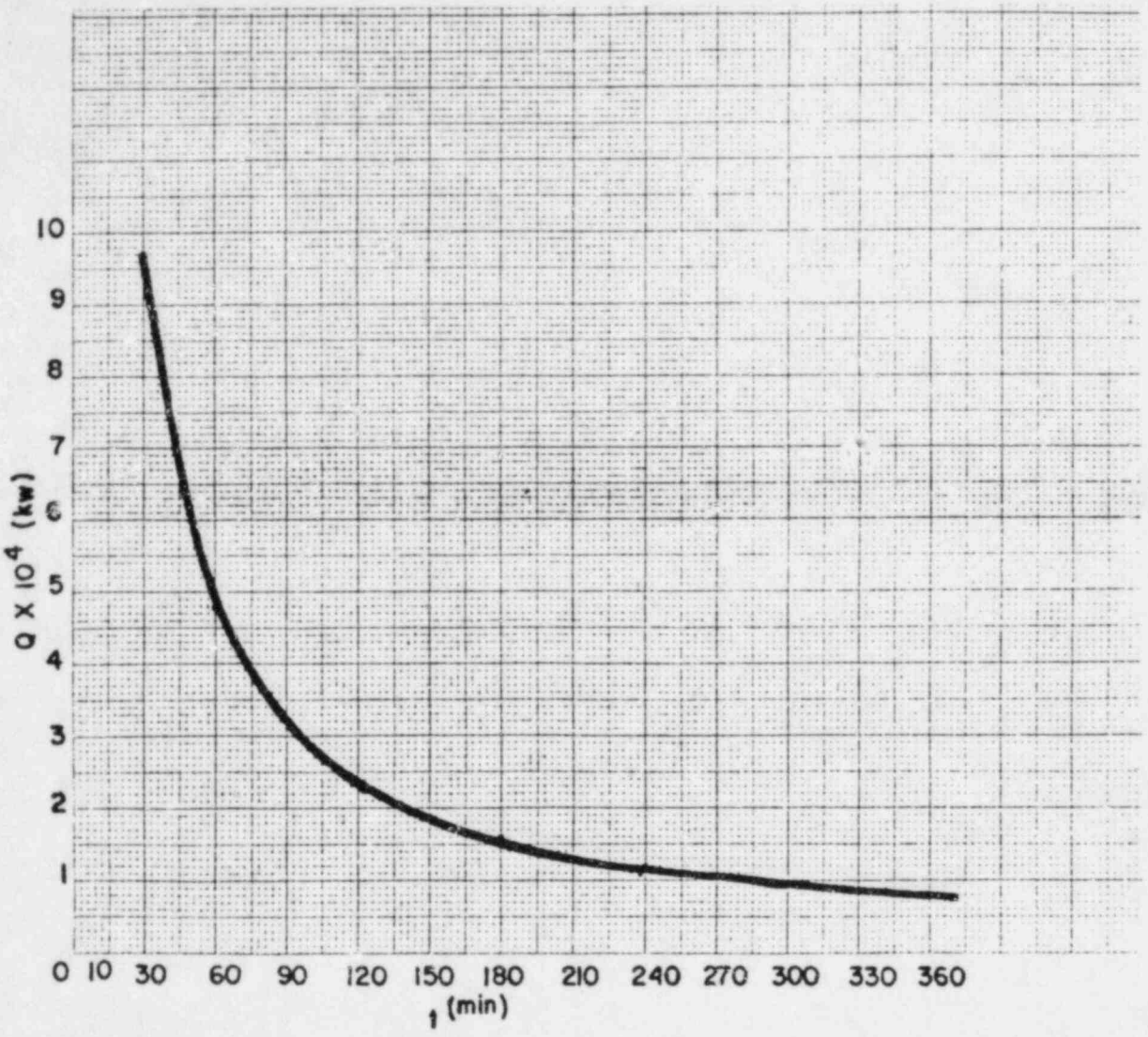
Combustible loading in this area consists of a single horizontal cable tray located along the west wall and a vertical tray leading to the floor below. Total surface area of cable trays is 100 ft^2 with an average combustible loading of the cable trays being 4 lbs/ft^2. All other cabling in area is routed in conduit and is not included in the combustible loading. There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

A 27 ft wide by 10 ft high opening into the area under consideration serves as the ventilation parameter. The other limiting factor will be the total volume of air in the Reactor Building available for combustion which is 1×10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

With the light combustible loading in this area the assumption that all cables are burning simultaneously would present the worst case. With all cables burning a surface area of 100 ft^2 would be involved. This corresponds to a heat output of approximately 1770 kW. With all cables



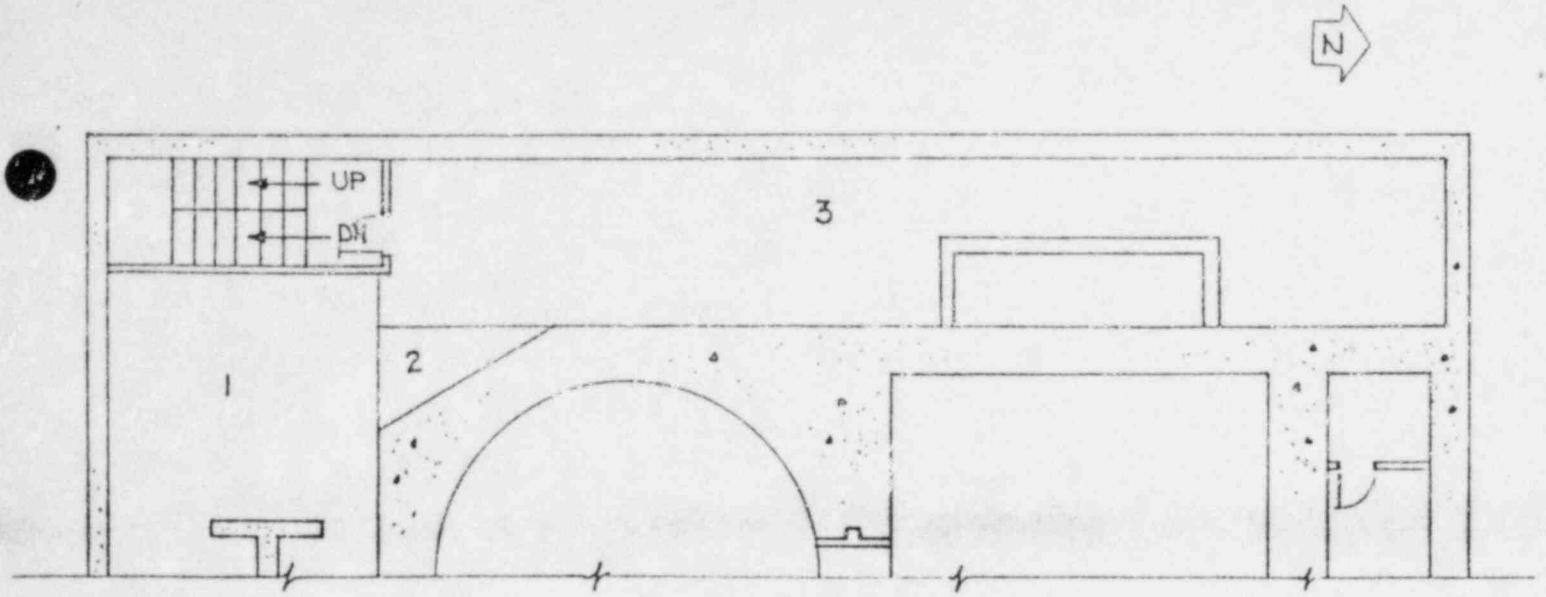
assumed to be burning simultaneously the duration of the fire will be

$4\ \text{lbs/ft}^2 \div \frac{0.1\ \text{lb}}{\text{min ft}^2} = 40$ minutes.

From the chart above the volume of air in the Reactor Building will not have an effect on the fire duration.

5. RESULTS

The worst case examined is with all cable trays in the area burning simultaneously with a ventilation opening measuring 27 ft wide by 10ft high. The gas temperature at the ceiling would be 145°F (see Attachment B) which will not fail the structural steel in the area. The cable trays in this area were positioned such that they did not present a localized heating exposure to structural steel.



Surface Area Calculation

Walls

West wall	(134' x 38')	5092 ft^2
South wall	(35' x 38')	1330 ft^2
North wall	(18' x 38')	684 ft^2
East wall	(140' x 38') + (24' x 10')	5560 ft^2
Stairwell	(19' x 38') + (8' x 38')	1026 ft^2
		13,692 ft^2

Ceiling

Area 1	[36' x 52' - (19' x 8')]	1720 ft^2
Area 2	1/2 (11' x 18')	99 ft^2
Area 3	(101' x 18') - 11' x 29'	1499 ft^2
		3318 ft^2

Total Surface Area for Heat Transfer 17,010 ft^2 (1581 m^2)

ATTACHMENT A

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 195' AREA WEST OF REACTOR CENTER LINE
CASE DESCRIPTION: ONE OPENING ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	270	10	17016	1770

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	109
20	124
30	136
40	145

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

UNIT 2

Reactor Building El. 195'

East of Reactor Center Line

Excluding Heating Equipment Area

September 7, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 195', area east of reactor centerline excluding Reactor Building Ventilating Equipment Area (Rooms 506, 510, and 511) (see Attachment A for sketch of area).

Bounding walls of area are reinforced concrete with an average thickness 2.5 ft.

Total surface area of bounding walls and ceiling is 18,741 ft^2 (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

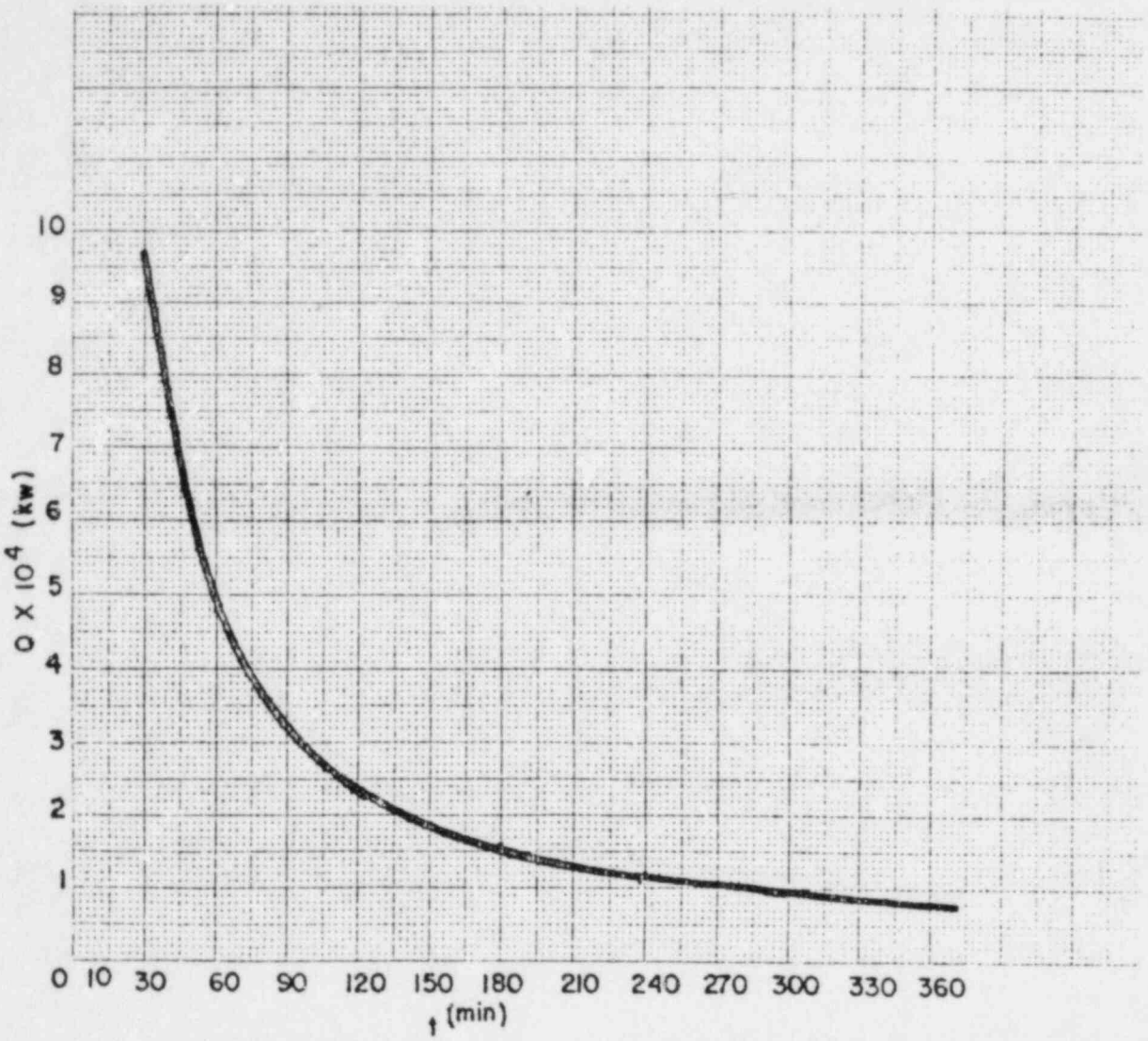
The area of heaviest cable concentration is located in the corridor which separates the Reactor containment wall and the Ventilation Equipment Area. The total surface area of cables in this area is 441 ft^2 with an average combustible loading of the cable trays being 4 lb/ft^2. A listing of the cable trays under consideration is included in Attachment B. There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

The opening at the south end of the corridor separating the ventilating equipment and containment wall will serve as the ventilation opening for a fire in this area. The opening measures 9 ft wide by 38 ft high. A possible limiting factor will be the total volume of air in the Reactor Building available for combustion which is 1×10^5 m^3. The curve below shows the duration of a fire at a given heat output.

4. CASES EXAMINED

With the light combustible loading in this area the assumption that all cables are burning simultaneously would present the worst case. With all cables burning a surface area of 441 ft^2 would be involved. This

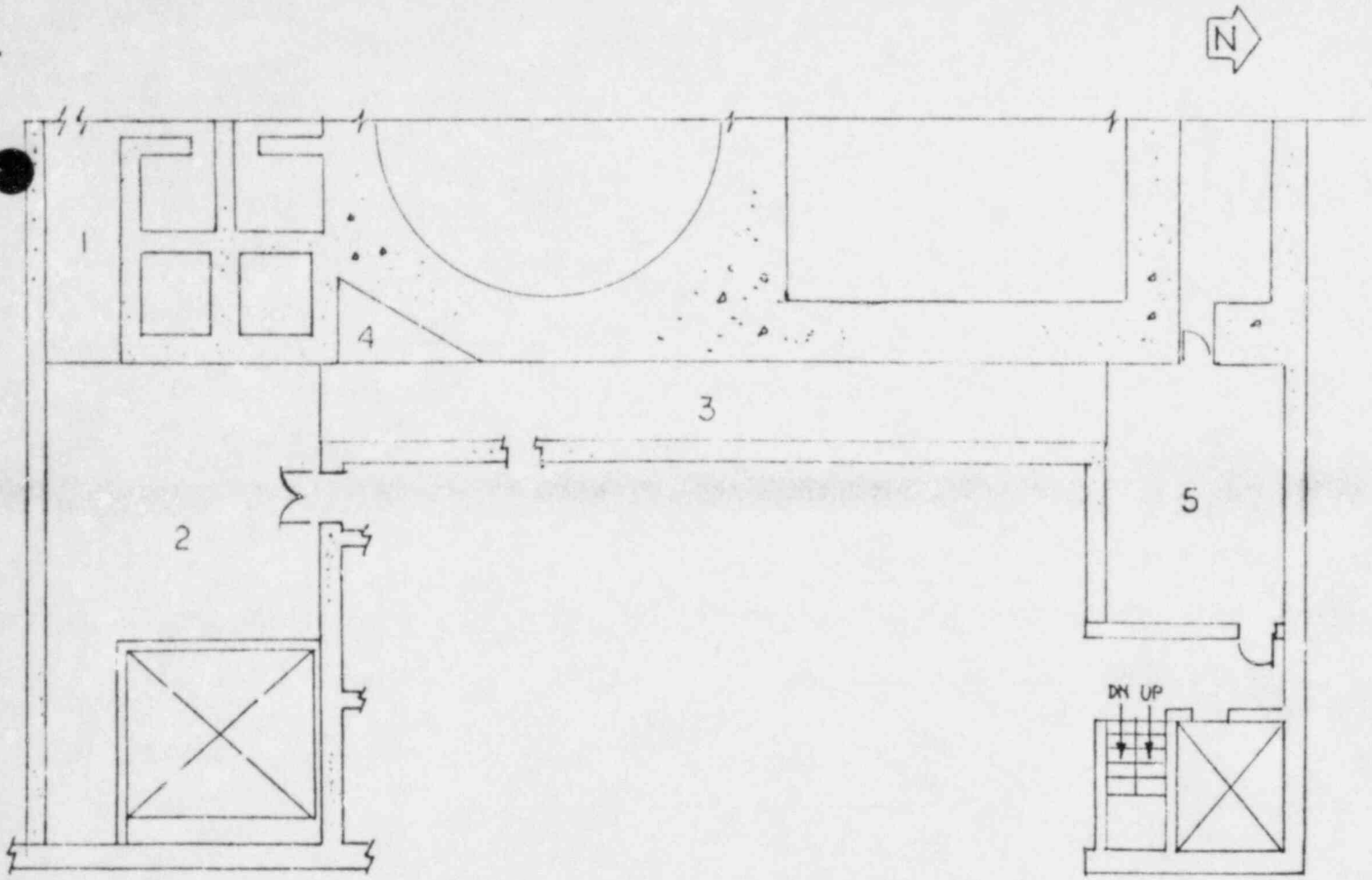


corresponds to a heat output of approximately 7787 kw. With all cables assumed to be burning simultaneously the duration of the fire will be $4 \text{ lbs/ft}^2 \div \frac{0.1 \text{ lb}}{\text{min ft}^2} = 40$ minutes.

From the chart above, the volume of air in the Reactor Building will not have an effect on the fire duration.

5. RESULTS

The worst case examined is with all cable trays located in the corridor burning simultaneously with a ventilation opening measuring 9 ft wide by 38 ft high. The gas temperature at the ceiling would be 366°F (see Attachment C) which will not fail the structural steel in the area. The cable trays in this area were positioned such that they did not present a localized heating exposure to structural steel.



UNIT 2 Reactor Building El. 195'

Surface Area Calculation

Walls

West wall	(139' x 38')	5282 ft^2
North wall	(30' x 38') + (24' x 10' south wall of Room 500 & 509)	1380 ft^2
South wall	(74' x 38')	2812 ft^2
East wall	(153' x 38')	5814 ft^2
		15,288 ft^2

Ceiling

Area 1	(28' x 25')	700 ft^2
Area 2	(30' x 50') - (21' x 17' open hatch)	1143 ft^2
Area 3	(108' x 9')	972 ft^2
Area 4	1/2 (15' x 17')	127.5 ft^2
Area 5	(17' x 30')	510 ft^2
		3453 ft^2

Total Surface Area for Heat Transfer 18,741 ft^2 (1741 m^2)

ATTACHMENT A

Cable Trays considered to be burning simultaneously:

Horizontal Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
2NA010	7.5	24	15
2NA020	41.5	24	83
2NB020	60	24	120
2NB030	41	24	82
2NB040	19	24	38
2NE010	20	24	40
Vertical Tray No.			
2NV010	4	12	4
2NV020	4	12	4
2NV030	4	12	4
2NV040	4	12	4
2NV120	4	12	4
2NV130	4	12	4
2NV050	3	12	3
2NV060	3	12	3
2NV070	3	12	3
2NV080	3	12	3
2NV090	3	12	3
2MV460	12	24	24
			441 ft^2

$$\frac{441\ ft^2}{10.75\ ft^2/m^2} \times 190\ \frac{kw}{m^2} = 7787\ kw$$

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 195' EAST OF REACTOR CENTER LINE
CASE DESCRIPTION: ONE OPENING ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	342	30	18741	7787

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	219
20	280
30	327
40	366

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

UNIT 2

Reactor Building El. 195' & 214'

Reactor Building Ventilating Equipment Area

and

Reactor Building Fan Room

September 7, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 195', Reactor Building Ventilating Equipment Area (Room 506) and Reactor Building Fan Room El. 214' (Room 529) (see Attachment A for sketch of area under consideration).

Bounding walls of area are reinforced concrete with an average thickness of 2.5 ft.

The area for heat transfer is considered only to be the walls and ceiling of the Reactor Building Fan Room El. 214' (Room 529). This was assumed because of the open grating in the Reactor Building Ventilating Equipment Area ceiling and the open stairway in the northwest corner which will allow the passage of heated gases to the Fan Room El. 214'. The total surface area of bounding walls and ceiling is 9334 ft (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

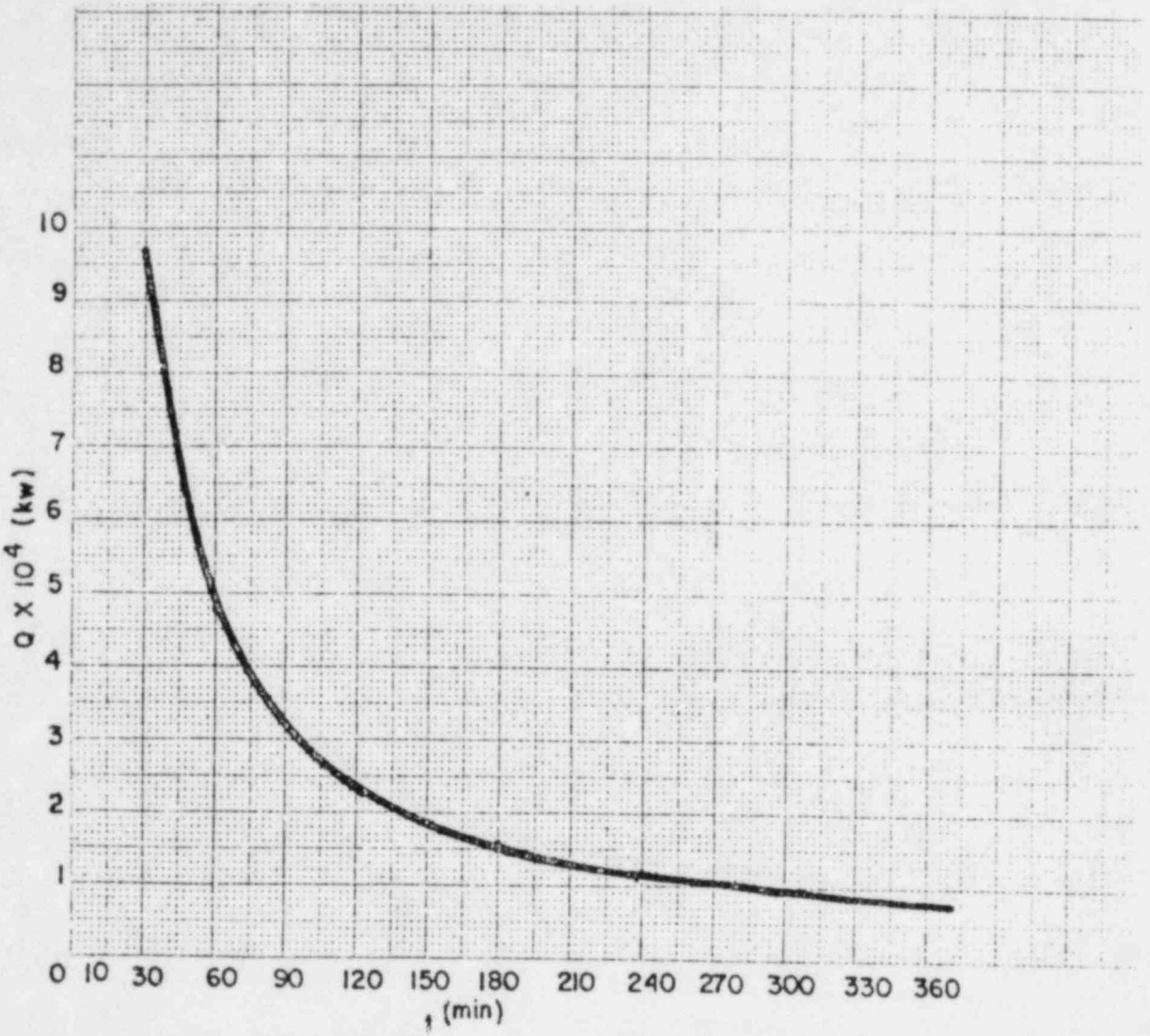
The heaviest combustible loading is in the Reactor Building Ventilating Equipment Area. The total surface area of cable trays in the area is 413 ft^2 with an average combustible loading of 4 lbs/ft^2. There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

There are two doors located on the 195' elevation which can provide air for combustion. A set of double doors at the south end of the Ventilating Equipment Area and a single door into the stairwell. A limiting factor for the duration of the fire will be the total volume of air in the Reactor Building which is 1×10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

With the light combustible loading in this area the assumption that all cables are burning simultaneously would present the worst case. With all cables burning a surface area of 413 ft^2 would be involved. With all cables assumed to be burning simultaneously, the duration of the



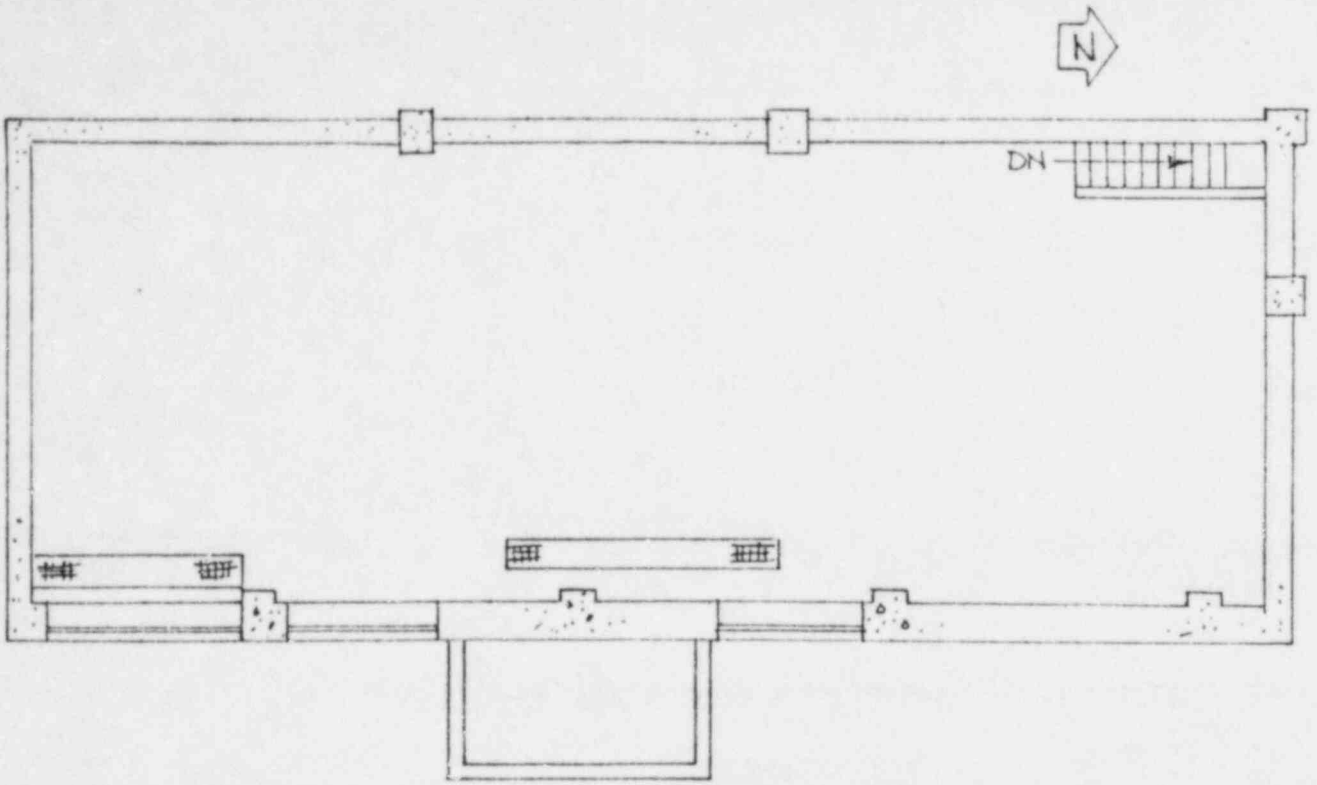
fire will be

$$4 \text{ lbs/ft}^2 \div \frac{0.1 \text{ lb}}{\text{min ft}^2} = 40 \text{ minutes.}$$

Cases were evaluated using one or more of the doors leading into the room as being open. From the chart above, the volume of air in the Reactor Building will not have an effect on the fire duration.

5. RESULTS

Two cases were examined each having different ventilation parameters. Case Number 1 had one 3' wide x 7' high door open. The fire is ventilation controlled and the resultant heat output of the fire would be 4504 kW which produces a gas temperature of 413°F (see Attachment C). Case Number 2 had the double doors measuring 6' wide x 7' high open. This produces a fuel controlled fire with a maximum gas temperature of 625°F (see Attachment D). These temperatures will not fail the structural steel in the area. The cable trays in this area were positioned such that they did not present a localized heating exposure to structural steel.



Unit 2 Reactor Building Fan Room El. 195'

Surface Area Calculation

Walls

North wall	(37' x 20')	740 ft^2
East wall	(102' x 20')	2040 ft^2
South wall	(37' x 20')	740 ft^2
West wall	(102' x 20')	2040 ft^2
		5560 ft^2
Ceiling	(37' x 102')	3774 ft^2
Total Surface Area for Heat Transfer		9334 ft^2

ATTACHMENT A

Cable Trays

Cable Trays considered to be burning simultaneously:

Horizontal Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
2NA020	10	24	20
2NC010	11	24	22
2ND010	20	24	40
2ND020	22	24	44
2ND030	7	24	14
2NF010	28	24	56
2NF020	28	24	56
Vertical Tray No.			
2MV420	16	24	32
2NV100	24	4	8
2NV101	12	3	3
2NV110	24	4	8
2NV140	24	16	32
2NV160	24	16	32
2NV161	24	2	4
2NV150	21	24	42
			413 ft^2

$$\frac{413\ ft^2}{10.76\ ft^2/m^2} \times 190\ \frac{kw}{m^2} = 7293\ kw$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 195' VENTILATING EQUIPMENT AREA
CASE DESCRIPTION: ONE DOOR OPEN 3'X 7' ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	21	7	9334	4504

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	243
20	314
30	368
40	413

ATTACHMENT C

CASE NUMBER: 2
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 195' VENTILATING EQUIPMENT AREA
CASE DESCRIPTION: DOUBLE DOORS OPEN 6'X 7' ALL CABLES BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	42	7	9334	7293

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	349
20	463
30	551
40	625

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 3

Cooling Water Equipment Room No. 162

Fire Zone 12B

September 12, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Cooling Water Equipment Room in the Radwaste Building El. 116' Unit 3, Room 162, Fire Zone 12B (see Attachment A for sketch of area). Bounding walls of the area are reinforced concrete with an average thickness of 2.5 ft. Total surface area of bounding walls and ceiling is 9,852 ft^2 (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

The area combustible loading consists of cable insulation. The cable trays containing these cables run along the perimeter of the room. The total cable tray surface area is 728 ft^2 with an average combustible loading of 5.5 lbs/ft^2. A listing of the cable trays under consideration is included in Attachment B. There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

There are two door openings 3' x 7' considered in this analysis. This represents a total of 42 ft^2 of ventilation openings.

The total volume of air available for combustion in the room is 1759 m^3. The curve in figure 1 shows the fire duration (min) for a given heat output (kW) given the volume of air in the room.

Due to the large amount of combustible cabling in the room in comparison to the air available, the fire in this area will be ventilation controllled.

4. CASES EXAMINED

With the high combustible loading compared to air availability, the worst case fire would involve all the cables burning simultaneously with the maximum ventilation openings available. However, since the fire is ventilation controlled by openings of 42 ft^2 the maximum heat release is 9008 kW. The calculations in Attachment B show a 12,867 kW fire with all the cables burning across a cable tray surface area of 728 ft^2.

17-2

This indicates that only 70% of the cable tray surface area could be burning simultaneously. Therefore, the worst case fire we can assume is one in which 70% of the cable trays burn for a duration of:

$$5.5 \text{ lb/ft}^2 \div \frac{0.1 \text{ lb}}{\text{min ft}^2} = 55 \text{ minutes}$$

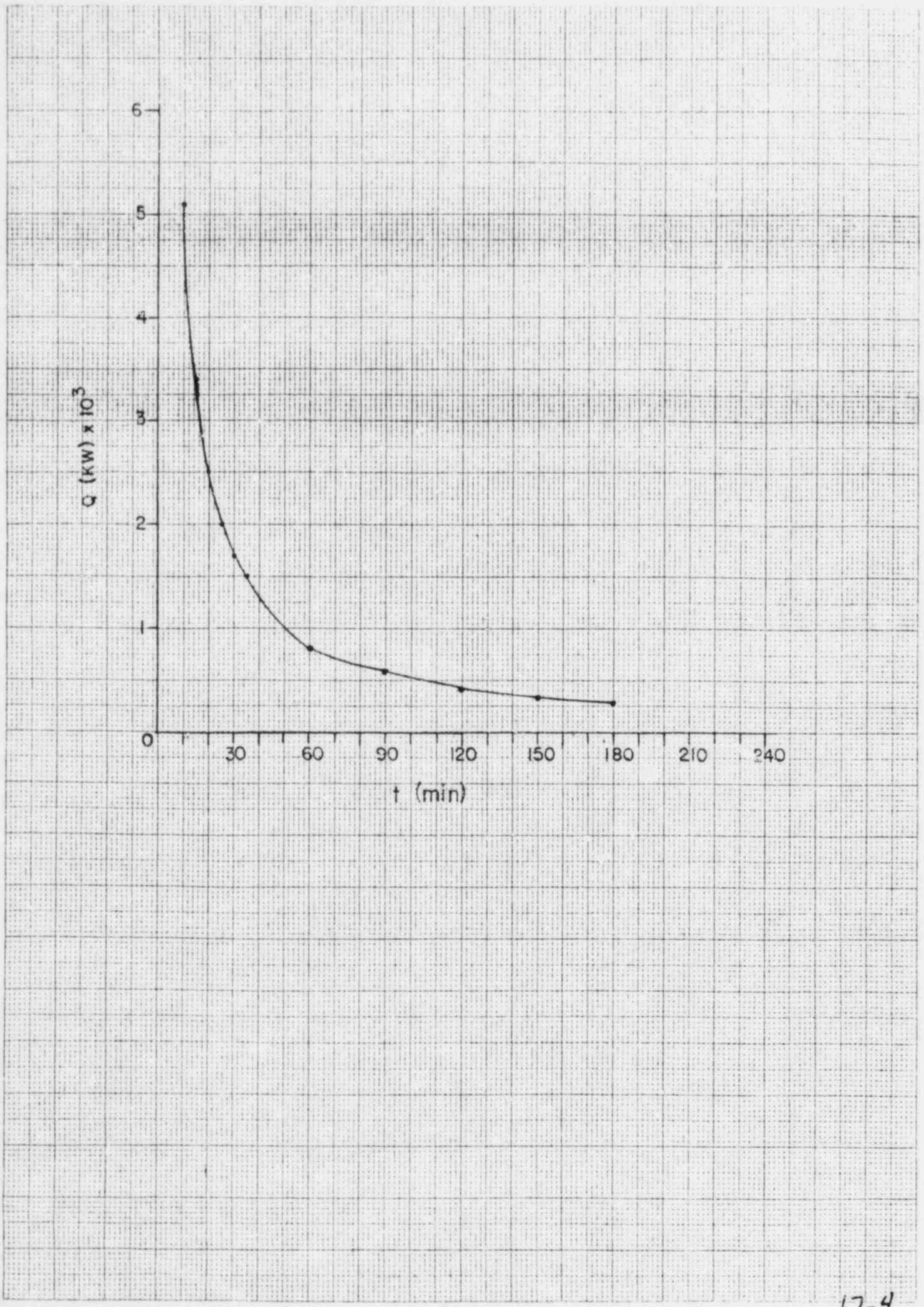
under ventilation controlled conditions. To include the remaining 30% of cable insulation we assume enough surface area is involved to maintain the fire at 9008 kW until the remaining cable is consumed. Since 70% of the 4.2×10^7 kj of heat energy available from cable insulation is generated in the first 55 minutes, this leaves 1.3×10^7 kj of heat energy remaining to be released. Assuming surface exposure conditions are correct to continue the fire at 9008 kW, the fire would then continue for an additional 23 minutes before all the combustible material had beeen consumed.

5. RESULTS

Even with this hypothetical worst case fire scenario, the gas temperature at the ceiling would only reach 975°F (see the calculations in Attachment C) which is not sufficient to fail the structural steel in the area.

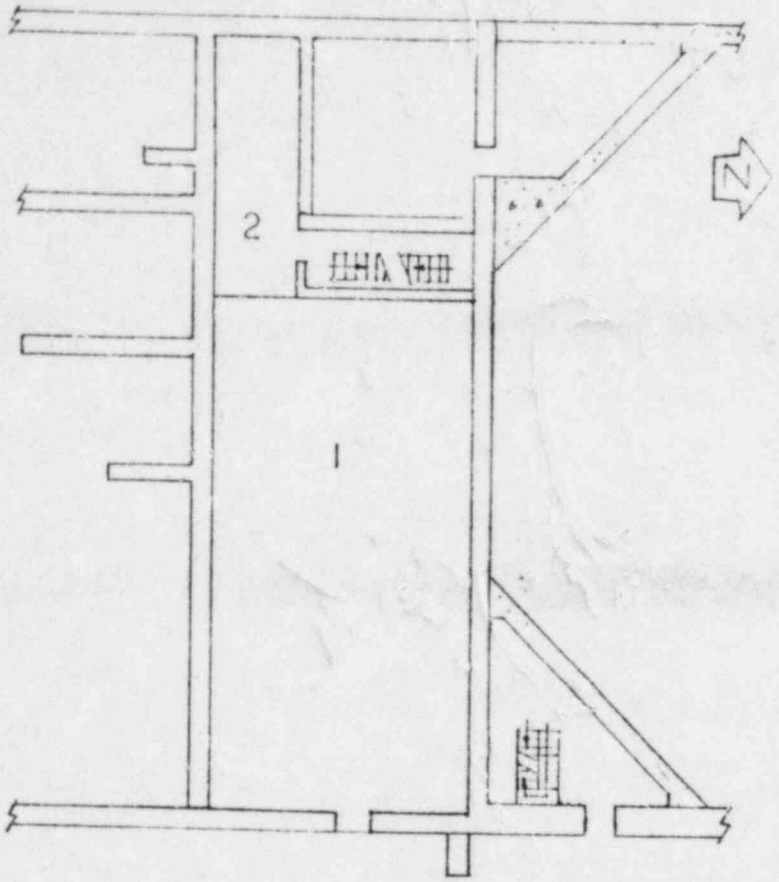
There are no cables located within 3 feet of any structural steel, therefore, localized heating is not a factor. The critical steel temperature will not be exceeded so a detailed analysis of the steel will not be performed.

Heat Output Duration for Available Air in Room



17-4

Figure 1



Unit 3 Cooling Water Equipment Room El. 116'

Surface Area Calculation

Walls

North wall zone 1	(18' x 98')		1764 ft^2
South wall zone 1	(18' x 98')		1764 ft^2
East wall zone 1	(18' x 30')	- (3' x 7' door)	519 ft^2
West wall zone 1	(18' x 20')		360 ft^2
North wall zone 2	(18' x 51')	- (3' x 7' door)	897 ft^2
South wall zone 2	(18' x 51')		918 ft^2
West wall zone 2	(18' x 10')		180 ft^2
			6402 ft^2

Ceiling

Area 1	(98' x 30')	2940 ft^2
Area 2	(51' x 10')	510 ft^2
		3450 ft^2

Total Surface Area for Heat Transfer 9852 ft^2 (916 m^2)

ATTACHMENT A

Cable Trays

Horizontal Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
ZB3GB03	8	24	16
ZA3GB01	36	24	72
ZA3GB02	4	24	8
ZA3GB03	5	24	10
ZA3GB04	4	24	8
ZA3GB05	11	24	22
ZB3GB04	4	24	8
ZA3GA02	3	24	6
ZA3GA03	3	24	6
ZA3GA04	4	24	8
ZA3GA05	14	24	28
ZB3GB03	16	24	32
ZA3GD04	32	24	64
ZA3GD05	26	24	52
ZA3GB05	5	24	10
ZA3GB06	5	24	10
ZA3GB07	5	24	10
ZA3GB08	5	24	10
ZA3GB09	18	24	36
ZA3GB10	28	24	56
ZA3GA05	5	24	10
ZA3GA06	5	24	10
ZA3GA07	5	24	10
ZA3GA08	5	24	10
ZA3GA09	15	24	30
ZA3GA10	28	24	56
Vertical Tray No.			
ZA3GV05	4	12	4
ZA3GV06	4	12	4
ZA3GV07	4	12	4
ZA3GV08	4	12	4
ZA3GV09	4	12	4
ZA3GV10	4	12	4
ZA3GV11	4	12	4
ZA3GV12	4	12	4
ZA3GV32	3	24	6
ZA3GV43	3	24	6
ZA3GV21	4	24	8
ZA3GV22	8	24	16
ZB3GV01	6	24	12
ZA3GV31	7	24	14
ZA3GV42	6	24	12
ZA3GV01	12	24	24
Total Surface Area for Heat Release			728 ft^2

$$\frac{728\ ft^2}{10.75\ ft^2/m^2} \times 190\ kW/m^2 = 12{,}867\ kW$$ assuming all cable involved simultaneously

ATTACHMENT B

CASE NUMBER: 1
BUILDING: RADWASTE UNIT 3
ELEVATION AND AREA DESCRIPTION: 116' EL. COOLING WATER EQUIPMENT ROOM
CASE DESCRIPTION: TWO DOORS AND CABLES

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	AW (ft2)	Q (kW)
2.5	CONCRETE	42	7	9852	9008

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
4	277
8	362
12	427
16	481
20	530
24	573
28	613
32	651
36	686
40	719
44	750
48	780
52	809
56	837
60	864
64	890
68	915
72	940
76	963
80	987

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

COMMON AREA

Radwaste Building El. 135'

Personnel Decontamination Station

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Personnel Decontamination Station (Room 239) in the 135' elevation of the Radwaste Building. (See Attachment A for a sketch of the area under consideration.) Bounding walls of the area are reinforced concrete construction with an average thickness of 1 ft. Total surface area of the bounding walls and ceiling is 1848 ft^2 (see Attachment A for a calculation of heat loss surface area).

2. COMBUSTIBLE LOADING

Fixed combustible loading in this area consists of horizontal and vertical cable trays located above the suspended ceiling. Total surface area of the cable trays is 56 ft^2 with an average combustible loading in the trays being 5.2 lbs/ft^2 of tray surface area. All other cabling in this area is routed in conduit and is not included in the combustible loading.

3. VENTILATION PARAMETERS

This area is served by two personnel doors, each being 3 ft wide by 7 ft high.

4. CASES EXAMINED

With the light combustible loading in this area, the assumption that all cables were burning simultaneously would present the worst case. A surface area of 56 ft^2 would be involved if all trays were burning at once. This corresponds to a heat output of 990 kW. With all cables burning simultaneously the duration of the fire would be

$$5.2 \text{ lbs/ft}^2 \div \frac{0.1 \text{ lb}}{\text{min ft}^2} = 52 \text{ minutes.}$$

5. RESULTS

The only case examined was with all cables burning simultaneously with one door open (see Attachment B for results of analysis). Since the fire was fuel controlled under this set of circumstances there is no need to examine the case with additional doors open. The peak fire temperature reached was less than 600°F. This is well below the critical temperature of the structural steel.

As can be seen on the sketch included in Attachment C, cable tray 2RU010(I) passes below two structural members and is located within 1 ft of the bottom of the beams. Attachment C includes the results of calculations performed to determine the response of the structural members. The beam temperatures approach but do not reach their critical temperatures. These results are very conservative because they are based on the entire member being exposed to a temperature of 1500°F rather than just the short sections (approximately 2 ft long) which are actually exposed.

Personnel Decontamination Station

Surface Area Calculation

Walls

North wall	(19' x 14')	266 ft^2
South wall	(19' x 14')	266 ft^2
East wall	(28' x 14')	392 ft^2
West wall	(28' x 14')	392 ft^2
		1316 ft^2
Ceiling	(28' x 19')	532 ft^2
Total Surface Area for Heat Transfer		1848 ft^2

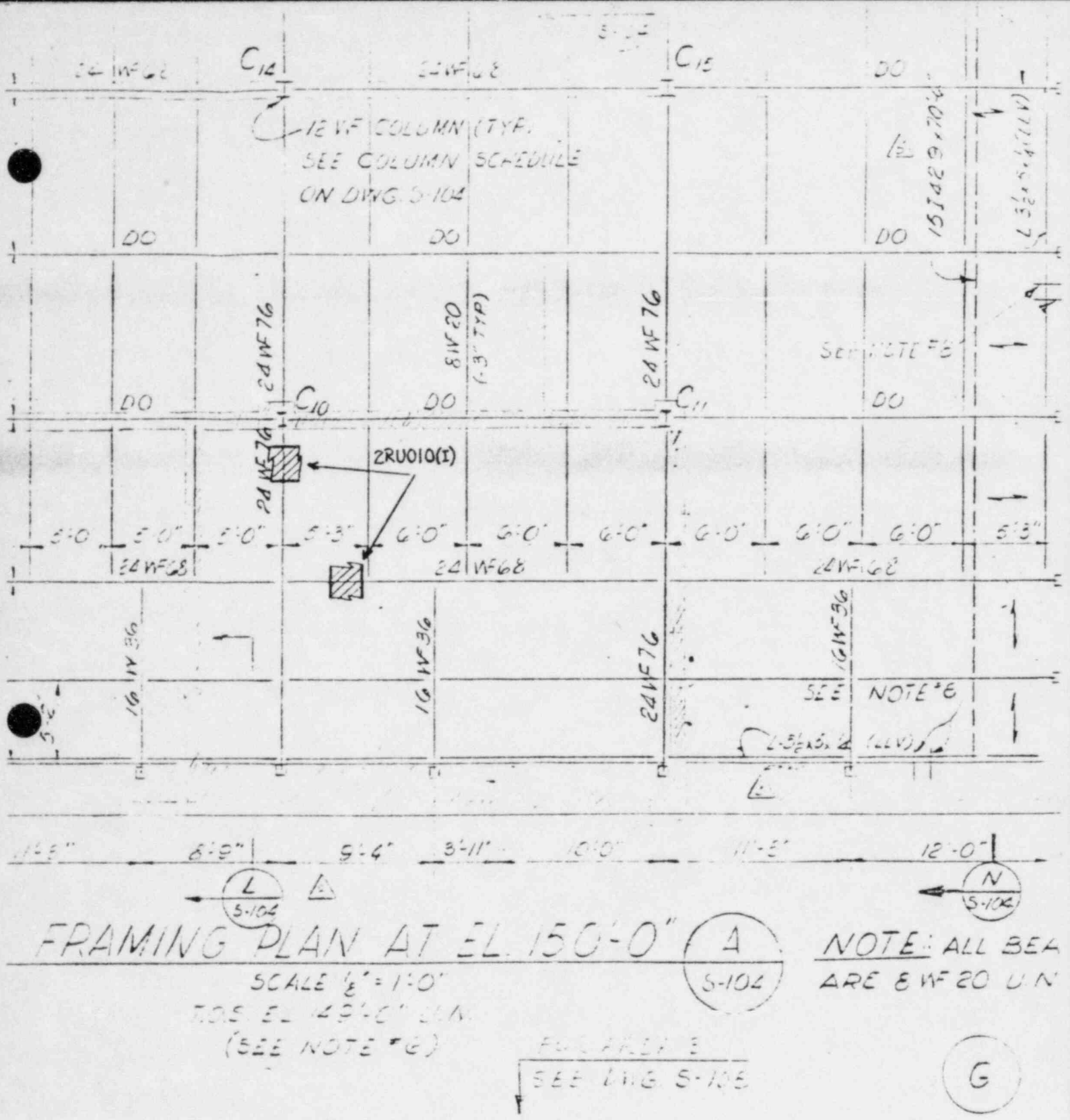
CASE NO.: 1
BUILDING: RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: PERSONNEL DECONTAMINATION STN., 135' ELEV.
CASE DESCRIPTION: ONE DOOR OPEN, ALL CABLES BURNING

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
1	CONCRETE	21	7	1848	990

FIRE IS FUEL CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
52	593.981

ATTACHMENT B



FRAMING PLAN AT EL. 150'-0"

SCALE ⅛" = 1'-0"

TOS EL. 149'-0" U.N.
(SEE NOTE "G")

A
S-104

NOTE: ALL BEA
ARE E WF 20 U N

FOR PANEL E
SEE DWG. S-105

G

ATTACHMENT C

18-6

CASE NO.: 1
BUILDING: RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: PERSONNEL DECONTAMINATION STN., 135' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 24WF76

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 76
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 5.34

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	465.777323
10	753.061073
15	960.54387
20	1110.392623
25	1218.61677
30	1296.778688
35	1353.228987
40	1393.998665
45	1423.443444
50	1444.709129
55	1460.067684

ATTACHMENT C

CASE NO.: 2
BUILDING: RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: PERSONNEL DECONTAMINATION STN., 135' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 24WF68

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 68
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 5.31

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	510.077044
10	815.679149
15	1026.937904
20	1172.978331
25	1273.934177
30	1343.723639
35	1391.968185
40	1425.319012
45	1448.374004
50	1464.31162
55	1475.329087

ATTACHMENT C

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

UNIT 2

Radwaste Building El. 135'

Reactor Recirculation Pump MG Set Room

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Recirculation Pump MG Set Room (Rm 206) on the 135' elevation of the Radwaste Building. (See Attachment A for a sketch of the area under consideration.) Bounding walls of the area are reinforced concrete construction with an average thickness of 2 ft. Total surface area of the bounding walls and ceiling is 12,124 ft^2 (see Attachment A for a calculation of heat loss surface area).

2. COMBUSTIBLE LOADING

Fixed combustible loading in this area consists of cable trays and lubricating oil for the MG sets. Total surface area of the cable trays is 971 ft^2 with an average combustible loading in the trays of 5.9 lbs/ft^2 of tray surface area. The lube oil systems for the MG sets contain 2200 gallons of oil. Fires involving burning pools of flammable or combustible liquids reach an equilibrium size when the rate at which liquid is spilled or leaked into the pool equals th rate at which it is being burned off. Attachment C is a graph that reflects equilibrium pool fire burning rates and duration for the complete combustion of 2200 gallons of lube oil.

3. VENTILATION PARAMETERS

This area is served by two personnel doors, one of which is located in the east wall and the other at the stairwell on the west side of the room.

4. CASES EXAMINED

Two cases were examined for this area and both were ventilation controlled. The first case was for one of the doors being open which supported a burning rate of approximately 4500 kW. The second case was for both doors open which supported a burning rate of approximately 9000 kW. In both cases the fire duration was assumed to be 3 hours.

5. RESULTS

The case with both doors open turned out to be the worst case (see Attachment B for results of analyses). The fire temperature reached at 180 minutes was approximately 1200°F which is below the critical temperature for the structural steel.

The ventilation controlled burning rate of 9008 kW is equivalent to the heat output from a pool fire with an area of 27.9 ft^2 (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 located at ceiling level directly above the fire, Heskested's (1) relations will be used:

Virtual point source determination:

$$Z_o = -1.02D + 0.083Q^4 = 1.3m$$

Plume temperature at bottom of steel:

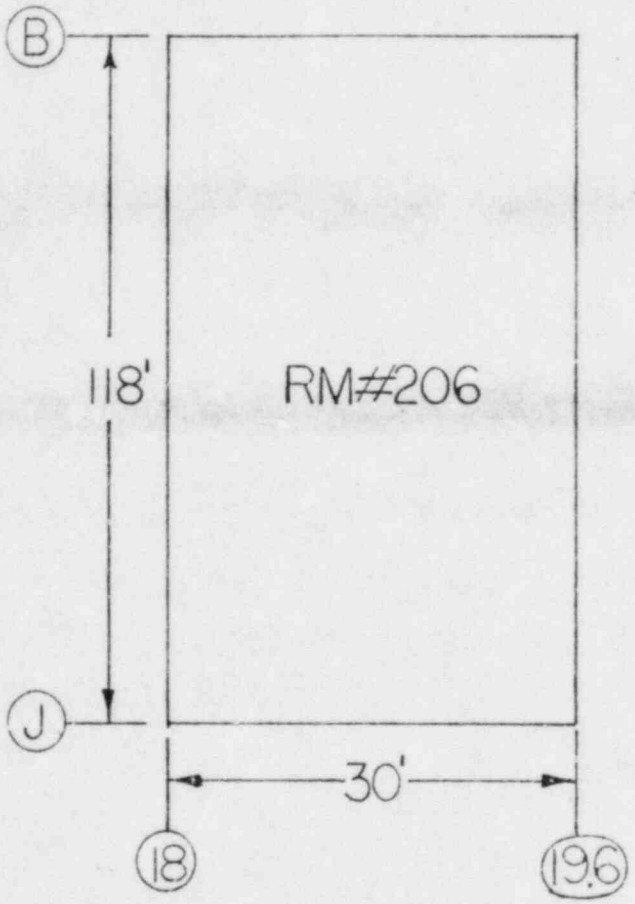
$$\Delta T_o = 9.1[T_\infty / (gC^2p \rho_\infty^2)]^{.333} Q_c^{.667} (Z - Z_o)^{-1.67}$$

$$\Delta T_o = 344 \text{ K temperature rise}$$

$$T = 687°F$$

This temperature is well below the critical temperature for 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 structural steel.



Unit 2 RCP MG Set Room

Surface Area Calculation

Walls

North wall	(118' x 29')	3422 ft^2
South wall	(118' x 29')	3422 ft^2
East wall	(30' x 29')	870 ft^2
West wall	(30' x 29')	870 ft^2
		8584 ft^2
Ceiling	(118' x 30')	3540 ft^2
Total Surface Area for Heat Transfer		12,124 ft^2

ATTACHMENT A

CASE NO.: 1
BUILDING: RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: UNIT 2 RX RECIRC PMP MG SET ROOM, 135' ELEV
CASE DESCRIPTION: ONE DOOR OPEN

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
2	CONCRETE	21	7	12124	4504.23

FIRE IS VENTILATION CONTROLLED

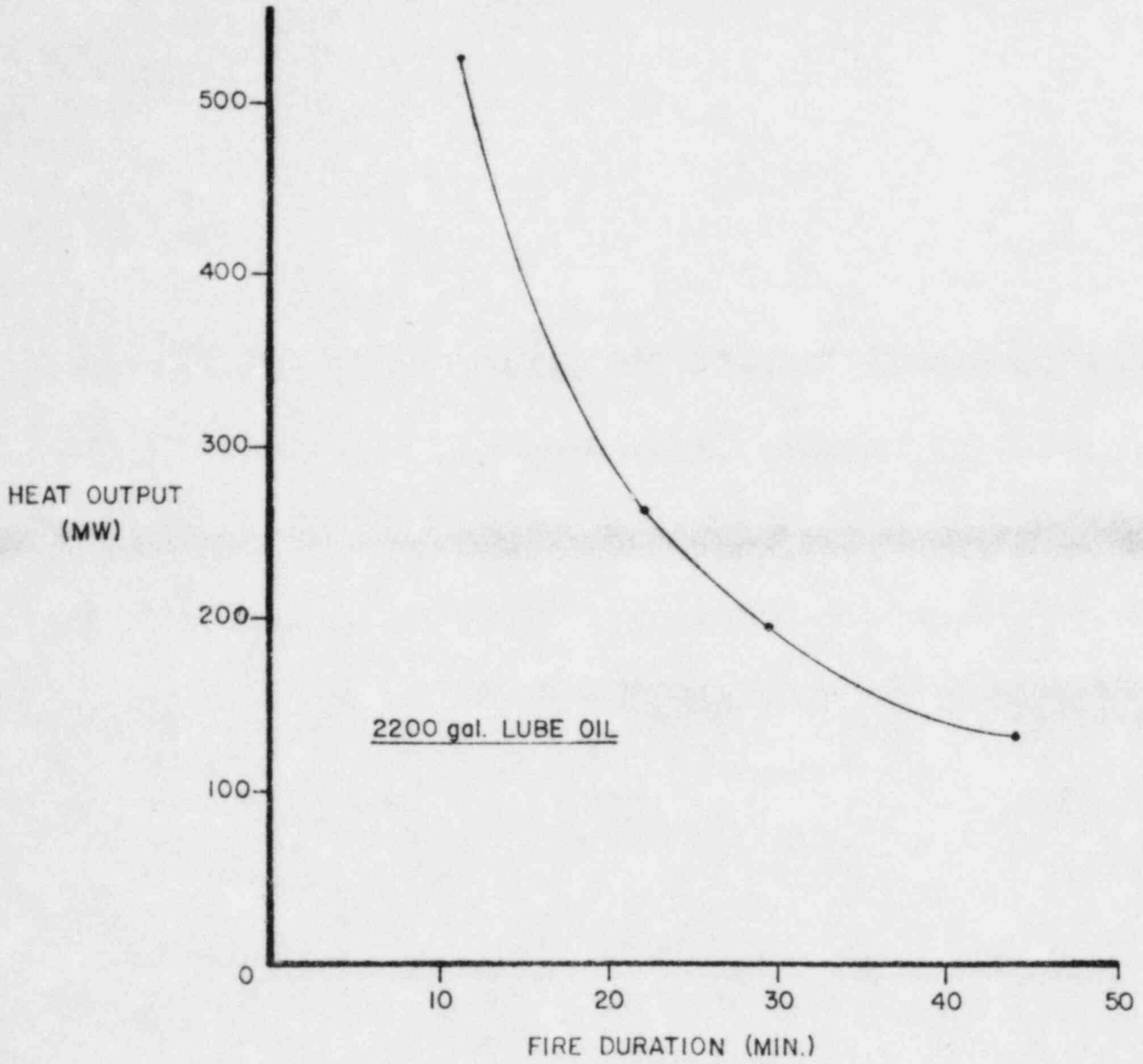
FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	203.709
20	257.990
30	299.668
40	334.818
50	365.794
60	393.804
70	419.565
80	443.546
90	466.071
100	487.378
110	507.645
120	527.011
130	545.587
140	563.461
150	580.708
160	597.390
170	613.559
180	629.260

CASE NO.: 2
BUILDING: RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: UNIT 2 RX RECIRC PMP MG SET ROOM, 135' ELEV.
CASE DESCRIPTION: BOTH DOORS OPEN

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
2	CONCRETE	42	7	12124	9008.45

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	335.228
20	443.825
30	527.225
40	597.565
50	659.550
60	715.599
70	767.148
80	815.132
90	860.203
100	902.835
110	943.385
120	982.131
130	1019.29
140	1055.05
150	1089.56
160	1122.93
170	1155.28
180	1186.69



EQUILIBRIUM POOL FIRE HEAT OUTPUT vs DURATION CURVE

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

COMMON AREA

Turbine Building El. 135'

Switchgear Room #231

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Switchgear Room #231 on the 135' elevation of the Turbine. (See Attachment A for a sketch of the area under consideration.) Bounding walls of the area are constructed primarily of 8" concrete block. Total surface area of the bounding walls and ceiling is 1813 ft^2 (see Attachment A for a calculation of heat loss surface area).

2. COMBUSTIBLE LOADING

Exposed combustible loading consists of cable trays. Total surface area of the cable trays is 138 ft^2 with an average combustible loading in the trays being 7 lbs/ft^2 of tray surface area. Enclosed combustibles are not included in the combustible loading.

3. VENTILATION PARAMETERS

This area is served by two personnel doors. Each door is 3 ft wide by 7 ft high.

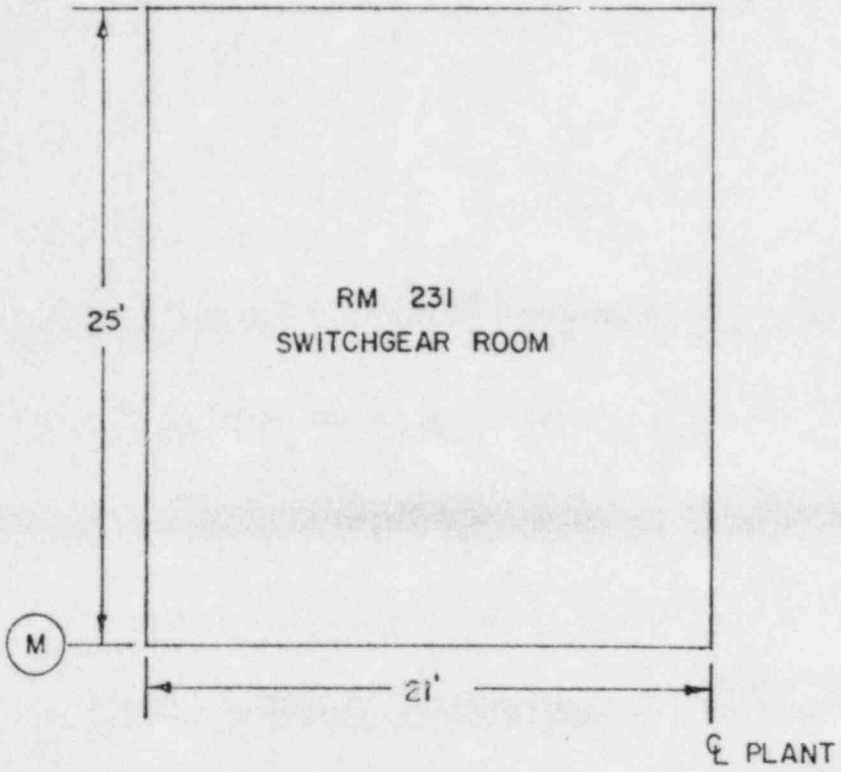
4. CASES EXAMINED

The assumption was made that all of the cabling in the area would burn simultaneously in order to present the worst case. Total surface area of the trays is 138 ft^2 which corresponds to a heat output of 2440 kW. With all cables burning at once the duration of the fire will be

$$7 \text{ lbs/ft}^2 \div \frac{0.1 \text{ lb}}{\text{min ft}^2} = 70 \text{ minutes.}$$

5. RESULTS

The only case examined was with all cables burning simultaneously with one door open (see Attachment B for results). Since the fire was fuel controlled under this set of circumstances there is no need to examine the case with the second door open. The peak fire temperature reached was approximatley 1440°F which is below the critical temperature of the structural steel. The cable trays were located far enough below the steel members to prevent localized heating effects.



Heat Loss Area Determination

Bounding Area (Excluding Floor)

Ceiling	(25' x 21')	525 ft^2
North wall	(25' x 14')	350 ft^2
South wall	(25' x 14')	350 ft^2
East wall	(21' x 14')	294 ft^2
West wall	(21' x 14')	294 ft^2
Total Surface Area for Heat Transfer		1813 ft^2

ATTACHMENT A

CASE NO.: 1
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: SWITCHGEAR ROOM # 231, 135' ELEV.
CASE DESCRIPTION: ALL CABLES BURNING, ONE DOOR OPEN

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
0.67	CONCRETE BLOCK	21	7	1813	2437

FIRE IS FUEL CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	588.939
20	802.683
30	966.794
40	1105.18
50	1227.11
60	1337.36
70	1438.74

ATTACHMENT B

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

UNIT 2

Reactor Building El. 165'

South of Column Line 10

September 8, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Reactor Building El. 165' south of column line 10 (see Attachment A for sketch of area).

Bounding walls of area are reinforced concrete with an average thickness of 3 ft.

Total surface area of bounding walls and ceiling is 10,218 ft^2 (949 m^2 (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

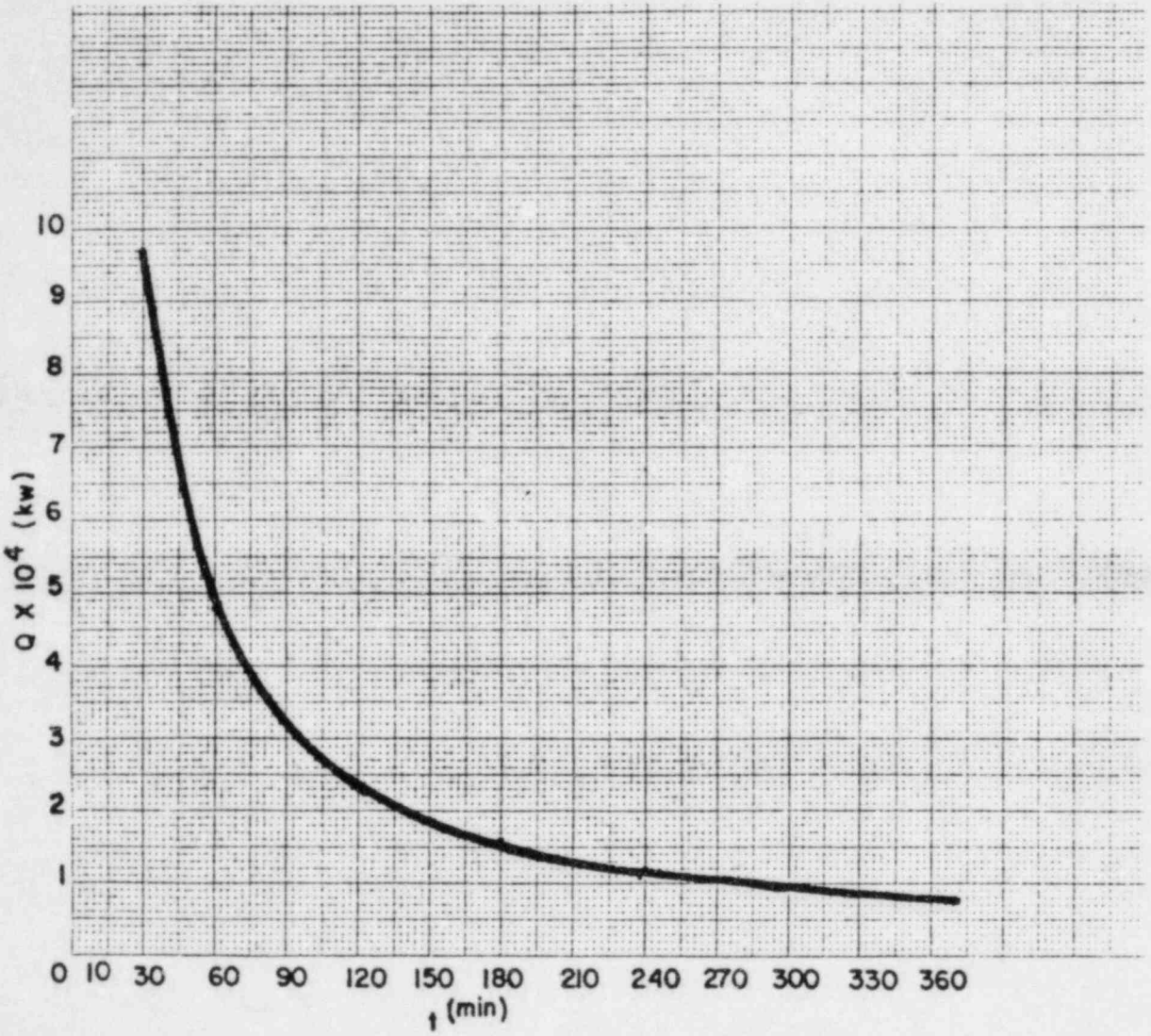
The heaviest combustible loading in this area is located along the south wall where six horizontal cable trays are present. Total surface area of cable trays to be considered involved in a fire is 260 ft^2 with an average combustible loading of the cable trays being 3 lbs/ft^2 (see Attachment B for calculation of cable tray area). There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

Two ventilation openings serve this area. The opening between the stairwell in the southwest corner and room 404 measures 5' wide by 29' high. The opening at the east side of the area measures 15' wide by 29' high. A possible limiting factor will be the total volume of air in the Reactor Building available for combustion, which is 1×10^5 m^3. The curve on the following page shows the duration of a fire at a given heat output.

4. CASES EXAMINED

A spreading cable fire was assumed in the area of heaviest cable concentration which is along the south wall. The fire is assumed to start at a point source and spread horizontally in each direction at a rate of 10 ft. per hour. The fire is assumed to extend along the cable trays to both the east and west of the ignition source, a distance of approximately 10 feet before the original source of the fire dies out. An area of 260 ft^2 of cable trays (see Attachment B for a list of cable

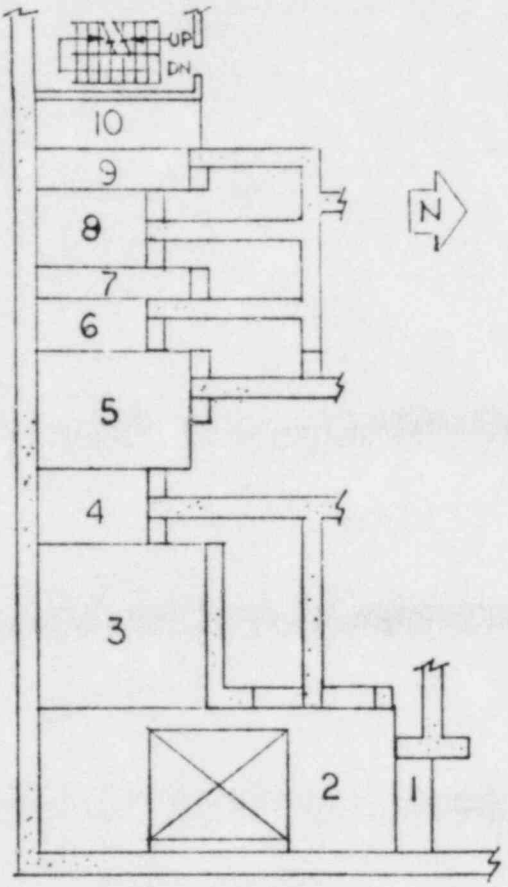


trays initially burning) will have a heat output of approximately 4600 kW, which is assumed to be constant throughout the fire duration. The actual heat output as the fire spreads out of the area originally involved would be less because concentrations of cabling that would become involved at any one time would be less. From the chart above, the volume of air in the Reactor Building would support combustion for approximately 10.5 hours.

5. RESULTS

For the above case with two openings having a total area of 580 ft^2 and a constant heat output of 4600 kW, this will produce a gas temperature of 747°F for a fire duration of three hours and a gas temperature of 1027°F for a fire duration of six hours (see Attachment C). These gas temperatures assume no mitigating actions are taken by plant personnel to extinguish the fire.

The above temperatures are not high enough to fail the structural steel in the area. The cable trays in this area were positioned such that they did not present a localized heating exposure to structural steel.



Unit 2 Reactor Building Elevation 165'

Surface Area Calculation

Walls

North wall	(88.5' x 29')	2567 ft^2
East wall	(47' x 29')	1363 ft^2
South wall	(109' x 29')	3161 ft^2
West wall	(19' + 28')29'	1363 ft^2
		8454 ft^2

Ceiling

Area 1	(6' x 15')	90 ft^2
Area 2	(41.5' x 22') - (21' x 17')	556 ft^2
Area 3	(15' x 25')	375 ft^2
Area 4	(8' x 12')	96 ft^2
Area 5	(15' x 14')	210 ft^2
Area 6	(8' x 7')	56 ft^2
Area 7	(15' x 4')	60 ft^2
Area 8	(8' x 12')	96 ft^2
Area 9	(15' x 8')	120 ft^2
Area 10	(19' x 5.5')	105 ft^2
		1764 ft^2

Total Surface Area for Heat Transfer 10,218 ft2 (949 m2)

Cable Trays

The following cable trays are present in the area defined for the source fire and all of the trays are assumed to burn simultaneously.

Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
2MT020	20	24	40
2XE150	2	24	4
2XE160	18	24	36
2XF150	2	24	4
2XF160	18	24	36
2MR150	2	24	4
2MR160	18	24	36
ZC2XK150	2	24	4
ZC2XK160	18	24	36
ZC2XL150	2	24	4
ZC2XL160	18	24	36
2KV270	10	24	20
			260 ft^2

For a fuel surface controlled fire involving all of these cable trays, the heat release rate can be calculated as follows:

$$\frac{260\ ft^2}{10.76\ ft^2/m^2} \times 190\ kW/m^2 = 4591\ kW$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: UNIT 2 REACTOR BUILDING
ELEVATION AND AREA DESCRIPTION: 165' AREA SOUTH OF COLUMN LINE 10
CASE DESCRIPTION: TWO OPENINGS SPREADING CABLE FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	580	29	10218	4600

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	232
20	297
30	348
40	390
50	428
60	462
70	493
80	522
90	550
100	575
110	600
120	623
130	646
140	668
150	688
160	709
170	728
180	747
190	766
200	784
210	801
220	819
230	835
240	852
250	868
260	884
270	899
280	914
290	929
300	944
310	958
320	972
330	986
340	1000
350	1014
360	1027

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

UNITS 2 & 3

Radwaste Building El. 165'

FAN ROOM

(Remote Shutdown Panel Area)

September 7, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Units 2 & 3 Radwaste Building El. 165' Fan Room column lines J to G and 18 to 23 (see Attachment A for sketch of area under consideration).

Bounding walls of area are reinforced concrete with an average thickness of 2.5 ft.

Total surface area of bounding walls and ceiling is 16,283 ft^2 (1513 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

The heaviest concentration of cabling in this area is located at the center line of the plant near the remote shutdown panels. Total surface area of cable trays considered to be involved in a fire is 316 ft^2 with an average combustible loading of the cable trays being 6 lbs/ft^2 (see Attachment B for calculation of cable tray area). There are no combustible liquids in this area.

3. VENTILATION PARAMETERS

Three doors serve this area. One on the north wall, one on the south and one on the west wall. All doors measure 3' wide by 7' high.

4. CASES EXAMINED

A spreading cable fire was assumed in the area of heaviest cable concentration which is at the center line of the plant in the area of the remote shutdown panels. The fire is assumed to start at a point source and spread horizontally in each direction at a rate of 10 ft. per hour. The fire is assumed to extend along the cable trays towards the west and downward toward the floor slab, a distance of approximately 10 feet before the original source of the fire dies out. An area of 316 ft^2 of cable trays (see Attachment B for a list of cable trays initially burning) will have a heat output of approximately 5600 kW, which is assumed to be constant throughout the fire duration. The actual heat output as the fire spreads out of the area originally involved would be less

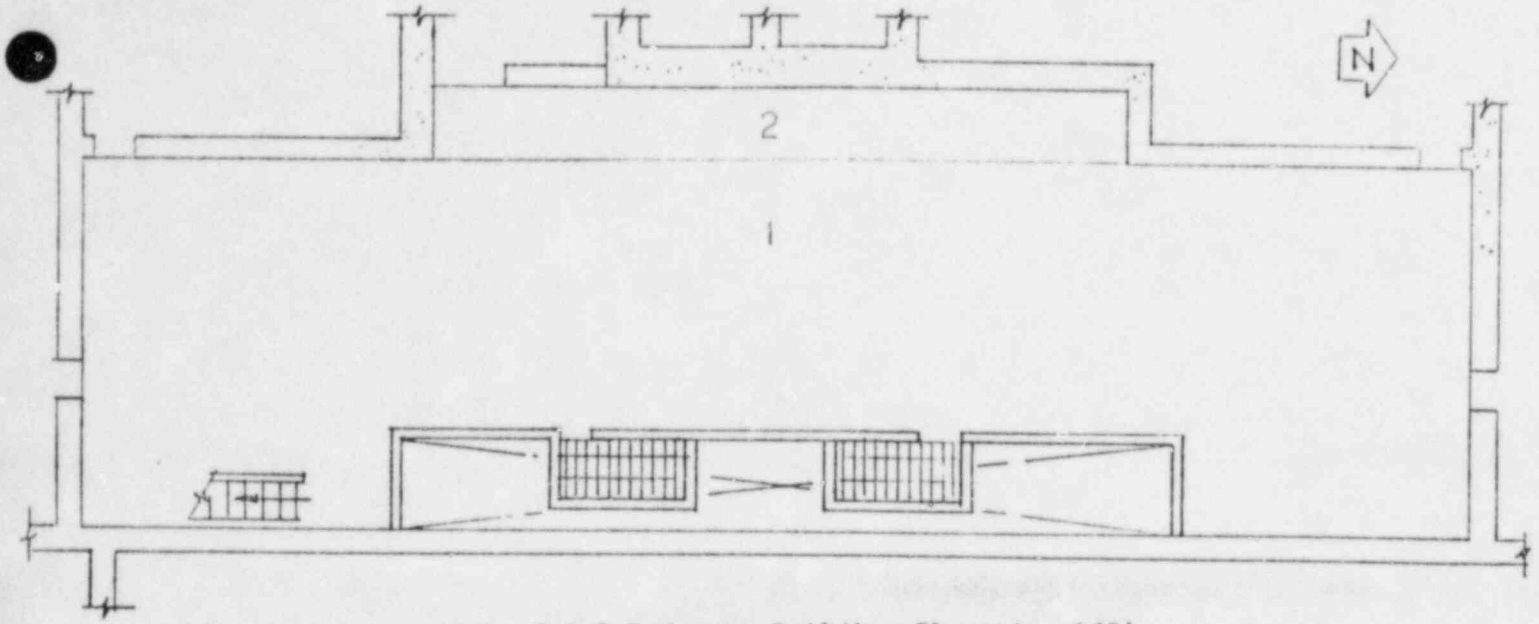
because the concentrations of cabling that would become involved at any one time would be less.

Different ventilation parameters were examined to determine their effect on the heat release rate of the fire and resulting gas temperature.

5. RESULTS

Two cases were examined each having different ventilation parameters. Case Number 1 had one 3' wide by 7' high door open. The fire is ventilation controlled and the resultant heat output of the fire would be 4504 kW. This will produce a gas temperature of 487°F for a fire duration of three hours and a gas temperature of 659°F for a fire duration of six hours (see Attachment C). Case Number 2 had two 3' wide by 7' high doors open. This produced a fuel controlled fire with a gas temperature of 588°F for a fire duration of three hours and a gas temperature of 802°F for a fire duration of six hours (see Attachment D). These gas temperatures assume no mitigating actions are taken by plant personnel to extinguish the fire.

None of the above temperatures are high enough to fail the structural steel in the area. The cable trays in this area were positioned such that they did not present a localized heating exposure to structural steel.



Units 2 & 3 Radwaste Building Elevation 165'
Remote Shutdown Panel Area

Surface Area Calculation

Walls

North wall	(43' x 29')	1247 ft^2
East wall	(132.5' x 29')	3843 ft^2
South wall	(43' x 29')	1247 ft^2
West wall	(132.5' x 29')	3843 ft^2
		10,180 ft^2

Ceiling

Area 1	(43' x 132.5)	5698 ft^2
Area 2	(67.5' x 6')	405 ft^2
		6103 ft^2

Total Surface Area for Heat Transfer 16,283 ft^2 (1513 m^2)

ATTACHMENT A

Cable Trays

The following cable trays are present in the area defined for the source fire and all of the trays are assumed to burn simultaneously.

Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
3MCX04	10	24	20
3MCX05	10	24	20
3MDI04	9	24	18
3MDI05	10	24	20
ZB3NA04	9	24	18
ZB3NA05	10	24	20
ZB3NB04	10	24	20
ZB3NB05	10	24	20
2XH010	20	24	40
2XJ010	20	24	40
ZC2XK010	20	24	40
ZC2XL010	20	24	40
			316 ft^2

For a fuel surface controlled fire involving all of these cable trays, the heat release rate can be calculated as follows:

$$\frac{316\ ft^2}{10.76\ ft^2/m^2} \times 190\ kW/m^2 = 5579\ kW$$

ATTACHMENT B

CASE NUMBER: 1
BUILDING: UNIT 2&3 RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: 165' REMOTE SHUTDOWN PANEL AREA
CASE DESCRIPTION: ONE DOOR OPEN SPREADING CABLE FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	21	7	16283	4584

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	170
20	210
30	242
40	268
50	291
60	312
70	331
80	349
90	365
100	381
110	396
120	411
130	425
140	438
150	451
160	463
170	475
180	487
190	498
200	509
210	520
220	531
230	541
240	551
250	561
260	571
270	580
280	589
290	599
300	608
310	616
320	625
330	634
340	642
350	651
360	659

CASE NUMBER: 2
BUILDING: UNIT 2&3 RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: 165' REMOTE SHUTDOWN PANEL AREA
CASE DESCRIPTION: TWO DOORS OPEN SPREADING CABLE FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	42	7	16283	5600

FIRE IS FUEL CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	194
20	244
30	283
40	315
50	344
60	370
70	394
80	416
90	437
100	457
110	475
120	493
130	510
140	527
150	543
160	558
170	573
180	588
190	602
200	616
210	629
220	642
230	655
240	668
250	680
260	692
270	704
280	715
290	727
300	738
310	749
320	760
330	770
340	781
350	791
360	802

ATTACHMENT D

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

COMMON AREA

Turbine Building El. 150'

Cable Spreading Room

September 9, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Cable Spreading Room on the 150' elevation of the Turbine Building. (See Attachment A for a sketch of the area under consideration.) Bounding walls of the area are reinforced concrete construction with an average thickness of 2 ft. Total surface area of the bounding walls and ceiling is 12,154 ft^2 (see Attachment A for a calculation of heat loss surface area).

2. COMBUSTIBLE LOADING

This area is heavily loaded with cable trays which are located such that 6 ft of clear space is maintained below the trays at floor level. The Fire Protection Program Report identifies the total quantity of cabling in the room as being 116,340 lbs. The average combustible loading of the cable trays in the room is 6.5 lbs/ft^2 of tray surface area.

3. VENTILATION PARAMETERS

This area is served by two personnel doors located in the east wall of the room.

4. CASES EXAMINED

Two cases were examined for this area and both fires were ventilation controlled. The first case was for one of the doors being open which supported a burning rate of approximately 4500 kW. The second case was for both doors open which supported a burning rate of approximately 9000 kW. In both cases the fire durations was assumed to be 3 hours.

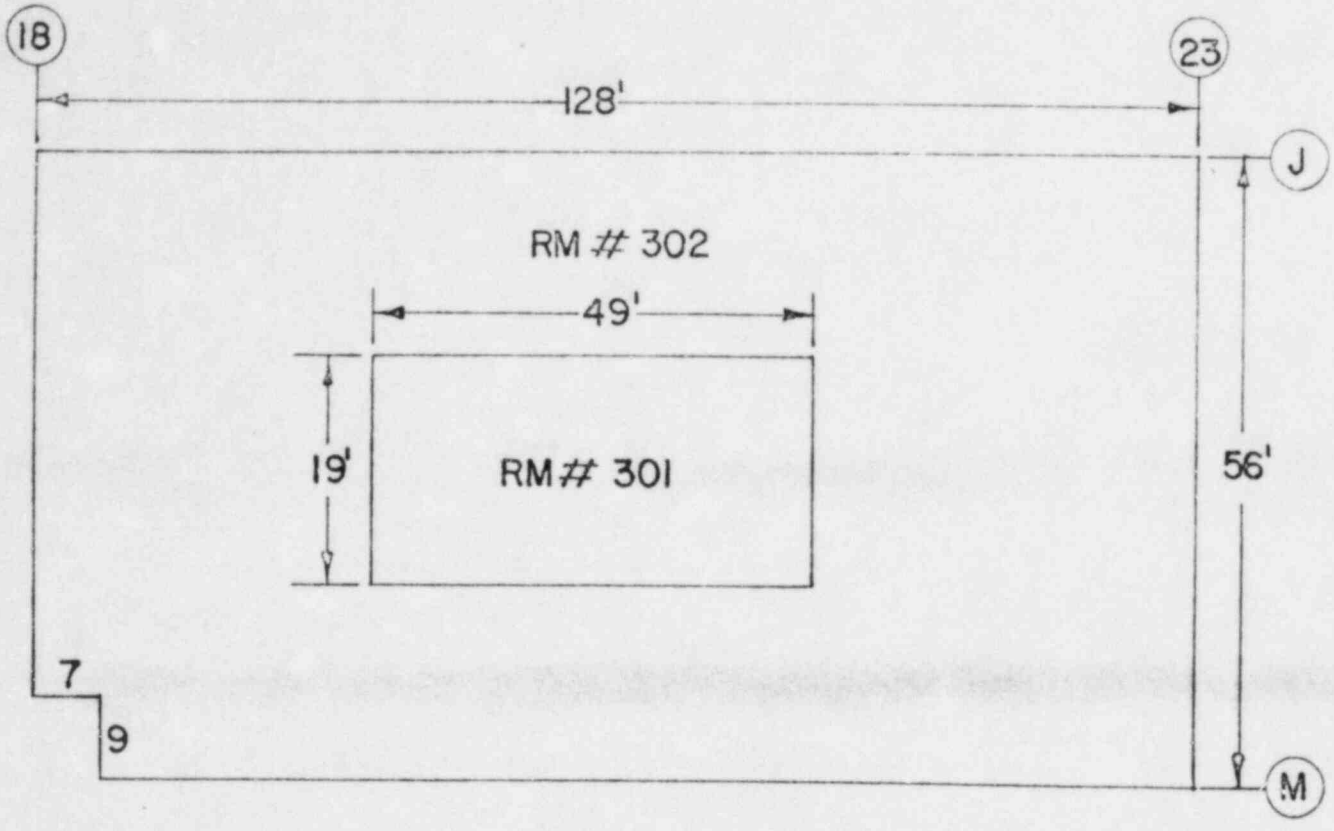
5. RESULTS

The case with both doors open turned out to be the worst case (see Attachment B for results of analysis). The fire temperature reached at 180 minutes was 1100°F which is below the critical temperature for the structural steel.

The ventilation controlled burning rate of 9008 kW is equivalent to the simultaneous burning of 510 ft^2 of cable tray surface area. Given the average combustible loading of the cable trays in the area the duration of the fire in any portion of tray (until all of the cable insulation is consumed) will be $6.5 \text{ lbs/ft}^2 \div \frac{0.1 \text{ lbs}}{\text{min ft}^2} = 65$ minutes

Attachment C contains a sketch showing all locations where cable trays pass under steel members with a vertical separation of 1 ft or less. Attachment C also includes the results of calculations performed to determine the response of the structural members. These calculations are generally conservative because they assume that the entire length of the member is exposed to a temperature of 1500°F which represents the duration of any local heating from a given cable tray. The exposure duration equals 65 minutes which is the time for the exposing tray to burn to completion.

Calculations were performed for structural members of the following sizes: 24WF68, 24WF100, 24WF145, 24WF160, 8WF17, and 24WF110. As can be seen from the results, the critical temperature of the member will be reached during the exposure period only for the types 8WF17 and 24WF68.



Cable Spreading Room

Surface Area Calculation

Walls

North wall	(56' x 14') + (19' x 12')	1012 ft^2
South wall	(56' x 14') + (19' x 12')	1012 ft^2
East wall	(128' x 14') + (49' x 14')	2478 ft^2
West wall	(128' x 14') + (49' x 14')	2478 ft^2
		6980 ft^2
Ceiling	(128' x 56') - (7' x 9') - (19' x 49')	6174 ft^2
Total Surface Area for Heat Transfer		13,154 ft^2

ATTACHMENT A

CASE NO.: 1
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: CABLE SPREADING ROOM, 150' ELEVATION
CASE DESCRIPTION: ONE DOOR OPEN

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
2	CONCRETE	21	7	13154	4504.23

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	193.396
20	243.428
30	281.842
40	314.238
50	342.788
60	368.603
70	392.346
80	414.448
90	435.209
100	454.846
110	473.525
120	491.374
130	508.494
140	524.968
150	540.865
160	556.240
170	571.142
180	585.612

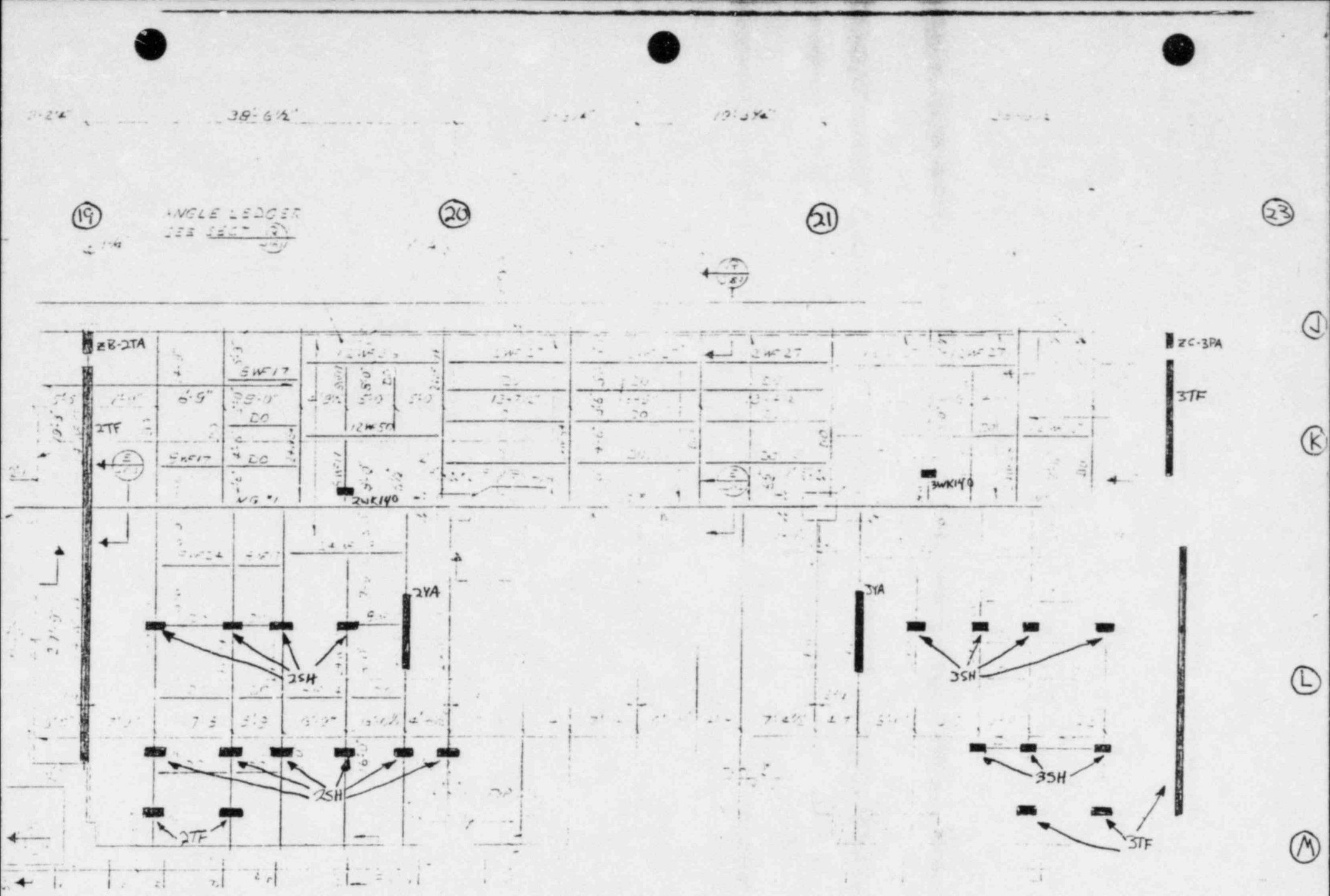
CASE NO.: 2
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: CABLE SPREADING ROOM, 150' ELEVATION
CASE DESCRIPTION: BOTH DOORS OPEN

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
2	CONCRETE	42	7	13154	9008.46

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	314.647
20	414.731
30	491.594
40	556.420
50	613.548
60	665.205
70	712.714
80	756.939
90	798.479
100	837.770
110	875.144
120	910.854
130	945.107
140	978.067
150	1009.87
160	1040.63
170	1070.44
180	1099.39

ATTACHMENT B



ATTACHMENT C

23-7

CASE NO.: 1
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: CABLE SPREADING ROOM, 150' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 24WF68

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 68
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 5.31

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	510.077044
10	815.679149
15	1026.937904
20	1172.978331
25	1273.934177
30	1343.723639
35	1391.968185
40	1425.319012
45	1448.374004
50	1464.31162
55	1475.329087
60	1482.945317
65	1488.210319

ATTACHMENT C

CASE NO.: 2
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: CABLE SPREADING ROOM, 150' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 24WF100

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 100
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 5.43

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	375.40589
10	616.82129
15	806.412308
20	955.304025
25	1072.23332
30	1164.061529
35	1236.177077
40	1292.811657
45	1337.288554
50	1372.217642
55	1399.648542
60	1421.190879
65	1438.108746

ATTACHMENT C

CASE NO.: 3
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: CABLE SPREADING ROOM, 150' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 24WF145

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 145
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 5.59

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	286.250959
10	471.238314
15	628.031768
20	760.928347
25	873.570174
30	969.044273
35	1049.967176
40	1118.556627
45	1176.692369
50	1225.967648
55	1267.732887
60	1303.132692
65	1333.137216

ATTACHMENT C

CASE NO.: 4
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: CABLE SPREADING ROOM, 150' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 24WF160

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 160
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 5.66

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	268.266729
10	440.525942
15	588.694521
20	716.141564
25	825.765002
30	920.057486
35	1001.163065
40	1070.925942
45	1130.932407
50	1182.546903
55	1226.943057
60	1265.130361
65	1297.97713

ATTACHMENT C

SE NO.: 5
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: CABLE SPREADING ROOM, 150' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 8WF17

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 17
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 2.14

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	780.651509
10	1138.643677
15	1318.476866
20	1408.81397
25	1454.193761
30	1476.989769
35	1488.441077
40	1494.193508
45	1497.083174
50	1498.534764
55	1499.263955
60	1499.630255
65	1499.814262

ATTACHMENT C

CASE NO.: 6
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: CABLE SPREADING ROOM, 150' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 24WF110

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 110
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 5.47

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	349.518534
10	575.693015
15	757.403592
20	903.391478
25	1020.679437
30	1114.90962
35	1190.614982
40	1251.43734
45	1300.302559
50	1339.56131
55	1371.102135
60	1396.442314
65	1416.800838

ATTACHMENT C

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

COMMON AREA

Turbine Building El. 116'

Common Equipment Area

September 12, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

The zone being evaluated is the common equipment area on the 116' elevation of the Turbine Building. This area is bounded on the north and south by the shield walls for the condenser bays for Units 3 and 2, respectively. (See Attachment A for a sketch of the area under consideration.) The barriers surrounding this area are of concrete construction and are of an average thickness of 2 ft. Total surface area of the bounding walls and ceiling 31,405 ft^2. (See Attachment A for a calculation of heat loss surface area.)

2. COMBUSTIBLE LOADING

Exposed combustibles in this area consist of cable trays. The trays have an average combustible loading of 5.4 lbs/ft^2 of tray surface area. Enclosed combustibles are not included in the combustible loading.

3. VENTILATION PARAMETERS

Numerous personnel type doors open into this area as well as a large (16 ft wide by 18 ft high) equipment door in the east wall. A 35 ft wide by 55 ft long open equipment hatch is located in the ceiling.

4. CASES EXAMINED

The scenario analyzed is a fire originating in the heavy concentration of cable trays located at the east end of the Unit 3 switchgear and spreading out along the trays leading into this area. This location contains the greatest concentration of trays in the area and presents the worst case. The maximum area of trays involved will be determined by the extent of fire spread which has occurred when the original portion of the trays involved burn themselves out. The burnout duration is dependent upon the loading of the cable trays:

$$5.4 \text{ lbs/ft}^2 \div \frac{0.1 \text{ lbs}}{\text{min ft}^2} = 54 \text{ minutes}$$

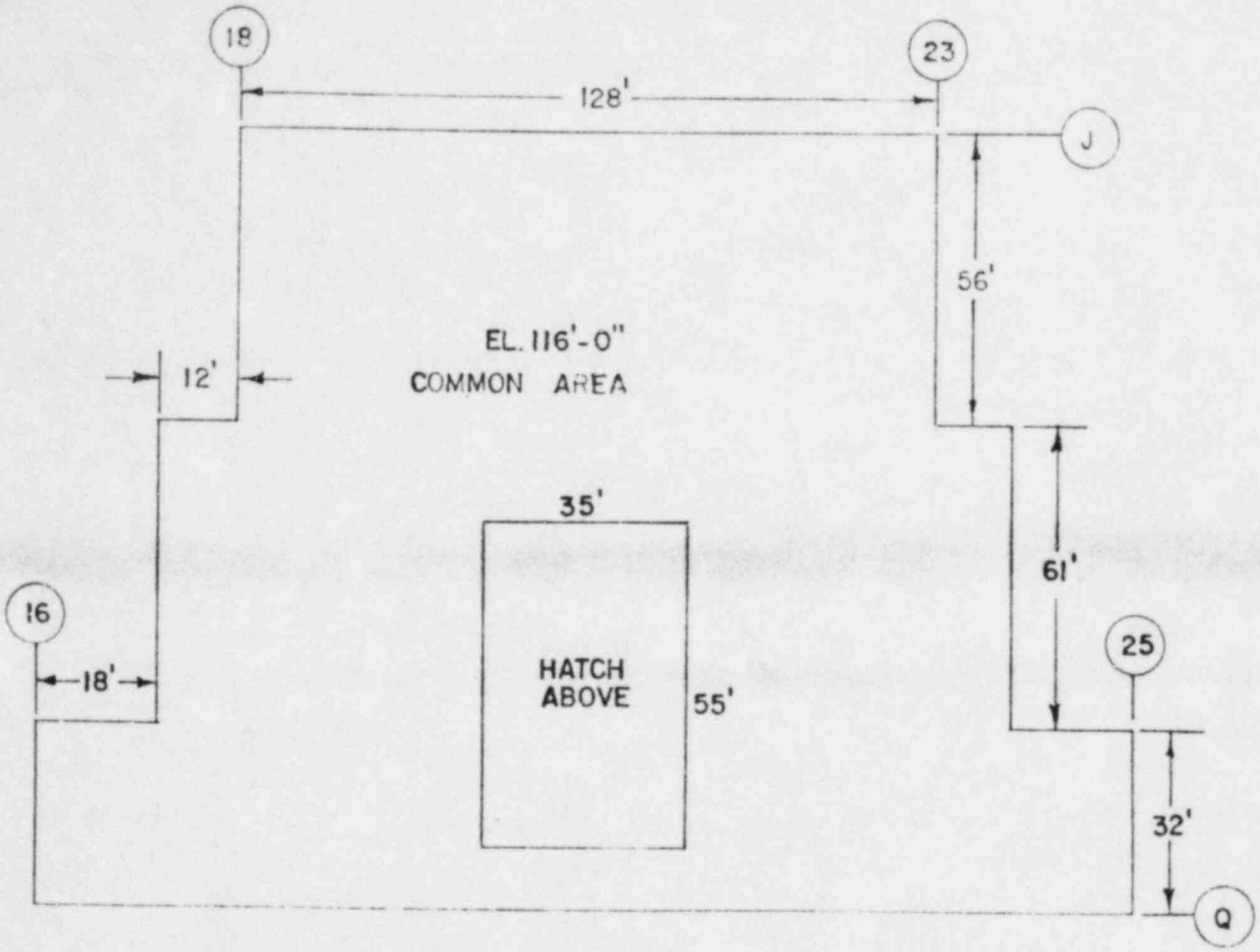
Given the cable fire spreading rate of 10 ft/hr, the fire will spread approximately 10 ft in each direction before the original source of the fire dies out. This will result in the simultaneous involvement of a maximum of 394 ft^2 of tray surface area at any one time. See Attachment D for a list of trays involved when the fire reaches its maximum size. This gives a heat output of 6960 kW which is assumed constant throughout the assigned 3 hour duration of the fire.

5. RESULTS

The peak fire temperature reached at the end of 3 hours is approximately 405°F which is well below the critical temperature of the structural steel (see Attachment B for the results of the analysis).

Raceway drawings were examined to determine if any cable trays were located such that they could present a local heating effect on the structural steel supporting the safety related areas on the 135' elevation of the Turbine Building. A sketch is provided in Attachment C which shows the placement of cable tray 2CH030 where it is in a position to cause localized heating of the steel members located above.

Calculations were performed to determine the response of the structural members and the results are included in Attachment C. These calculations are quite conservative because they assume that the entire length of the member is exposed to a temperature of 1500°F when in actuality only a short section (approximately 1 ft long) will actually be exposed. The exposure duration was taken to be 55 minutes which is the time required for a tray to burn to completion. The calculations show that the types of members exposed (12WF27 and 16WF36) could lose their load bearing capacity within 35 to 40 minutes under the assigned conditions.



Heat Loss Area Determination

Bounding Area (Excluding Floor)

A_1 = Ceiling = (158' x 149') - (35' x 55') = 21,617 ft^2
A_2 = North wall = (149' x 18') = 2682 ft^2
A_3 = South wall = (149' x 18') = 2682 ft^2
A_4 = East wall = (158' x 14') = 2212 ft^2
A_5 = West wall = (158' x 14') = 2212 ft^2
$A_w = A_1 + A_2 + A_3 + A_4 + A_5$
A_w = 21617 + 2682 + 2682 + 2212 + 2212 = 31,405 ft^2

ATTACHMENT A

CASE NO.: 1
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: COMMON EQUIPMENT AREA, 115' ELEV.
CASE DESCRIPTION: SPREADING CABLE FIRE

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
2	CONCRETE	288	18	31405	5960

FIRE IS FUEL CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	150.527
20	182.918
30	207.783
40	228.750
50	247.226
60	263.932
70	279.297
80	293.599
90	307.033
100	319.740
110	331.828
120	343.378
130	354.456
140	365.116
150	375.402
160	385.352
170	394.995
180	404.358

CASE NO.: 1
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: COMMON EQUIPMENT AREA, 116' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 12WF27

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 27
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 3.04

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	705.414848
10	1059.102258
15	1255.355585
20	1364.252219
25	1424.676554
30	1458.204683
35	1476.808701
40	1487.13166
45	1492.859642
50	1496.037972
55	1497.801556

ATTACHMENT C

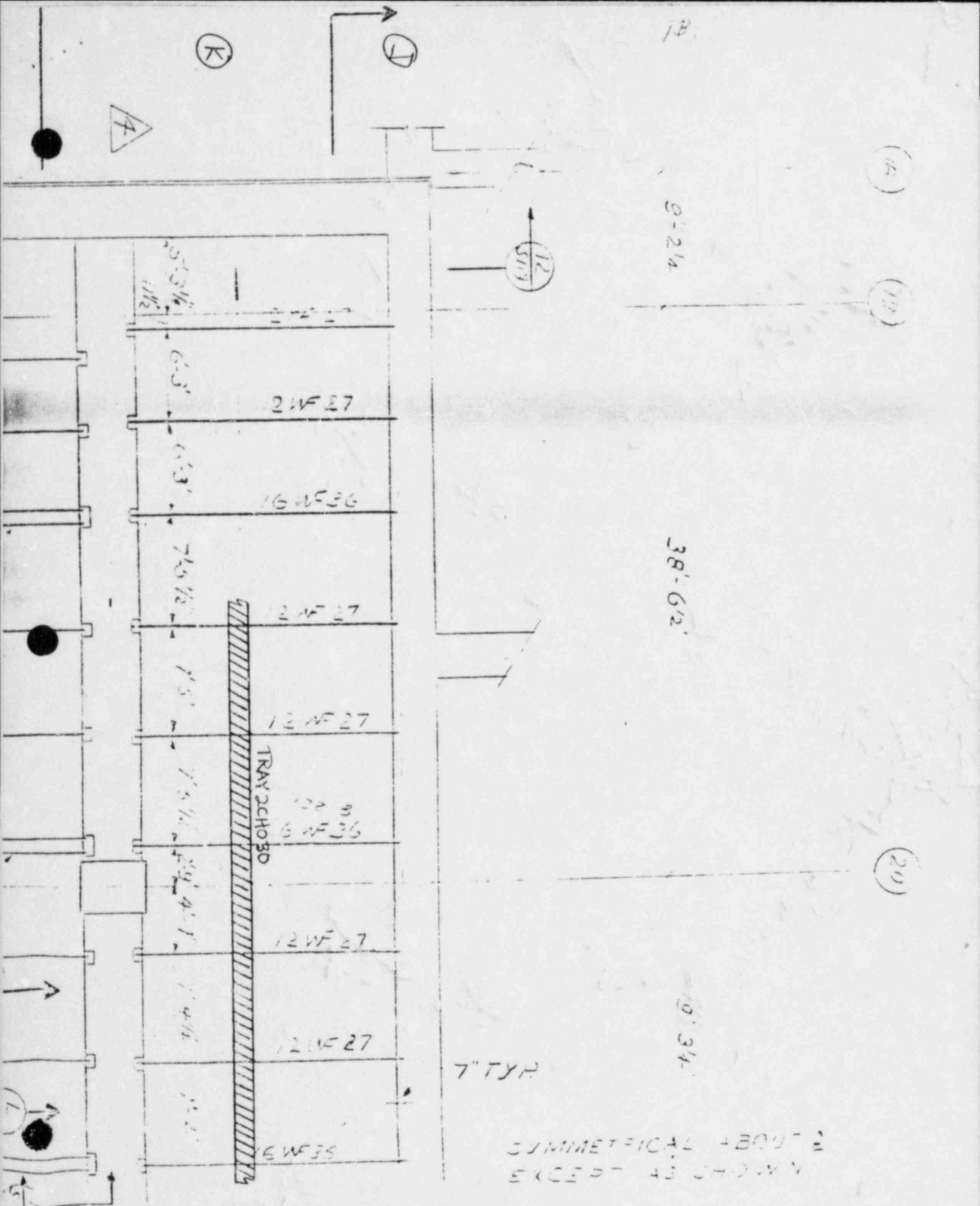
CASE NO.: 2
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: COMMON EQUIPMENT AREA, 116' ELEV.
CASE DESCRIPTION: LOCALIZED HEATING OF MEMBER TYPE 16WF36

EFFECTS OF LOCAL HEATING ON STRUCTURAL STEEL

FIRE TEMPERATURE (DEF. F): 1500
WEIGHT OF STEEL MEMBER (LBS./FT.): 36
SURFACE OF STEEL MEMBER HEATED (SQ. FT./FT): 4.28

TIME (MIN.)	STEEL TEMPERATURE (DEG. F)
5	741.059756
10	1097.772141
15	1286.824784
20	1387.020075
25	1440.122198
30	1468.26559
35	1483.181198
40	1491.086265
45	1495.275843
50	1497.49626
55	1498.673051

ATTACHMENT C



ATTACHMENT C

Original Cable Trays Involvedin Spreading Fire Scenario

Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
3AB088	12	18	18
3ABB091	3	24	6
3ABB050	4	24	8
3ACA050	4	24	8
3ABB051	11	24	22
3ACA051	11	24	22
3ABB052	5	24	10
3ACA052	5	24	10
3ABB053	8	24	16
3ACA053	8	24	16
3AAC053	8	24	16
3AAC052	5	24	10
3AAC049	8	24	16
2RF049	15	24	30
2RF110	6	24	12
3AAC051	17	24	34
2RF070	14	24	28
2CJ070	18	24	36
2FK110	6	24	12
2FL110	6	24	12
2FJ110	6	24	12
2FJ070	4	24	8
2CK030	8	24	16
2CJ030	8	24	16
			394 ft^2

ATTACHMENT D

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

COMMON AREA

Turbine Building El. 150'

Computer Room

September 12, 1983

P. O. Box 446 • Oak Ridge, Tennessee 37830 • (615) 482-3511

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Computer Room on the 150' elevation of the Turbine Building (see Attachment A for a sketch of the area under consideration). Bounding walls of the area are of concrete block construction and are 8" thick. Total surface area of the bounding walls and ceiling is 2523 ft^2 (see Attachment A for a calculation of heat loss surface area).

2. COMBUSTIBLE LOADING

Exposed combustibles in this area consist of cable trays. Total surface area of the cable trays is 1,210.5 ft^2 with an average combustible loading in the trays of 2.4 lbs/ft^2 of tray surface area. Enclosed combustibles are not included in the combustible loading.

3. VENTILATION PARAMETERS

This area is served by two sets of double doors with each opening being approximately 5 ft wide by 7 ft high. These doors are normally kept locked. A ventilation damper leads into the room and measures 28" wide by 12" high.

4. CASES EXAMINED

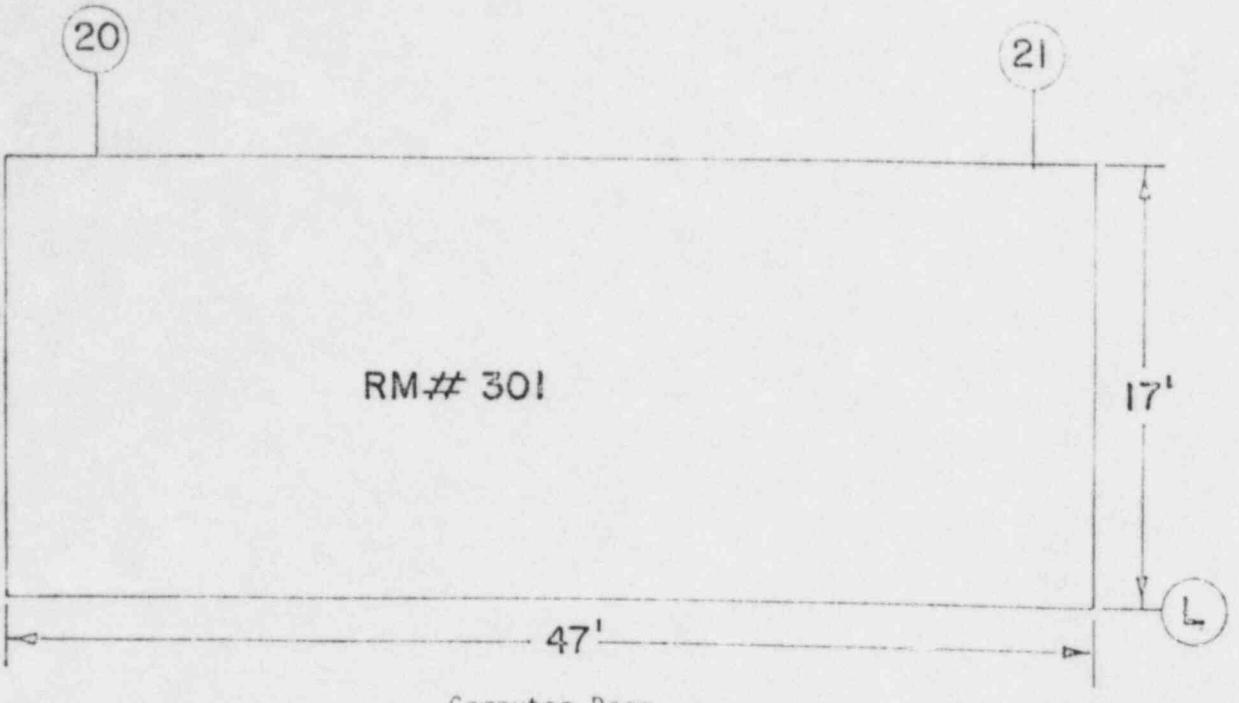
The scenario analyzed is a fire originating in the southeast corner of the room along the tray stacks along the east and south walls. This fire will be ventilation controlled since the amount of combustibles cannot be totally consumed with the available air in the room. The fire examined assumes one 28" x 12" damper is open providing ventilation to support combustion. This limits the heat release rate of the fire to approximately 189 kW. This represents 1% of the 21,375 kW fire which would burn for a period of 24 minutes if all the cables were burning simultaneously. This can be interpreted as 3.0×10^7 kJ of heat energy available from the combustible material in the room. Assuming the maximum heat release fire of 189 kW can be maintained throughout the fire duration, the fire would last longer than 189 minutes before all the cable material is consumed.

5. RESULTS

The fire scenario examined is ventilation controlled and burns until all the combustibles have been consumed. The calculations in Attachment B indicate that at the fire rated design of the zone of (180 minutes) the gas temperature in the room would be approximately 185°F. This temperature is below the critical temperature of the steel.

Cable trays in the room were positioned so as to have a local heating effect on structural steel. Calculations were performed to determine the effect of the localized heating on the structural steel. The results of these calculations are included as Attachment C. Attachment C also includes a sketch of the computer room showing the framing plan for the ceiling. Three types of members were present and were analyzed: 24WF145, 24WF110, and 24WF160. The concrete block walls on the north and south ends of the room are built up to the bottoms of the 24WF160 beams in these locations.

As can be seen from the results, only the beam type 24WF110 is heated up to its critical temperature during the 3 hour duration of the fire. As a result, failure of the beams along column lines 20 and 21 is assumed.



Computer Room

Surface Area Calculation

Walls

North wall	(17' x 20')	204 ft^2
South wall	(17' x 12')	204 ft^2
East wall	(47' x 14')	658 ft^2
West wall	(47' x 14')	658 ft^2
		1724 ft^2

Ceiling	(47' x 17')	799 ft^2
Total Surface Area for Heat Transfer		2523 ft^2

Cable Heat Release = $\frac{1210.5\ ft^2}{10.76\ ft^2/m}$ x 190 kW/m^2 = 21,375 kW

Burnout duration = 2.4 lbs/ft^2 ÷ $\frac{0.1\ lb}{min\ ft^2}$ = 24 minutes (if all cable trays are burning simultaneously)

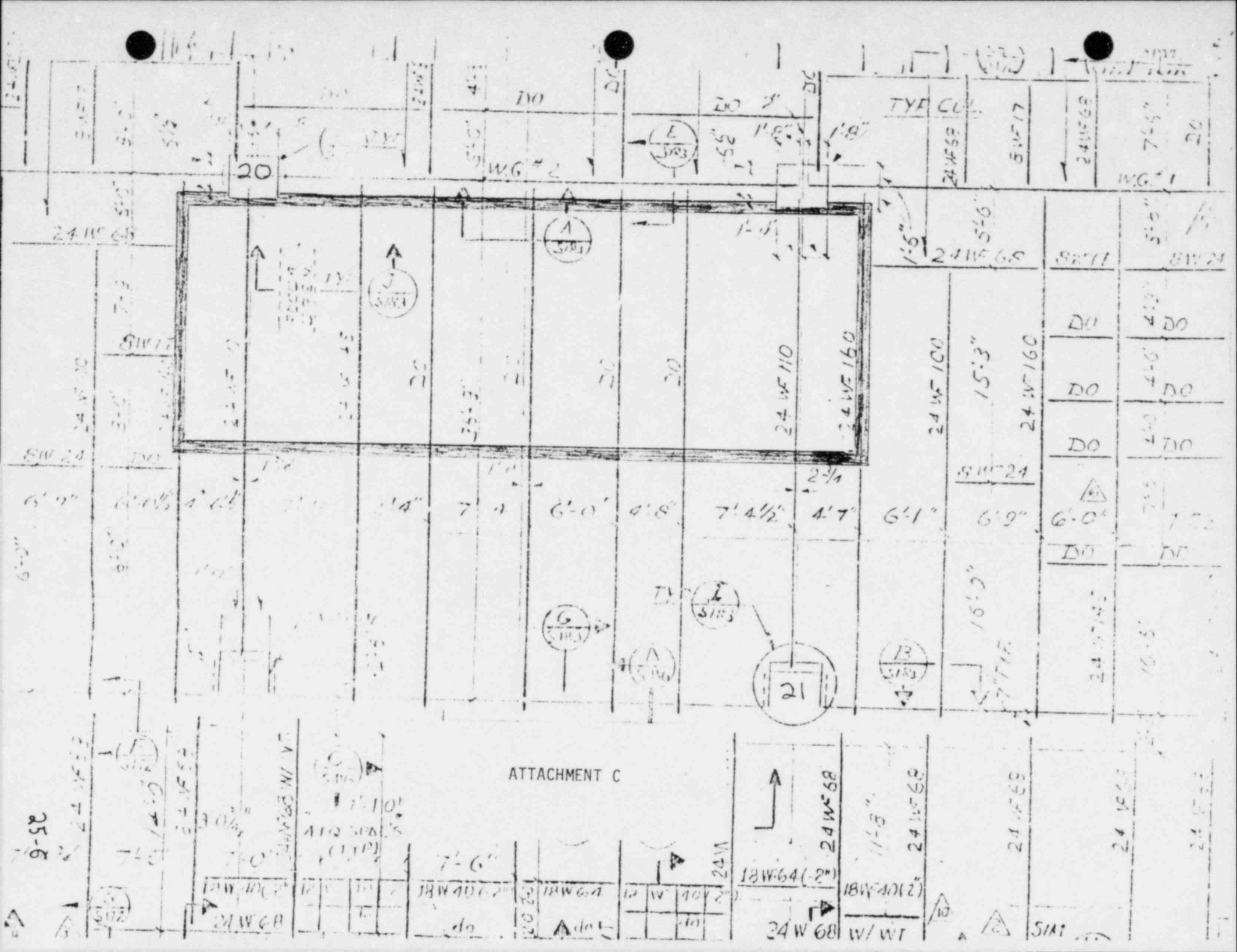
ATTACHMENT A

CASE NUMBER: 1
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: COMPUTER ROOM
CASE DESCRIPTION: SPREADING CABLE FIRE DAMPER OPEN

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
.7	BLOCK	2	1	2523	189

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	98
20	109
30	118
40	125
50	131
60	137
70	142
80	147
90	151
100	156
110	160
120	164
130	167
140	171
150	174
160	178
170	181
180	184


20
21
TYP CU
DO
24 W 68
24 W 110
24 W 160
24 W 100
SW 24
SW 11
ATTACHMENT C

CASE NO.: 2
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: COMPUTER ROOM, 150' ELEV.
CASE DESCRIPTION: GENERALIZED HEATING OF MEMBER TYPE 24WF110

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
0.67	CONCRETE BLOCK	17.5	7	2523	2350

GENERALIZED HEATING OF STRUCTURAL STEEL CALCULATION

WEIGHT OF STEEL MEMBER (LBS./FT.): 110
SURFACE AREA OF STEEL HEATED (SQ. FT./FT.): 5.47

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)	STEEL TEMPERATURE (DEG. F)
5	325.835	93.3440
10	430.367	149.324
15	510.666	212.468
20	578.398	277.749
25	638.092	342.722
30	692.072	406.095
35	741.719	467.195
40	787.935	525.707
45	831.346	581.526
50	872.408	634.675
55	911.466	685.250
60	948.787	733.391
65	984.584	779.254
70	1019.03	823.006
75	1052.26	864.810
80	1084.41	904.823
85	1115.57	943.192
90	1145.82	980.054
95	1175.25	1015.53
100	1203.91	1049.75
105	1231.87	1082.80
110	1259.16	1114.79
115	1285.85	1145.80
120	1311.96	1175.90
125	1337.53	1205.16
130	1362.59	1233.64
135	1387.18	1261.41
140	1411.32	1288.51
145	1435.03	1314.98
150	1458.33	1340.87
155	1481.25	1366.22
160	1503.80	1391.05
165	1526.01	1415.40
170	1547.87	1439.29
175	1569.42	1462.76
180	1590.67	1485.81

SE NO.: 1
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: COMPUTER ROOM, 150' ELEV.
CASE DESCRIPTION: GENERALIZED HEATING OF MEMBER TYPE 24WF145

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
0.67	CONCRETE BLOCK	17.5	7	2523	2350

GENERALIZED HEATING OF STRUCTURAL STEEL CALCULATION

WEIGHT OF STEEL MEMBER (LBS./FT.): 145
SURFACE AREA OF STEEL HEATED (SQ. FT./FT.): 5.59

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)	STEEL TEMPERATURE (DEG. F)
5	325.835	87.6483
10	430.367	131.916
15	510.666	183.522
20	578.398	238.543
25	638.092	294.890
30	692.072	351.311
35	741.719	407.029
40	787.935	461.561
45	831.346	514.612
50	872.408	566.015
55	911.466	615.688
60	948.787	663.612
65	984.584	709.803
70	1019.03	754.308
75	1052.26	797.187
80	1084.41	838.513
85	1115.57	878.366
90	1145.82	916.824
95	1175.25	953.959
100	1203.91	989.880
105	1231.87	1024.63
110	1259.16	1058.29
115	1285.85	1090.94
120	1311.96	1122.64
125	1337.53	1153.44
130	1362.59	1183.41
135	1387.18	1212.59
140	1411.32	1241.04
145	1435.03	1268.80
150	1458.33	1295.91
155	1481.25	1322.41
160	1503.80	1348.34
165	1526.01	1373.72
170	1547.87	1398.60
175	1569.42	1422.99
180	1590.67	1446.93

CASE NO.: 3
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: COMPUTER ROOM, 150' ELEV.
CASE DESCRIPTION: GENERALIZED HEATING OF MEMBER TYPE 24WF160

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
0.67	CONCRETE BLOCK	17.5	7	2523	2350

GENERALIZED HEATING OF STRUCTURAL STEEL CALCULATION

WEIGHT OF STEEL MEMBER (LBS./FT.): 160
SURFACE AREA OF STEEL HEATED (SQ. FT./FT.): 5.66

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)	STEEL TEMPERATURE (DEG. F)
5	325.835	86.0292
10	430.367	126.875
15	510.666	174.934
20	578.398	226.623
25	638.092	279.993
30	692.072	333.848
35	741.719	387.418
40	787.935	440.199
45	831.346	491.866
50	872.408	542.214
55	911.466	591.123
60	948.787	638.533
65	984.584	684.425
70	1019.03	728.812
75	1052.26	771.723
80	1084.41	813.206
85	1115.57	853.313
90	1145.82	892.106
95	1175.25	929.647
100	1203.91	966.000
105	1231.87	1001.22
110	1259.16	1035.39
115	1285.85	1068.55
120	1311.96	1100.76
125	1337.53	1132.09
130	1362.59	1162.57
135	1387.18	1192.26
140	1411.32	1221.21
145	1435.03	1249.46
150	1458.33	1277.04
155	1481.25	1303.99
160	1503.80	1330.36
165	1526.01	1356.17
170	1547.87	1381.45
175	1569.42	1406.23
180	1590.67	1430.54

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 2

Cooling Water Pump Structure El. 112'

Column Lines 5 to 6 and A to B

(Fire Area 143)

September 14, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Cooling Water Pump Structure on the 112' elevation. Column lines 5 to 6 and A to B (Fire Area 143) (see Attachment A for sketch of area under consideration). Bounding walls on the west, south, and east sides of this area are reinforced concrete with an average thickness of 2 ft. A wall constructed of steel plate serves as the north wall. This wall was not included in the surface area calculations. Total surface area of the bounding walls and ceiling 2831 ft^2 (265 m^2).

2. COMBUSTIBLE LOADING

Combustible loading in this area consists of lubricating oil contained in the pumps. There are four (4) High Pressure Service Water Pumps, serving Unit 2 located in this area each containing 25 gallons of lube oil. There is also one Emergency Service Water Pump, serving Unit 2 containing 1.2 gallons of lube oil. Total quantity of lube oil contained in all pumps is 102 gallons.

3. VENTILATION PARAMETERS

There are three doors which serve this area. One door enters from the west wall, one from adjacent fire area 144 and one from the south wall. All doors measure 3'4" wide by 6'2" high and are water tight doors. The most probable limiting ventilation parameter will be the volume of air in the area because the doors are normally closed and are of water tight construction. The total volume of air in the area is 544 m^3.

4. CASES EXAMINED

The case of a single High Pressure Water Service Pump failing and the subsequent fire involving an additional High Pressure Service Water Pump. The total quantity of lube oil involved would be 50 gallons. This was considered to be a worst case fire. Two ventilation cases were examined, they included no doors open and one door open. The factor which limits the heat output in each case is the amount of air available for combustion.

Using the equation $Qv = 1580\ Ao\sqrt{Ho}$, the maximum heat output of fires was calculated for the following ventilation parameter:

1 door open 4127 kW

With one door open, the 4127 kW corresponds to a lube oil burn rate of 1.57 gallons per minute. The duration of the oil fire at this rate will be 32 minutes, totally consuming the 50 gallons of lube oil.

5. RESULTS

Two cases were examined each having different ventilation parameters. In both cases 50 gallons of lube oil were assumed to have spilled from two High Pressure Service Water Pumps.

Case Number 1 had one door open. The fire is ventilation controlled and the resultant heat output of the fire would be 4127 kW. This would produce a fire duration of 32 minutes with a gas temperature of 994°F (see Attachment B) which is below the critical temperature for the structural steel.

The ventilation controlled burn rate of 4127 kW is equivalent to the heat output from a pool fire with an area of 13 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 located on the 130' elevation directly above the fire, Heskested's relatons will be used:

Virtual point source determination:

$$Za = -1.02D + .083\ Q^4 = 1.07$$

Plume temperature at bottom of steel on 130' elevaton:

$$\Delta To = 9.1\ (T_\infty/(g\ Cp^2 \rho_\infty^2))^{.333} Qc^{.667}\ (Z - Zo)^{-1.67}$$

$$\Delta To = 594°K$$

$$T = 1137°F$$

This temperature is below the critical temperature for the structural steel. It can be 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 area.

Case Number 2 assumed no doors into the room were open. Using the equation T = 29Ve/Q, the duration of a fire at a specified heat output could be determined. Several size fires were examined. Their heat output duration and gas temperature are as follows:

Heat Output (kW)	Duration (min)	Gas Temperature (°F)
5000	3.2	429
3000	5.25	344
1000	16	230

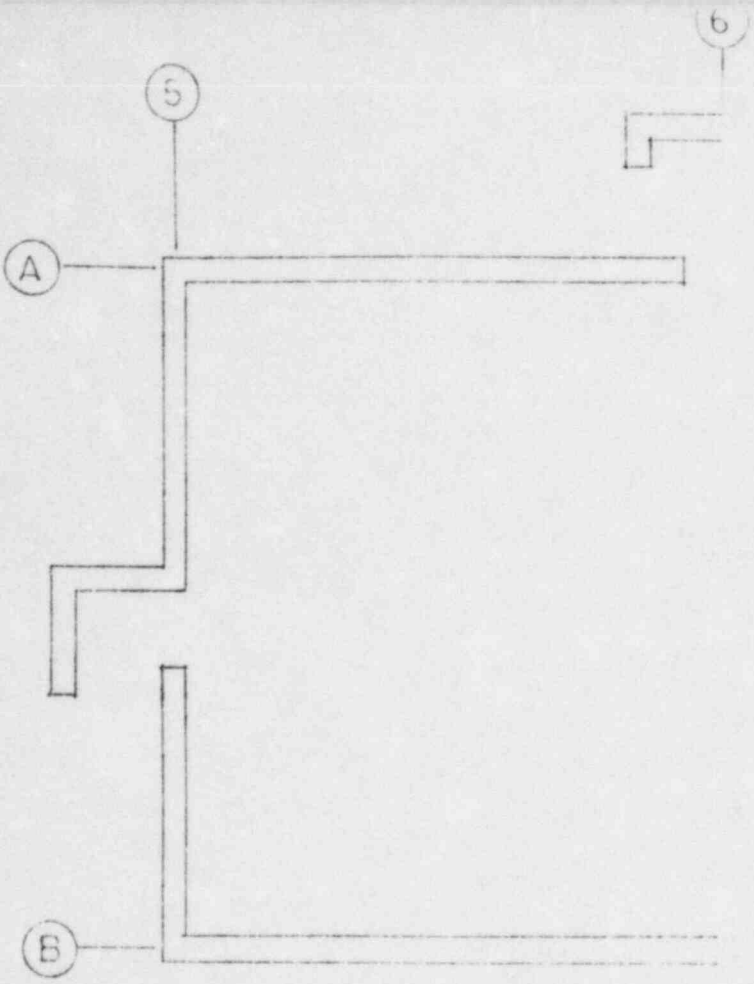
Attachment C contains computer printouts for the above cases.

In order to assess the effect of the plume of heated gases above the pool fire on the structural steel located on the 130' elevation directly above the fire, Sketed's relation will be used. Those relations given on the previous page yield the following results:

Heat Output (kW)	Zo (m)	ΔT°K	T°F
5000	1.12	694	1318
3000	.97	460	895
1000	.70	196	420

These temperatures are below the critical temperature for the structural steel.

It can be 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 in this area.



Unit 2 Cooling Water Pump Structure El. 112' Fire Area 143

Surface Area Calculation

Walls		
West wall	(31' x 18')	558 ft^2
East wall	(31' x 18')	558 ft^2
South wall	(35' x 18')	630 ft^2
		1746 ft^2
Ceiling	(31' x 35')	1085 ft^2
Total Surface Area for Heat Transfer		2831 ft^2 (263 m^2)

ATTACHMENT A

CASE NUMBER: 1
BUILDING: UNIT 2 CIRC WATER PUMP STRUCTURE
ELEVATION AND AREA DESCRIPTION: 112' FIRE AREA 143
CASE DESCRIPTION: ONE DOOR OPEN LUBE OIL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.0	CONCRETE	21	6	2831	4127

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
1	237
2	304
3	355
4	399
5	437
6	472
7	504
8	534
9	561
10	588
11	613
12	637
13	660
14	682
15	704
16	724
17	744
18	764
19	783
20	801
21	819
22	837
23	854
24	871
25	887
26	903
27	919
28	935
29	950
30	965
31	980
32	994

CASE NUMBER: 2
BUILDING: UNIT 2 CIRC. WATER PUMP STRUCTURE
ELEVATION AND AREA DESCRIPTION: 112' FIRE AREA 143
CASE DESCRIPTION: NO DOORS OPEN

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.0	CONCRETE			2831	5000

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
.25	174
.50	215
.75	245
1.00	272
1.25	295
1.50	316
1.75	335
2.00	353
2.25	370
2.50	386
2.75	401
3.00	415
3.25	429

CASE NUMBER: 2
BUILDING: UNIT 2 CIRC. WATER PUMP STRUCTURE
ELEVATION AND AREA DESCRIPTION: 112' FIRE AREA 143
CASE DESCRIPTION: NO DOORS OPEN

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.0	CONCRETE			2831	3000

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
.25	134
.50	158
.75	177
1.00	192
1.25	206
1.50	219
1.75	230
2.00	241
2.25	251
2.50	261
2.75	270
3.00	278
3.25	287
3.50	295
3.75	302
4.00	310
4.25	317
4.50	324
4.75	331
5.00	338
5.25	344

CASE NUMBER: 2
BUILDING: UNIT 2 CIRC. WATER PUMP STRUCTURE
ELEVATION AND AREA DESCRIPTION: 112' FIRE AREA 143
CASE DESCRIPTION: NO DOORS OPEN

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.0	CONCRETE			2831	1000

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
1.00	112
2.00	128
3.00	141
4.00	151
5.00	161
6.00	169
7.00	177
8.00	184
9.00	191
10.00	197
11.00	203
12.00	209
13.00	215
14.00	220
15.00	225
16.00	230

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Diesel Generator Building El. 127'

Diesel Generator Room

September 14, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Emergency Diesel Generator Building, 127' Elevation, Diesel Generator room between columns 2.5 and 3.0. (See Attachment A for a sketch of area under consideration). Bounding walls are reinforced concrete with an average thickness of 2 ft. Total surface area of the bounding walls and ceiling 5050 ft^2. (See Attachment A for a calculation of heat loss surface area.)

2. COMBUSTIBLE LOADING

The major amourt of combustible loading in this room is from the diesel fuel and lubricating oil in the engine crankcase. Any cable material in this area is small in comparison to the combustible liquids and will be insignificant. There is 550 gallons of diesel fuel in the Diesel's day tank and 480 gallons of lubricating oil in the engine crankcase.

3. VENTILATION PARAMETERS

Each diesel generator room has approximately 33,212 ft^3 (981 m^3) of available air for combustion in the room. The curve in figure 1 shows the duration of a fire at a given heat output with the available air in the room. The curve indicates that there is only enough air to burn a portion of the total fuel. This indicates that the worst case fire will be ventilation controlled.

The four diesel generator rooms are identical in room configuration. Each room has an access door on the east side of the room. The two end rooms have one connecting door to the adjacent diesel room and the center two rooms have two doors, one each connecting to the adjacent diesel rooms. The size of the doors are 3'4" x 6'8" providing an opening size of 22 ft^2 per door opening.

4. CASES EXAMINED

Each diesel generator room is the same size and configuration. A fire in any diesel room will be a ventilation controlled fire. This analysis is typical for any of the four diesel rooms. It examines a fire which

occurs with the east access door open. This is the most conservative case since the doors in the area are normally closed and key card controlled.

The centerline plume temperature at the ceiling 23 ft from the pool fire will be examined for the above case to determine the effect of localized heating on the structural steel.

5. RESULTS

The case examined is a fire that is ventilation controlled by an opening of 22 ft^2. This size opening would allow a maximum heat release fire of 4582 kW. The burn rate of the fuel (assuming adquate surface area) would be approximately 2 gallons per minute based on this maximum size fire. With over 1000 gallons of potential fuel, the fire could theoretically burn for over 8 hours, however, the room is designed as a 3 hour passive fire zone so we are only concerned with the first 180 minutes of the fire. If active fire suppression is not taken within 180 minutes, the entire fire zone will be in question, not just the structural steel. The calculations in Attachment B show that the gas temperature will be approximately 1433°F after 180 minutes.

The centerline plume temperature for a 4582 kW fire, 4 ft in diameter, would be 544°F at the ceiling.

The results above show that the critical steel temperature will not be reached for this scenario, therefore a detailed analysis of the steel will not be performed.

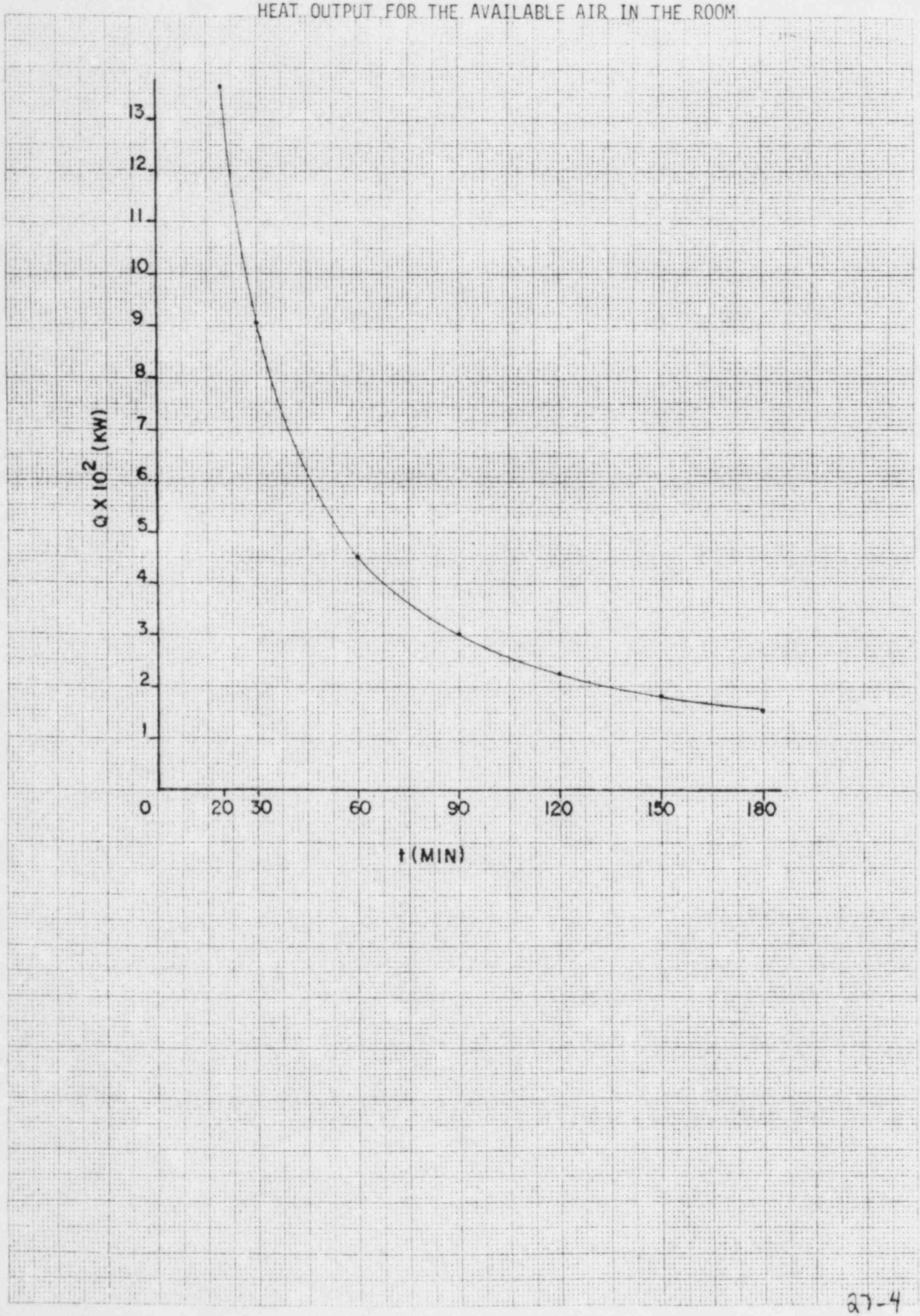
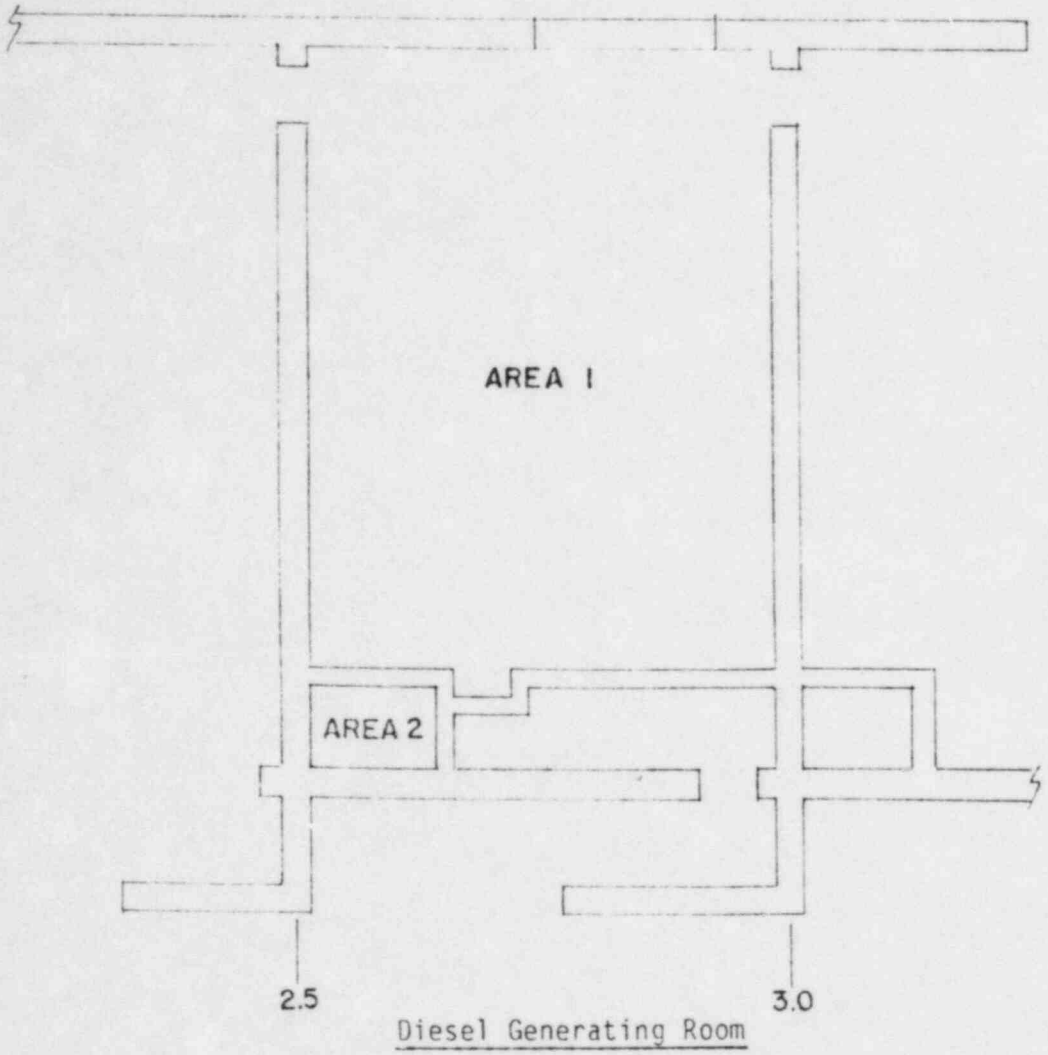


FIGURE 1



Diesel Generating Room

Surface Area Calculation

Walls		
North wall	(60' x 23') - (3'4" x 6'8" door)	1358 ft^2
South wall	(53' x 23') - (3'4" x 6'8" door)	1197 ft^2
East wall	(25' x 23') - (3'4" x 6'8" door)	553 ft^2
North wall	(7' x 23')	161 ft^2
West wall	(25' x 23') - (10'3" x 23' Equip door)	337 ft^2
		3606 ft^2
Ceiling	(25' x 60') - (7' x 8' Fuel Storage Area)	1444 ft^2
Total Surface Area for Heat Transfer		5050 ft^2

ATTACHMENT A

CASE NUMBER: 1
BUILDING: DIESEL GENERATOR BUILDING
ELEVATION AND AREA DESCRIPTION: 127' EL. DIESEL GENERATOR ROOM
CASE DESCRIPTION: ONE DOOR OPEN LIQUID FUEL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.0	CONCRETE	22	7	5050	4582

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	393
20	526
30	628
40	714
50	789
60	858
70	921
80	979
90	1034
100	1087
110	1136
120	1183
130	1229
140	1272
150	1315
160	1355
170	1395
180	1433

ATTACHMENT B

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Diesel Generator Building El. 127'

Fuel Transfer Room

September 14, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Emergency Diesel Generator Building, 127' Elevation, Fuel Transfer Room between columns I and 1.5. (See Attachment A for a sketch of area under consideration). Bounding walls are reinforced concrete with an average thickness of 2 ft. Total surface area of the bounding walls and ceiling is 5161 ft^2. (See Attachment A for a calculation of heat loss surface area.)

2. COMBUSTIBLE LOADING

The major amount of combustible material in the room is the combustible liquid being pumped through the diesel transfer pump and the limited amount of combustible lubricating liquid inside the pumps. The amount of cable material in the area is not significant in comparison to the liquid fuel and will be neglected in this analysis.

3. VENTILATION PARAMETERS

The Fuel Transfer Pump Room has approximately 33,120 ft^3 (938 m^3) of available air for combustion in the room. The curve in figure 1 shows the duration of a fire at a given heat output with the available air in the room. The curve indicates that there is only enough air to burn a small pool fire (e.g., a 1.7 gpm spill fire @ ±4500 kW) for 6 minutes.

The worst case fire will be a ventilation controlled fire. There is only one access door to this area in the east wall of the room. This door is 3'4" x 6'8" providing a maximum ventilation opening of 22 ft^2 to supply air to a fire in this room.

4. CASES EXAMINED

The worst case fire would be caused by a fuel line leak creating a fuel spill spreading across the floor of the room. The size of the fire and surface area of fuel involved would be limited by the quantity of air available for combustion. The worst case would be with the east access door open providing a 22 ft^2 of ventilation opening for combustion air to burn at the maximum heat release rate of 4582 kW for a duration of

180 minutes. The designed fire resistive rating of the room is 180 minutes.

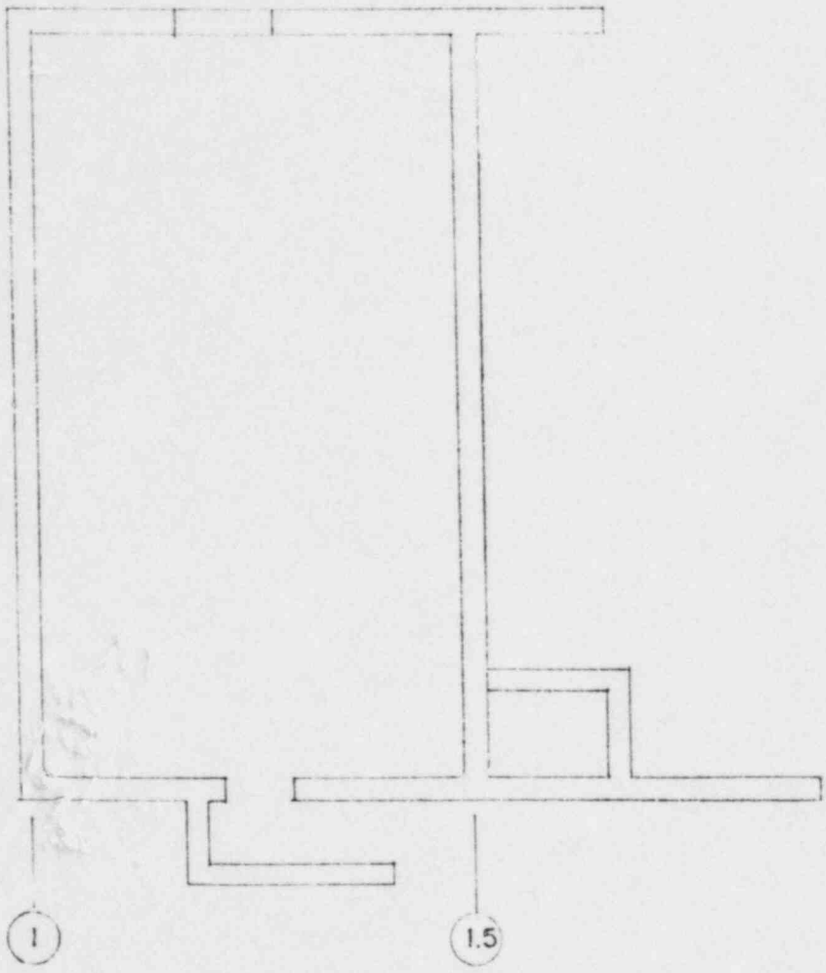
The centerline plume temperature for this size pool fire will be examined to determine the effect of localized heating on the structural steel.

5. RESULTS

The largest surface area of a fuel spill that will burn with a controlled ventilation opening of 22 ft^2 (4582 kW) is a 4 ft diameter (14 ft^2) pool fuel surface. This represents a fuel line leak of 1.7 gallons per minute. A spill rate larger than this would not have any impact since there is only enough air available for combustion to burn 1.7 gallons per minute. Assuming this fire continues to burn at this maximum heat release rate for the duration of 180 minutes, 300 gallons of fuel would be consumed. The gas temperature reached in this period is 1404°F. (See calculations in Attachment B).

The centerline plume temperature for a fire of this size would be 548°F at 23' above the surface of the fuel pool. The structural steel will not be adversely affected by localized heating from this fire plume.

The critical steel temperature will not be exceeded in this analysis so a detailed analysis of the steel will not be performed.



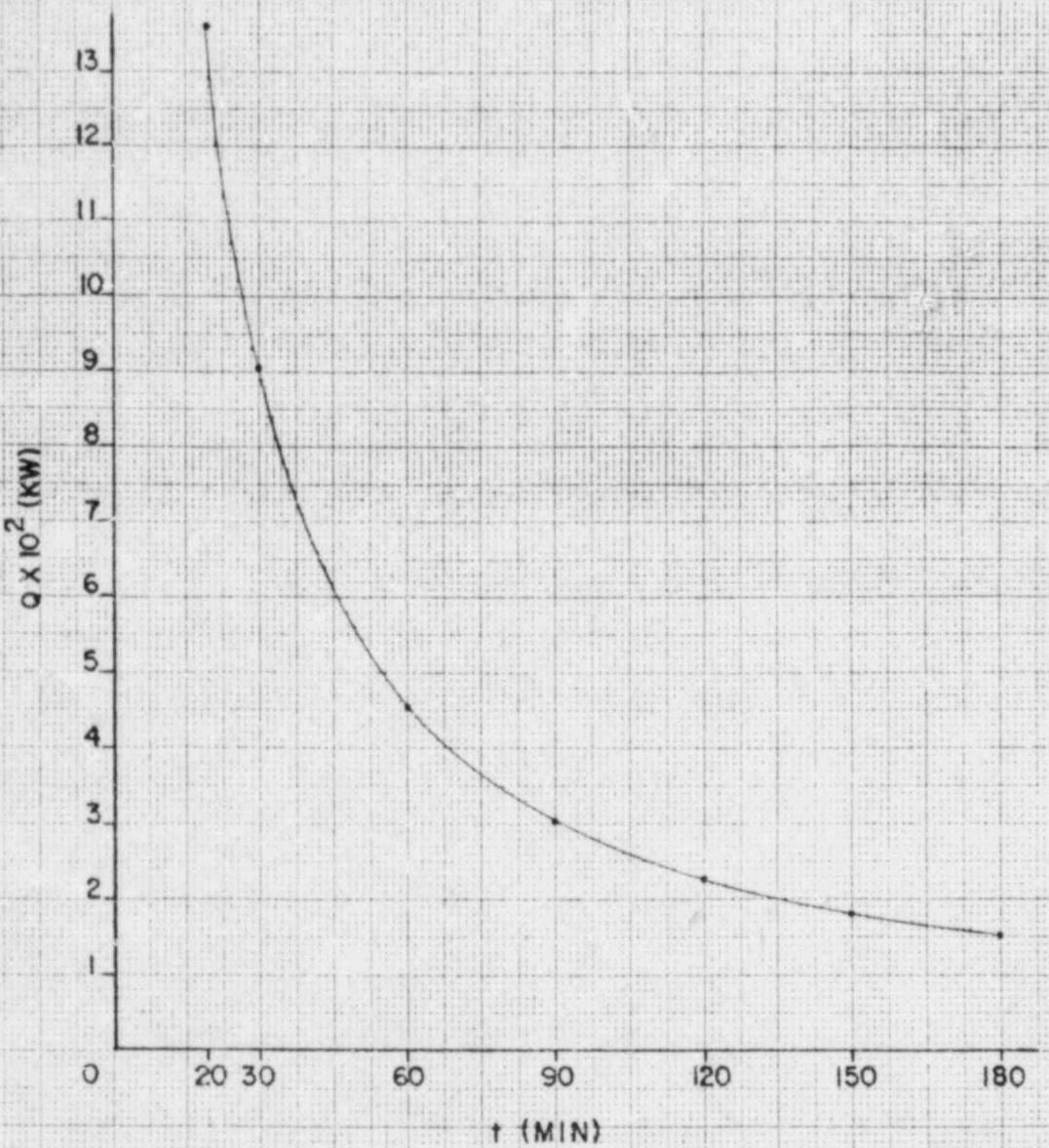
Fuel Transfer Pump Room

Surface Area Calculation

Walls		
North wall	(60' x 23')	1380 ft^2
South wall	(60' x 23')	1380 ft^2
East wall	(24' x 23') - (3'4" x 6'8" door)	530 ft^2
West wall	(24' x 23') - (5'3" x 23' Equip door)	431 ft^2
		3721 ft^2
Ceiling	(24' x 60')	1440 ft^2
Total Surface Area for Heat Transfer		5161 ft^2

ATTACHMENT A

HEAT OUTPUT DURATION FOR THE AVAILABLE AIR IN THE ROOM



28-5

FIGURE 1

CASE NUMBER: 1
BUILDING: DIESEL GENERATOR BUILDING
ELEVATION AND AREA DESCRIPTION: 127' EL. FUEL TRANSFER PUMP ROOM
CASE DESCRIPTION: ONE DOOR OPEN LIQUID SPILL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.0	CONCRETE	22	7	5161	4582

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	386
20	516
30	616
40	700
50	774
60	841
70	903
80	960
90	1014
100	1065
110	1113
120	1159
130	1204
140	1247
150	1288
160	1328
170	1366
180	1404

PLC *Professional Loss Control, Inc.*

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 2

Radwaste Building El. 88'

Reactor Sump Room

Fire Zone 61

September 12, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 Radwaste Building El. 88' Reactor Sump Room (see Attachment A for sketch of area under consideration). Bounding walls of area are reinforced concrete with an average thickness of 2.5 ft. Total surface area of bounding walls and ceiling is 3006 ft^2 (279 m^2) (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

Combustible loading in the area consists of cable insulation and lubricating oil. There are only two cable trays in this area. These tray numbers are listed in Attachment B, but will not be considered in the analysis because their contribution to the overall heating in the room in comparison to the large quantities of oil will be minimal.

A quantity of 300 gallons of oil could be contained in one of the sump areas at any one time. An oil fire of this quantity and size will cause the greatest heat exposure to the steel in the room.

3. VENTILATION PARAMETERS

Two doors serve this area each measuring 3' x 7' for a total of 42 ft^2 ventilation opening. One door is located on the west wall and the other opens into the Core Spray Pump Room. The total volume of air within the room for combustion is 1279 m^3. Figure 1 illustrates the fire duration for various heat output fires for this volume of air. We assume 300 gallons of oil had spilled into one sump area 126 ft^2 (14' x 9'). The sump area is totally enclosed by concrete except for an access hatch on top of the sump. This hatch is 3'2" x 4'2" (13 ft^2). With an oil fire in the sump area, the limiting factor would be the available air provided to the fire through the hatch area assuming the hatch is not in place. The available air in the room will not be sufficient to consume all the fuel in the sump. The fire would consume all the air in the room in less than 17 minutes. Therefore, the fire will be ventilation controlled by the size of the hatch area and at least one door must be open to allow enough air for combustion of the fuel.

4. CASES EXAMINED

A quantity of 300 gallons of oil is assumed to be contained within one of the two reactor sump areas (14' x 9') 126 ft^2. The worst case fire will occur with one door open to allow sufficient air for combustion for a period of 180 minutes or until all the fuel is consumed. The time of 180 minutes is used because it is the designed passive fire rating of the zone. The critical steel temperature must not be reached within the design rated fire resistance period. The limiting factor controlling the combustion of the fuel is the actual ventilation opening to the fire. This is the 3'2" x 4'2" (13 ft^2) hatch opening to the sump pit.

The other case to be examined is the localized heating effect on structural steel from a fire in the sump.

5. RESULTS

This case examines a 13 ft^2 ventilation controlled sump oil fire. The maximum heat release which can be achieved with a ventilation opening of this size is 2160 kW. This would consume a total of 0.8 gallons of oil per minute. Theoretically, the quantity of oil available (300 gallons) is sufficient to burn for over 360 minutes (6 hours) at this constant burn rate. The calculations in Attachment C indicate that after 180 minutes the room gas temperature is 1150°F. This does not exceed the critical steel temperature so a detailed analysis of the steel will not be performed.

The centerline plume temperature caused by this fire will not be sufficient to become a factor in the failure of structural steel in the room. The plume temperature at 27' above the floor (assuming the fire is at floor level) from a 2160 kW fire will only be 270°F. This is below the critical steel temperature so a detailed analysis of the steel will not be performed.

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

Heat Output Duration for Available Air in Room

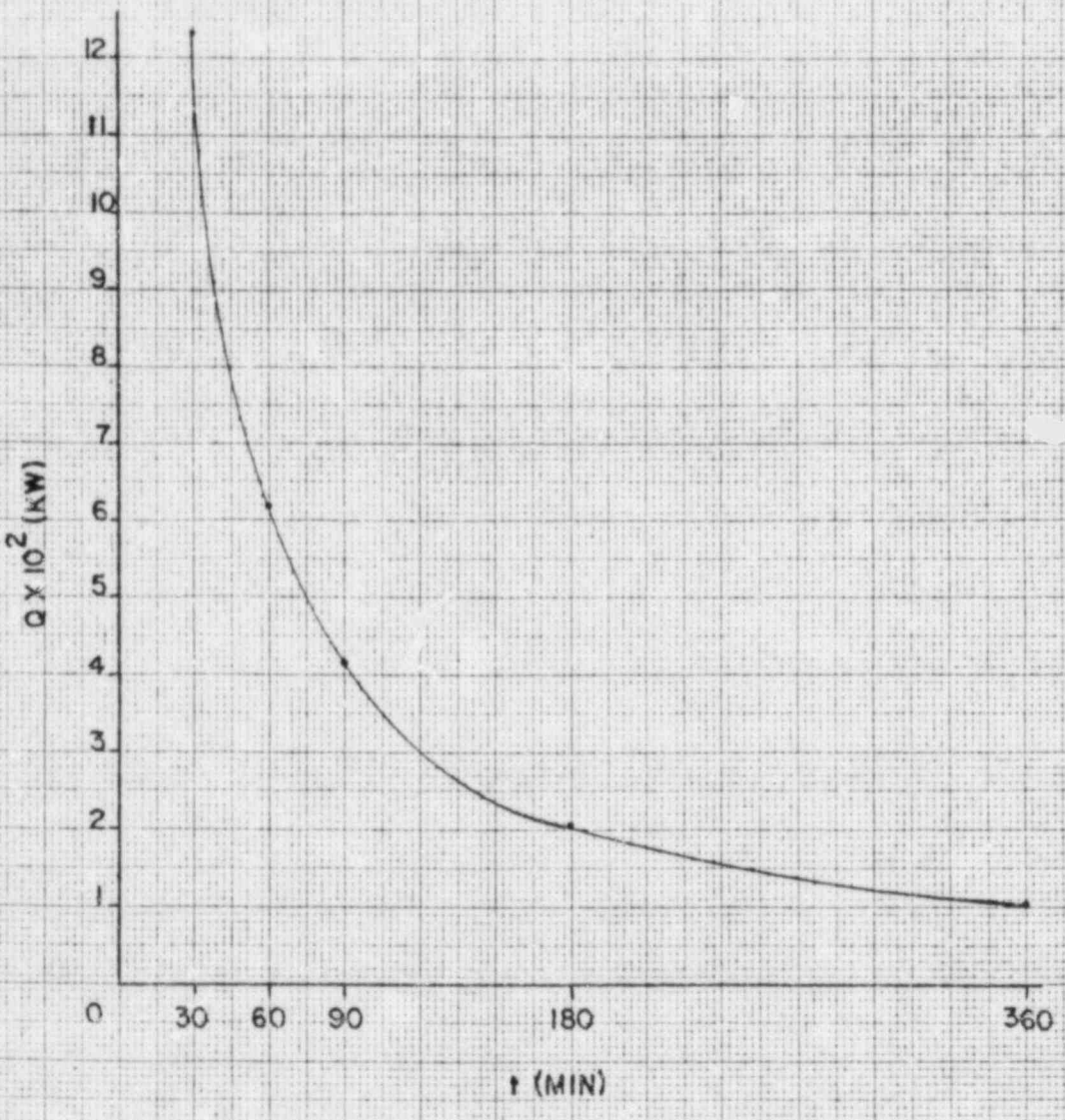
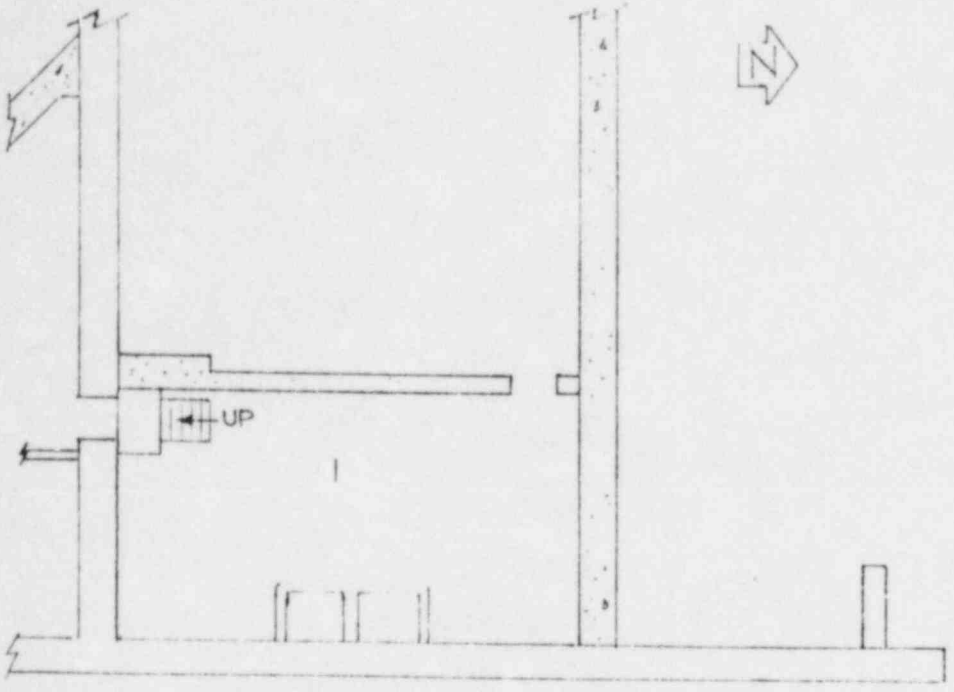


Figure 1



Unit 2 Reactor Sump Area El. 88'

Surface Area Calculation

Walls

North wall	(27' x 17')	459 ft^2
South wall	(27' x 17') - (3' x 7' door)	438 ft^2
East wall	(27' x 30')	810 ft^2
West wall	(27' x 30') - (3' x 7' door)	789 ft^2
		2496 ft^2

Ceiling

Area 1	(30' x 17')	510 ft^2

Total Surface Area for Heat Transfer 3006 ft^2 (279 m^2)

ATTACHMENT A

Cable Trays

Cable trays located in the Reactor Sump Room.
Note: Cable material contribution to heat release in the room not considered.

Horizontal Tray No.	Width (in)	Surface Area (ft^2)
ZA2MA220	24	4
ZB2MA030	24	4

ATTACHMENT B

CASE NUMBER: 1
BUILDING: RADWASTE BUILDING UNIT 2
ELEVATION AND AREA DESCRIPTION: 80' EL. REACTOR SUMP ROOM
CASE DESCRIPTION: ONE DOOR OPEN SUMP HATCH OPEN OIL FIRE

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
2.5	CONCRETE	13	4	3006	2160

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
10	327
20	432
30	512
40	580
50	640
60	694
70	744
80	791
90	834
100	875
110	915
120	952
130	988
140	1023
150	1056
160	1089
170	1120
180	1150

ATTACHMENT C

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

Unit 2

Radwaste Building El. 88'

HPCI Pump Room

Fire Zone 59

September 12, 1983

P. O. Box 146 • Oak Ridge, Tennessee 37830 • (615) 482-3541

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Unit 2 side of the Radwaste Building El. 88' in the HPCI Pump Room, Fire Zone 59 (Room No. 6). Bounding walls of the area are reinforced concrete with an average thickness of 3 ft. Total concrete surface area of bounding walls and ceiling is 8395.75 ft^2 (see Attachment A for calculation of areas).

2. COMBUSTIBLE LOADING

The combustible loading in the area includes both cable insulation and lubricating oil for the HPCI pump. The total surface area of cables in this area is 166 ft^2 with an average combustible loading of the cable trays of 3.8 lb/ft. A listing of the cable trays considered, surface area, combustible loading and fire duration calculations is included in Attachment B.

The quantity of oil in the room used for equipment operation was taken to be 155 gallons. This quantity was doubled to account for potential transient combustible conditions (oil changes, etc.).

3. VENTILATION PARAMETERS

There are two door openings in this room. One door is located at the northeast corner and the other is at the southwest center of the room leading into the enclosed stairway. The doors are 3' x 7'. This provides a total ventilation opening in the room of 42 ft^2.

The total volume of air in the HPCI Pump Room is 44,988 ft^3 (1274.9 m^3). The curve in Figure 1 represents the ventilation controlled fire duration based on the volume of air (i.e., without openings). This curve illustrates that there is only sufficient air to burn approximately 25% of the cable insulation in the room (excluding any involvement of oil). Therefore, it is apparent that the quantity of combustibles available is far greater than the air necessary for combustion indicating that the worst case fire will be ventilation controlled.

4. CASES EXAMINED

The first case involves both doors being open allowing the maximum ventilation opening of 42 ft^2. The ventilation controls the combustion rate (explained above).

The heat release rate related to a ventilation opening of 42 ft^2 is 9008 kW.

$$Q_V = 1580\ Ao\ \sqrt{Ho} = 9008\ (kW)$$

$$Ao = 42\ ft^2 \quad Ho = 7\ ft$$

The initial stages of the fire are assumed to involve all the cable trays simultaneously (representing 2933.9 kW) with the remaining 6074.1 kW (9008 kW - 2933.9 kW) being released from the combustion of oil. Once the cable insulation is fully consumed, the oil combustion rate can increase due to an increase in air availability. The maximum heat release is maintained until all the oil is consumed. The fire duration is calculated to provide the room gas temperature at this maximum heat release.

The second case involves an analysis of localized heatng of structural steel. The fire plume generated from the oil fire is assumed to be directly under the structural steel such that the steel will be in the centerline of the plume. The highest plume temperatures are produced when the most oil is consumed. This is during the later stage of Case 1 where the oil fire is responsible for the full 9008 kW of heat release.

5. RESULTS

Case 1

The average combustibie loading per surface area of tray is 3.79 lb/ft^2 (see Attachment B). Using a cable burn rate of $\frac{.1\ lb/ft^2}{min}$, the cable insulation will contribute to the fire for a period of 37.9 minutes. During this same period 89 gallons of oil will be consumed to produce the maximum heat release of 9008 kW.

After the 37.9 minutes, 221 gallons of the 310 initial gallons of oil remain. The remaining oil will be burned in 63 minutes. The total fire duration at the maximum heat release rate of 9008 kW is 101 minutes. This fire duration represents a room gas temperature of 1278°F (see Attachment C). The critical steel temperature will not be exceeded so a detailed analysis of the steel will not be performed.

Case 2

The centerline plume temperature at a height of 27' from the surface of the oil pool is calculated as 648°F using the oil pool combustion methodology.

This temperature is below the critical steel temperature so a detailed analysis of the steel will not be performed.

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

Heat Output Duration for Available Air in Room

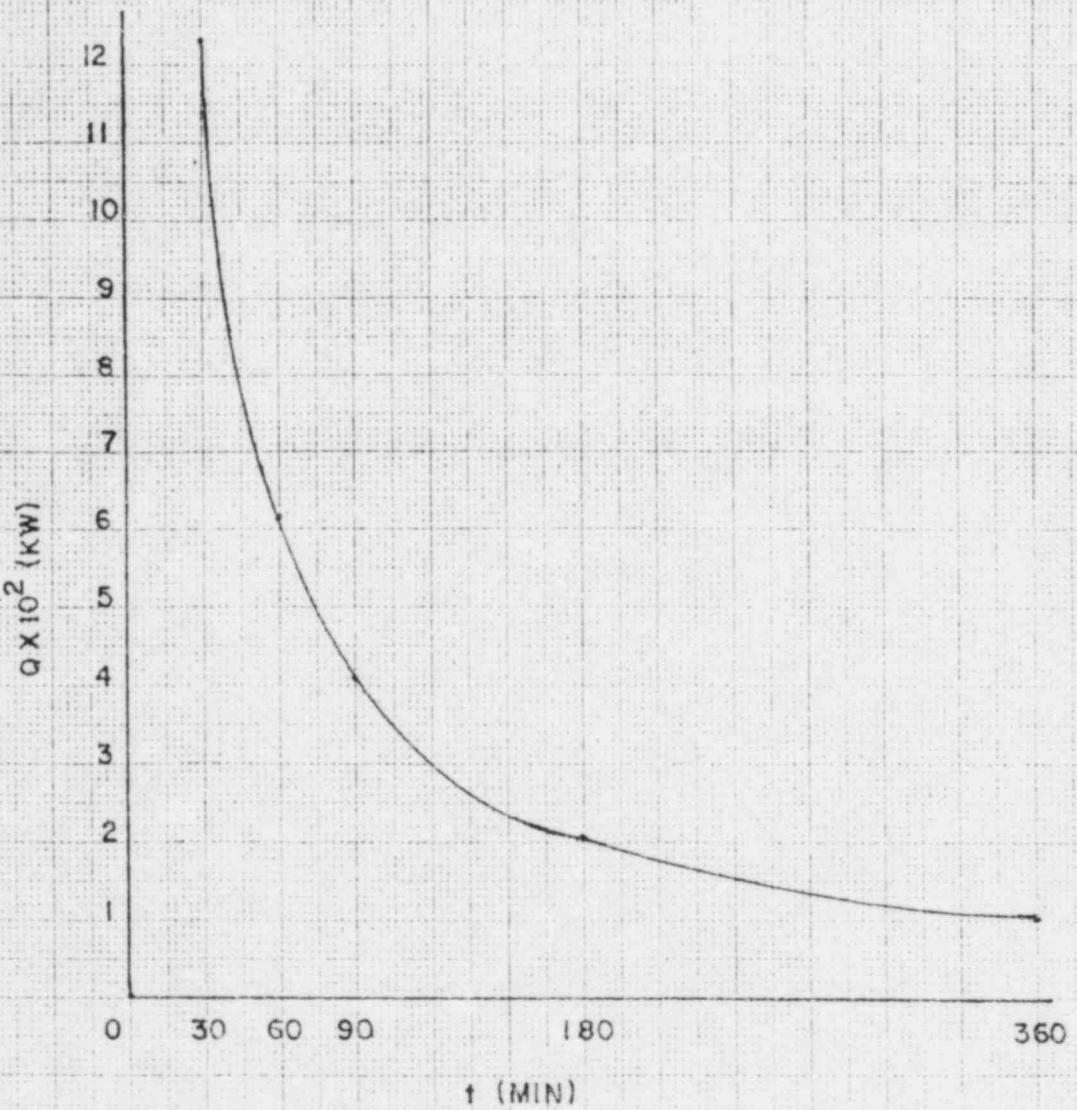
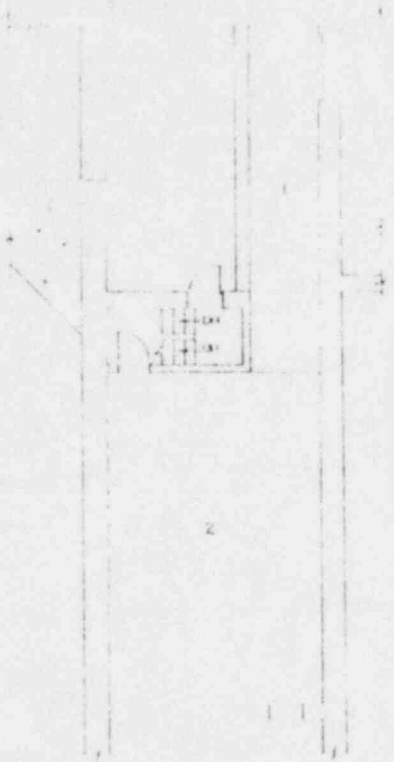


Figure 1



Unit 2 Radwaste Building El. 88'
HPCI Pump Room Fire Zone 59

Surface Area Calculation

Walls

North wall	(96'9" x 27') - (10' x 10' equip. hatch)	2512.25 ft^2
East wall	(30'6" x 27') - (3' x 7' door)	802.5 ft^2
South wall	(47'9" x 27') + (49' x 27')	2612.25 ft^2
West wall	(10'6" x 27') + (20' x 27') - (3' x 7' door)	802.5 ft^2
		6729.5 ft^2

[Wall height = 116' el.-88' el. - (1' floor slab) = 27']

Ceiling

Area 1	(30'6" x 47'6") - (27' x 11' hatches)	1151.75 ft^2
Area 2	(49' x 10'6")	514.5 ft^2
		1666.25 ft^2

Total Surface Area for Heat Transfer 8395.75 ft^2
(2559.7) m^2

ATTACHMENT A

HPCI Room Cable Insulation Fire Load

Wt of Cables (lbs) =

$\frac{0.5 \text{ lb/ft}}{\text{in}^2}$ (Tray Cross Sectional area in^2)(Cable Length ft) (actual fill %)

*Wt. of combustible material is $\frac{0.5 \text{ lbs/ft}}{\text{in}^2}$ electrical cable

a) Actual Cable Insulation Load

Tray No.	Tray Cross-Sectional Area (in^2)	Cable Length (ft)	Actual Fill (%)	Wt of Cable (lbs)
ZB2KB010	72	21	17	128.5
ZB2MA012	72	21	13	98.3
ZB2MB012	72	21	19	143.6
ZB2MB020	72	20	28	201.6
				572 lbs

b) Future Cable Insulation Load (+10%)

(1.1) (572 lbs) = 629.2 lbs

c) Average Combustible Loading per Surface Area of Tray

(629.2 lbs)/(166 ft^2) = 3.79 lbs/ft^2

d) Fire Duration of Cabling in Room

$= 3.79 \text{ lbs/ft}^2 \div \frac{.1 \text{ lb/ft}^2}{\text{min}} = 37.9$ minutes

$\frac{.1 \text{ lb/ft}^2}{\text{min}}$ = cable tray surface controlled rate of combustion

ATTACHMENT B

Oil Combustion

Time Period during Cable Burn

Vol oil consumed (gal) =

$$Q\left[\begin{array}{l}\text{Heat of combus.}\\ \text{kW by oil}\end{array}\right] \times T(\text{Time min}) \times \frac{1}{(\text{Heat Release BTU/gal})} \times \text{Units conversion factor}$$

Q = 6014 kW (9008 kW - 2993.9 kW)
T = 37.9 minutes (during cable burn)
Combus Rate oil = 149,940 btu/gal
Units conversion factor = 58.8

$$\text{Vol} = (6104\ \text{kW}) \times (37.9\ \text{min}) \times \frac{1}{(149{,}940\ \text{btu/gal})} \times (58.8)$$

Vol oil consumed during cable burn = 89 gallons

Vol of oil remaining = 310 gal - 89 gal = 221 gallons

Time Period after Cable Burn

T is unknown; Qv is now 9008 kW

$$T = (\text{Vol}) \times (\text{Heat Release}) \times \frac{1}{Q} \times \frac{1}{\text{conversion factor}}$$

$$T = (221\ \text{gal}) \times (149{,}940\ \text{Btu/gal}) \times \left[\frac{1}{9008\ \text{kW}}\right] \times \left[\frac{1}{58.8}\right]$$

T = 62.6 minutes

Fire Duration = 37.9 min. + 62.6 min = 101 minutes

CASE NUMBER: 1
BUILDING: UNIT 2 RADWASTE BUILDING
ELEVATION AND AREA DESCRIPTION: 88' HPCI ROOM
CASE DESCRIPTION: TWO DOORS OPEN CABLES & 310 GAL OIL BURNING

CEILING/WALL THICKNESS (ft)	CEILING/ WALL MATERIAL	Ao (ft2)	Ho (ft)	Aw (ft2)	Q (kW)
3.0	CONCRETE	42	7	8396	9008

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (min)	GAS TEMPERATURE (deg.F)
5	341
10	452
15	537
20	609
25	672
30	729
35	782
40	831
45	877
50	920
55	962
60	1001
65	1039
70	1076
75	1111
80	1145
85	1178
90	1210
95	1241
100	1272
105	1301

Cable Trays

Cable trays considered to be burning simultaneously:

Horizontal Tray No.	Length (ft)	Width (in)	Surface Area (ft^2)
ZB2KB010	21	24	42
ZB2MA012	21	24	42
ZB2MB012	21	24	42
Vertical Tray No.			
ZB2MB020	20	24	40
			166 ft^2

$$\frac{166\ ft^2}{10.75\ ft/m^2} \times 190\ kW/m^2 = 2933.9\ kW$$

ATTACHMENT D

PLC Professional Loss Control, Inc.

STRUCTURAL STEEL ANALYSIS

for

PEACH BOTTOM ATOMIC GENERATING STATION

COMMON AREA

Turbine Building El. 135'

Battery Room #225

September 12, 1983

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

PEACH BOTTOM ATOMIC GENERATING STATION

1. AREA DESCRIPTION

Battery Room #225 on the 135' elevation of the Turbine Building. See Attachment A for a sketch of the area under consideration. Bounding walls of the area are constructed primarily of reinforced concrete and are an average of 1.5 ft thick. Total surface area of bounding walls and ceiling is 1832 ft^2 (see Attachment A for a calculation of heat loss surface area).

2. COMBUSTIBLE LOADING

The exposed combustible loading in this area consists solely of plastic battery cases. The Fire Protection Program Report identifies the total quantity of plastic in the room as 2600 lbs.

3. VENTILATION PARAMETERS

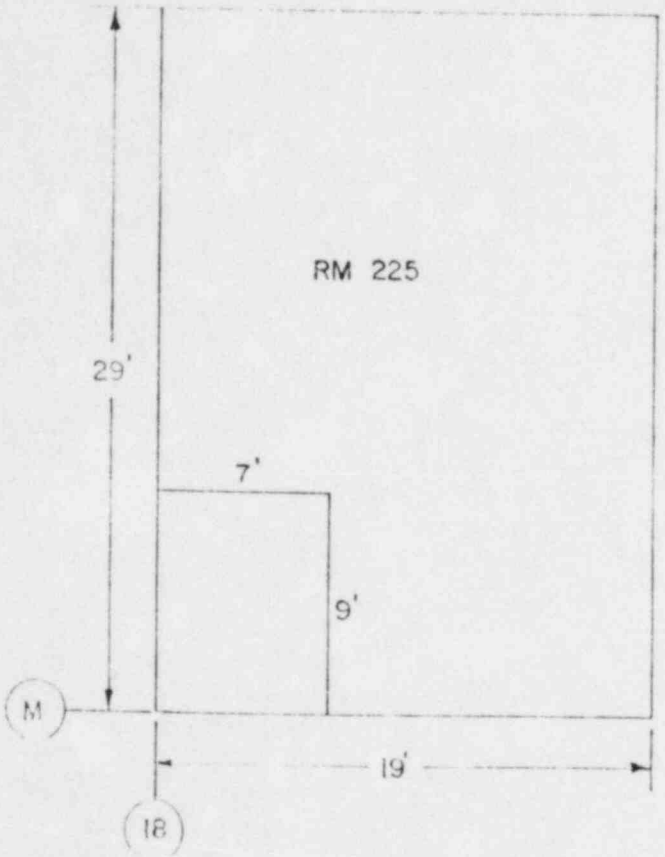
This area is served by two personnel doors. Each door is 3 ft wide by 7 ft high.

4. CASES EXAMINED

Both cases examined were ventilation controlled fires. The first case assumed that one door was opened which resulted in a constant burning rate of approximately 4500 kW and a duration of 80 minutes. The second case was with both doors open which resulted in a burning rate of approximately 9000 kW and a duration of 40 minutes.

5. RESULTS

Both cases resulted in rapid failure of the structural steel in the room. (See Attachment B for the results of the analysis.)



Heat Loss Area Determination

Bounding Area (Excluding Floor)

A_1 = Ceiling = (29' x 19') - (7' x 9') = 488 ft^2
A_2 = North wall = (29' x 14') = 406 ft^2
A_3 = South wall = (29' x 14') = 406 ft^2
A_4 = East wall = (19' x 14') = 266 ft^2
A_5 = West wall = (19' x 14') = 266 ft^2
$A_w = A_1 + A_2 + A_3 + A_4 + A_5$
A_w = 488 + 406 + 406 + 266 + 266 = 1832 ft^2

ATTACHMENT A

SE NO. : 1
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: BATTERY ROOM 225, 135' ELEV.
CASE DESCRIPTION: ONE DOOR OPEN

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
1.5	CONCRETE	21	7	1832	4504.2

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	941.714
20	1301.67
30	1577.98
40	1810.95
50	2016.21
60	2201.79
70	2372.45
80	2531.30

ATTACHMENT B

CASE NO.: 2
BUILDING: TURBINE BUILDING
ELEVATION AND AREA DESCRIPTION: BATTERY ROOM 225, 135' ELEV.
CASE DESCRIPTION: BOTH DOORS OPEN

CEILING/WALL THICKNESS (FT.)	CEILING/WALL MATERIAL	AO SQ. FT.	HO FT.	AW SQ. FT.	Q KW
1.5	CONCRETE	42	7	1832	9008.4

FIRE IS VENTILATION CONTROLLED

FIRE DURATION (MIN.)	GAS TEMPERATURE (DEG. F)
10	1811.07
20	2531.35
30	3084.11
40	3550.12