Consumers Power
POWERING MICHIGAN'S PROGRESS

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS COVER SHEET

EA- FPP-95-054

Total Number of Sheets 31

Title Evaluation of the Effects of a Fire on the West Wall of the Turbine Lube Oil Room adjacent to the Pipe Tunnel Between the Turbine Building and the Feedwater Purity Building.

INITIATION AND REVIEW

Calculation Status: Preliminary X Pending ☐ Final ☐ Superseded ☐

Rev #	Description	Initiated By	Initiated Date	Init Appd By	Review Method: Alt Calc	Review Method: Detail Review	Review Method: Qual Test	Technically Reviewed By	Technically Reviewed Date	Revr Appd By	CPCo Appd
0	Original Issue	Larry D Young LDYoung	12/12/95	[illegible] 12/14/95		✔		[illegible]	1/17/96	[illegible]	[illegible] 1-19-96

1.0 OBJECTIVE

The purpose of this Engineering Analysis is to show the impact of a fire on the West wall of the Turbine Lube Oil Room adjacent to the tunnel travelling between the Turbine Building (EL. 590'-0") and the Feedwater Purity Building. Specifically, the analysis will consider the equivalent fire resistance of the barriers, combustible loading within the rooms and suppression and detection. Through these considerations, this analysis will demonstrate the ability of the system as a whole to prevent a direct fire exposure hazard to safety related equipment or openings in other fire area barriers required to meet NRC guidelines.

2.0 ANALYSIS INPUT

2.1 Consumers Power Co. Palisades Nuclear Plant Drawings:

A-108,	Rev. 1	Feedwater Purity Modification, Architectural, Pipe Gallery
C-825,	Rev. 2	Feedwater Purity Modification, Pipe Gallery, Foundation & Floor Slab Plans - Area 8, 14 & 15
M-216, Sh.14	Rev. 5	Fire Protection, turbine Building, Plan of EL. 590'-0"

2.2 National Fire Protection Association, Fire Protection Handbook, 17th Edition.

2.3 Palisades Nuclear Plant Engineering Analysis EA-FPP-95-11, Analysis of Combustible Loading for Fire Area 22, Turbine Lube Oil Room.

2.4 Palisades Nuclear Plant Engineering Analysis EA-FPP-95-18, Analysis of Combustible Loading for Fire Area 23D, Turbine Building - General.

2.5 Palisades Nuclear Plant Fire Hazards Analysis, Revision 2, February 1, 1989.

2.6 Palisades Nuclear Plant Fire Protection Program Report (FPPR), Volume 2, Section VIII; List of Changes to Appendix A to Branch Technical Position APCSB 9.5-1 and Regulatory Guide 1.78 and 1.101, Revision 1, October 26, 1989.

2.7 Palisades Nuclear Plant Fire Protection Program Report (FPPR), Volume 3, Section IX, #46.

2.8 U.S. Nuclear Regulatory Commission (NRC) Generic Letter 86-10, Implementation of Fire Protection Requirements, April 24, 1986.

2.9 NRC Standard Review Plan NUREG-0800, BTP CMEB 9.5-1, Guidelines for Fire Protection for Nuclear Power Plants, Revision 2, July 1981.

2.10 FPETOOL: Fire Protection Engineering Tools for Hazard Estimation, Version 3.0, National Institute of Standards and Technology, October 1990.

2.11 Palisades Nuclear Plant Engineering Analysis EA-APR-95-001, Appendix R Safe Shutdown Equipment List and Logic Diagrams.

2.12 Methods of Quantative Fire Hazard Analysis, EPRI Research Project 3000-37, by F.W. Mowrer, dated May 1992.

2.13 Palisades Nuclear Plant Engineering Analysis EA-FPP-96-012, System Hydraulic Analysis for the Lube Oil Storage Room.

2.14 National Fire Protection Association, Automatic Sprinkler Systems Handbook, 6th Edition

3.0 ASSUMPTIONS

None

Reference/Comment

4.0 ANALYSIS

4.1 General

General Guidelines for Plant Protection are discussed in the List of Changes and Response to Appendix A to BTP APCSB 9.5-1 and Regulatory Guide 1.78 and 1.101, Subsection D.1.j. The regulatory position states that concerning compartmentation "...Floors, walls and ceilings enclosing separate fire areas should have minimum fire rating of three hours." It then goes on to state that "...The fire hazard in each area should be evaluated to determine barrier requirements." Also, ..."If barrier fire resistance cannot be made adequate, fire detection and suppression should be provided..."

Reference 2.6, Page 27

Based upon the above statements, it is apparent that the analysis of a specific barrier for acceptability should subsequently follow this order of importance:

a. The capability of the barrier must satisfy the minimum fire rating guideline of 3-hours. If not then;

b. The barrier must be adequate to withstand the actual combustible loading in the fire areas separated by the barrier. If not then;

c. The actual configuration must be reviewed in order to take credit for other systems or circumstances that may increase the acceptability of the barrier (e.g. suppression, detection, etc...).

This analysis is based upon the above three criteria. It shall be used to demonstrate the capability of the fire barrier and its supporting systems to adequately prevent the spread of fire through the pipe tunnel separating the Feedwater Purity Building and the Turbine Building (EL. 590'-0").

Additional regulatory guidance is provided in NUREG 0800, Section 9.5.1, sub-section C.7.h, "Turbine Building," which states, in part:

Reference 2.9

> The turbine building should be separated from adjacent structures containing safety-related equipment by a fire barrier with a minimum rating of 3 hours.... Openings and penetrations in the fire barrier should be minimized and should not be located where the turbine lube oil or generator hydrogen cooling system creates a direct fire exposure hazard to the barrier. Considering the severity of the fire hazards, defense in depth may dictate additional protection to ensure barrier integrity.

In summary, the regulatory goal of the Turbine Lube Oil Room walls is to prevent a direct exposure fire hazard to either safety related equipment or openings and penetrations in fire barriers containing safety related equipment.

Reference/Comment

4.2 Description of the Fire Barrier

The West wall of the Turbine Lube Oil Room is corrugated sheet metal directly connected to building support steel. The remaining walls are concrete block walls. The ceiling is approximately 8" thick reinforced concrete, based on field measurement, and the floor is reinforced concrete resting on the grade elevation. The two doors in the south wall are three-hour rated doors. There are two openings in the ceiling for equipment access. These openings are protected by concrete plugs the same thickness as the ceiling with metal framing. The room is curbed to contain potential oil spills or a single tank rupture within the room.

The Turbine Lube Oil Room is a free standing room within the main Turbine Building. Figure #1 shows a plan view of the area. This room does not provide structural support for the Turbine Building. However, the lower portion of two columns supporting the Turbine Building are located within the Turbine Lube Oil Room walls near the west end. Also, the concrete slab ceiling of the room is supported by structural steel beams. Neither the Turbine Building structural steel nor the ceiling beams are protected with fireproofing materials. The size of the columns and beams and connecting steel outside the room, provide a large heat sink, and in conjunction with the automatic sprinkler system ensure these components will not fail prior to the arrival of additional fire fighting equipment to further suppress a fire in this area. The Palisades Fire Brigade is specifically trained to fight liquid petroleum fires as part of their hands on training.

Reference Content

Figure #1 - Plan View 590' Elev. of Turbine Building

Not To Scale

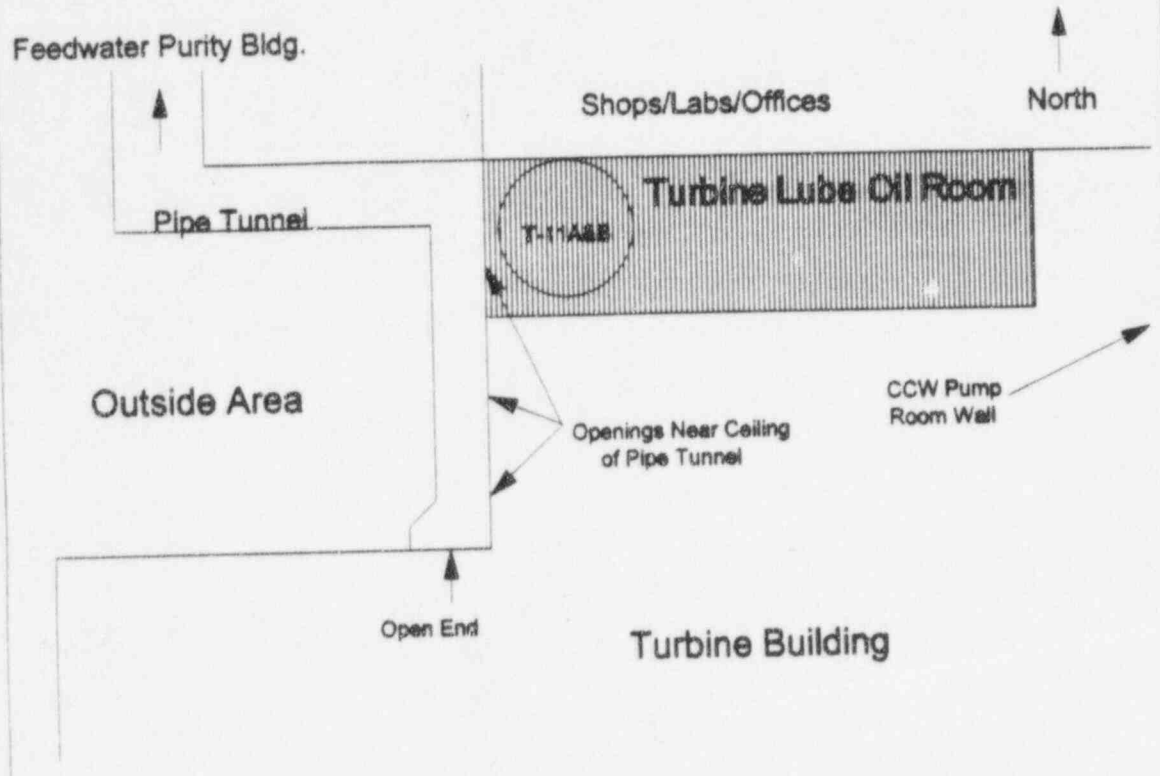
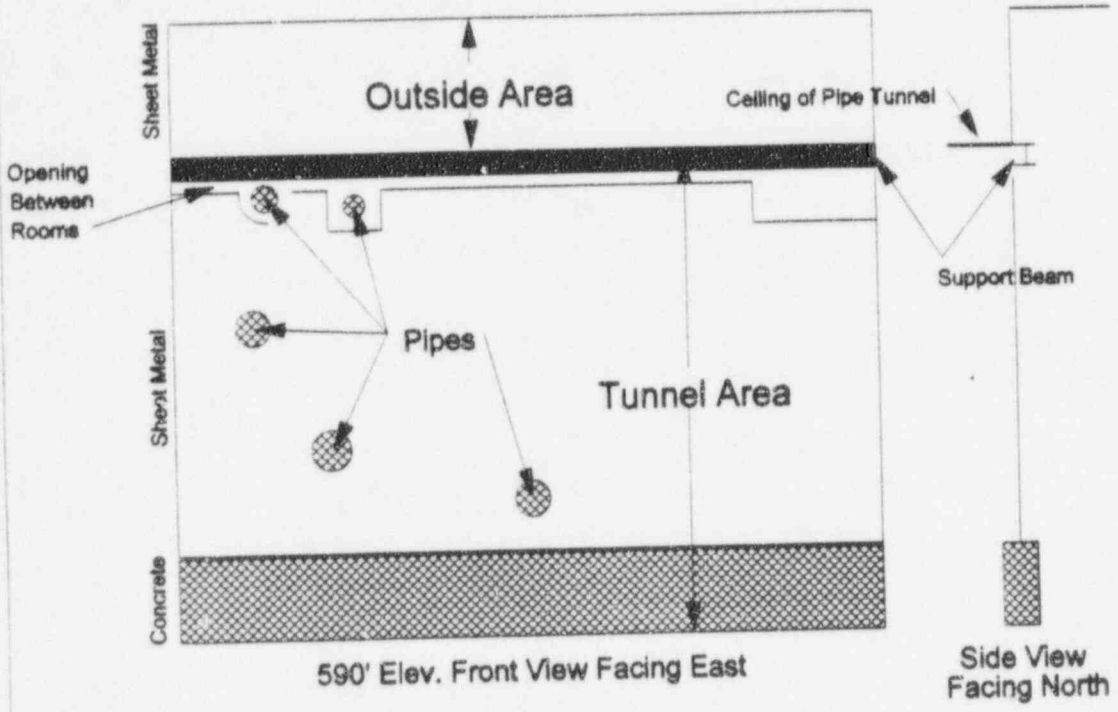


Figure #2 is an elevation view of the west wall of the Turbine Lube Oil Room. An opening approximately nine inches wide running the width of the wall is located about 15 ft. high on the 21 ft. high wall, where the ceiling supports for the Feedwater Purity Tunnel were added. This provides a direct air flow path from the Turbine Lube Oil Room to just below the ceiling area of the Feedwater Purity Building. In addition, various piping penetrations are made in the west wall that are not sealed around the annular spaces. The upper 5 to 6 ft. of the Turbine Lube Oil west wall is above the Feedwater Purity Tunnel ceiling and is exposed to the outside plant area.

Figure #2 - Elev. View of Turbine Lube Oil West Wall

Not To Scale



The Feedwater Purity Tunnel connects the separate Feedwater Purity Building to the Turbine Building and is over 150 ft. long. A portion of this tunnel runs adjacent to the lower portion of the Turbine Lube Oil Room west wall. The tunnel is constructed of structural steel with a corrugated sheet metal wall and ceiling containing fiberglass insulation between the inner and outer sheet metal walls. The structure has no listed fire resistance rating.

Reference 2.1

The Turbine Building wall adjacent to the Feedwater Purity Tunnel is sheet metal supported on structural steel, similar to the Turbine Lube Oil west wall. There are numerous openings in the east wall of the Feedwater Purity Tunnel adjacent to the Turbine Building and the south end of the tunnel opens directly into the Turbine Building.

4.3 Description of Combustible Loading

a. Feedwater Purity Pipe Tunnel

The pipe tunnel contains two condensate pipes, a fuel oil transfer pipe (welded fittings), four lightly loaded cable trays, and other minor electrical and mechanical items. The electrical cables in the cable trays enter conduits approximately 20 ft. from the south end of the tunnel opening into the 590' elevation of the Turbine Building. There are no significant combustible materials that traverse the openings from the Feedwater Purity Tunnel into the Turbine Building. The Feedwater Purity Tunnel contains no safety related equipment or circuits and has minimal combustible loading, so it is not classified as a separate fire area. Reference 2.11

b. Turbine Building (General Area @ EL. 590'-0") North & West Side

Combustible loading in the Turbine Building general area at EL. 590'-0" is less than 20 minutes. This fire loading is spread over three elevations of the Turbine Building. Reference 2.4

Equipment such as a heater drain cooler, feedwater heater, and air ejector are located near the east and south openings to the pipe tunnel. Any cable in this area is enclosed in conduit. Based on plant walkdowns, there are no significant combustibles within a radius of 20 ft. from the various openings of the Feedwater Purity Tunnel into the 590' elevation of the Turbine Building. Waste oil tanks (T-130 and M-18) are located to the west of the Feedwater Purity Tunnel south opening. These tanks are positioned just outside of the 20 ft. distance from the Feedwater Purity Tunnel, and are protected by a wet pipe sprinkler system. Reference 2.1

The next level above the 590'-0" elevation, in this area of the Turbine Building, is the 607'-6" elevation. This floor level is metal grating, which is not a confining space for smoke or heat. Therefore, any smoke or heat generated from combustibles on the 590' elevation would rise, not affecting the pipe tunnel, its contents, or the Feedwater Purity Building. This area is also connected to the turbine operating floor above by open stairwells and various large openings with metal open grating coverings that provide an even larger vent area for any smoke and hot gasses and minimize heat buildup on the 590' elevation.

Transient combustibles are administratively controlled in all plant areas by plant procedure. Transients brought into this area of the Turbine Building for maintenance and operating activities, would be expected to be minimal based upon the type of equipment located in the area.

c. Turbine Lube Oil Room

The fire loading in the Turbine Lube Oil Room (Fire Area 22), results in an Equivalent Fire Severity of "greater than 9 hours" and therefore has a VERY HIGH Fire Loading Classification. A significant fire in this area would be ventilation limited and could not achieve the temperatures normally projected for an open combustible liquid pool fire. Reference 2.3

The only significant openings to allow combustion air into the room are through the west wall to the Feedwater Purity Tunnel. These openings are estimated to provide less than 32 square feet of vent area as shown in Attachment 'A'. A parametric evaluation, using FPETOOL, of the average upper level smoke temperature for the Turbine Lube Oil Room using the 32 square feet vent opening is presented in Attachment 'B'. The results show that the fire would be ventilation limited in 2 to 8 minutes (120 to 500 seconds), depending on the fire growth rate, with an upper level temperature of 800^0 F after 20 minutes. Reference 2.10

The 800^0 F temperature is below the allowable structural steel average temperature limits for steel columns and beams of 1000^0 F and 1100^0 F, respectively. This fire model indicates adequate time is available for manual fire fighting activities to begin and provide additional cooling water on the affected structural steel. Additional runs of the model using either a 50% larger vent area or a 50% lower concrete heat sink still yielded results below the average allowable structural steel temperature for columns and beams after a 20 minute fire duration. Reference 2.2, Page 6-76

No credit is taken for the full area automatic suppression system in arriving at these temperature values. Realistically, the sprinklers would greatly limit the temperature rise during any postulated fire.

d. Feedwater Purity Building

The Feedwater Purity Building is over 150 ft. from the Turbine Lube Oil Room west wall and the Turbine Building. Some electrical cables in cable tray traverse the distance separating these buildings inside the Feedwater Purity Pipe Tunnel. The Boiler Room in the Feedwater Purity Building is protected by a sprinkler system. The Feedwater Purity Building and connecting tunnel do not contain safety related equipment. No combustible loading calculation was performed for this building due to the large separation from the Turbine Building or any safety related structures or components. Reference 2.1

Reference 2.11

Reference / Comment

4.4 Description of Suppression and Detection

a. Suppression

The Turbine Lube Oil Room is equipped with full area automatic wet pipe suppression system. Sprinkler hydraulic analysis shows the spray density is greater than 0.5 gpm/3,000 sq. ft. which exceeds the 0.30 gpm/3,000 sq. ft. design specified for Extra Hazard (Group 1) protection.

Reference 2.13

Manual suppression is provided by a hose station located less than 20 ft. away from the Turbine Building entrance to the pipe tunnel at the 590'-0" elevation. Various other hose stations are located throughout the Turbine Building on this and other elevations to provide backup fire fighting capability. Fire fighting foam equipment is located just outside the Turbine Lube Oil Room on the 590'-0" elevation.

Ref. 2.14, Fig. 1.24

The Turbine Building has partial area automatic wet pipe suppression systems located in areas around the Turbine Lube Oil Room. These systems provide protection for areas with cable trays, lube oil, hydraulic oil reservoirs and office areas on both the 590'-0" elevation and the 607'-6" elevation. The Turbine Building areas to the north, south and east of the Turbine Lube Oil Room are protected by these sprinkler systems. Portions of these systems are located between the Turbine Lube Oil Room and the Component Cooling Water (CCW) Pump Room wall located east of the Turbine Lube Oil Room. The CCW Pump Room wall, which contains non-fire rated openings, provides separation of safety related equipment from the Turbine Building.

b. Detection

There is no automatic detection located in the general Turbine Building area near the access door to the pipe gallery (EL. 590'-0"). However, the automatic sprinkler systems in both the Turbine Lube Oil Room and the Turbine Building are equipped with flow alarms. These alarms will provide notification to the continuously manned plant Control Room.

c. Fire Brigade/Equipment

The plant fire brigade training program includes actual involvement with fighting flammable liquid fires during the live fire training. The 590'-0" elevation of the Turbine Building contains one of the fire brigade depot areas for equipment storage providing ready access to equipment for a fire in this area. Equipment such as self-contained vent fans capable of delivering 16,000 CFM are also located outside the

Turbine Lube Oil Room. As mentioned above, the area also contains fire fighting foam equipment for a potential lube oil fire.

4.5 Overview of Fire Barrier Concerns

The primary concern for this area is the spread of a fire from the Turbine Lube Oil Room into the Turbine Building that may ultimately affect either safety related equipment in the Turbine Building or openings in walls separating the Turbine Building from safety related plant areas such as the CCW Pump Room. There is minimal concern for the spread of fire from the Turbine Building back into the Turbine Lube Oil Room due to the low combustible loading on the Turbine Building side.

From the descriptions provided above there are several defense-in-depth barriers to prevent the spread of fire from the Turbine Lube Oil Room back into the Turbine Building. These can be summarized as follows:

- The Turbine Lube Oil Room has full area automatic suppression and the curbing is provided to contain potential oil spills within the room.
- The non-fire rated west wall is exposed to the exterior for the upper 5 to 6 ft. and if wall failure did occur due to a fire, then this area would be expected to fail first venting the smoke and hot gasses outside the Turbine Building area.
- The size of the worst case fire in the Turbine Lube Oil Room is not projected to reach temperatures that may fail the west wall for over 20 minutes. The ventilation limited fire would remain below 1000^0 F for that period of time allowing the plant fire brigade time to establish manual fire fighting apparatus to contain and extinguish the fire.
- Any smoke and hot gasses vented into the Feedwater Purity Tunnel and Turbine Building would ultimately disperse over the entire Turbine Building area and minimize heat stress on nearby equipment. The areas within 20 ft. of the Feedwater Purity Tunnel opening on the 590' elevation into the Turbine Building are virtually devoid of combustible material and contain no safety related equipment.
- The plant fire brigade is available to respond to any plant fire and is specifically trained to fight oil fueled fires.

The remaining concern is for direct fire exposure to openings in walls separating safety related equipment from the Turbine Building. The west wall of the CCW Pump Room contains various openings into the Turbine Building and these are described in a separate evaluation. However, the additional

defense-in-depth features, from those described above, that protect these openings are a follows:

- The areas within 20 ft. of these openings on the Turbine Building side are almost devoid of combustible materials. Floor drains are located throughout the Turbine Building to prevent the spread of liquid pool fires to the area adjacent to these openings on the 590' elevation.

- Automatic wet pipe suppression systems are located in the Turbine Building such that a fire on the west side of the Turbine Building (near the Turbine Lube Oil area) would have to cross these protected areas before exposure of the openings could occur.

Additionally, the original Appendix R post-fire safe shutdown evaluation and the current revision to this analysis do not consider the Turbine Building and the Turbine Lube Oil Room as requiring separate fire areas, because no safe shutdown components are located in the Turbine Lube Oil Room. Should a fire spread from the Turbine Lube Oil Room to the Turbine Building, it would result in the same consequences as a Turbine Building fire alone. The Turbine Building and the CCW Pump Room are evaluated as separate fire areas in the Appendix R analysis. However, since the west wall of the Turbine Lube Oil Room is facing opposite and over 100' away from the unrated openings in the CCW Pump Room wall, no direct fire exposure hazard is considered credible.

Reference 2.11

5.0 CONCLUSION

The regulatory goal of the Turbine Lube Oil Room walls is to prevent a direct exposure fire hazard to either safety related equipment or openings and penetrations in fire barriers containing safety related equipment. The plant configuration described above provides adequate defense-in-depth such that the system as a whole prevents a direct fire exposure hazard to safety related equipment or openings in other fire area barriers required to meet NRC guidelines.

6.0 ATTACHMENTS

Attachment A - Estimation of Vent Area for Turbine Lube Oil Room West Wall and Surface Area of Interior Walls

Attachment B - FPETOOL Summary of Upper Level Temperatures for the Turbine Lube Oil Room

ATTACHMENT A

Estimation of Vent Area

for

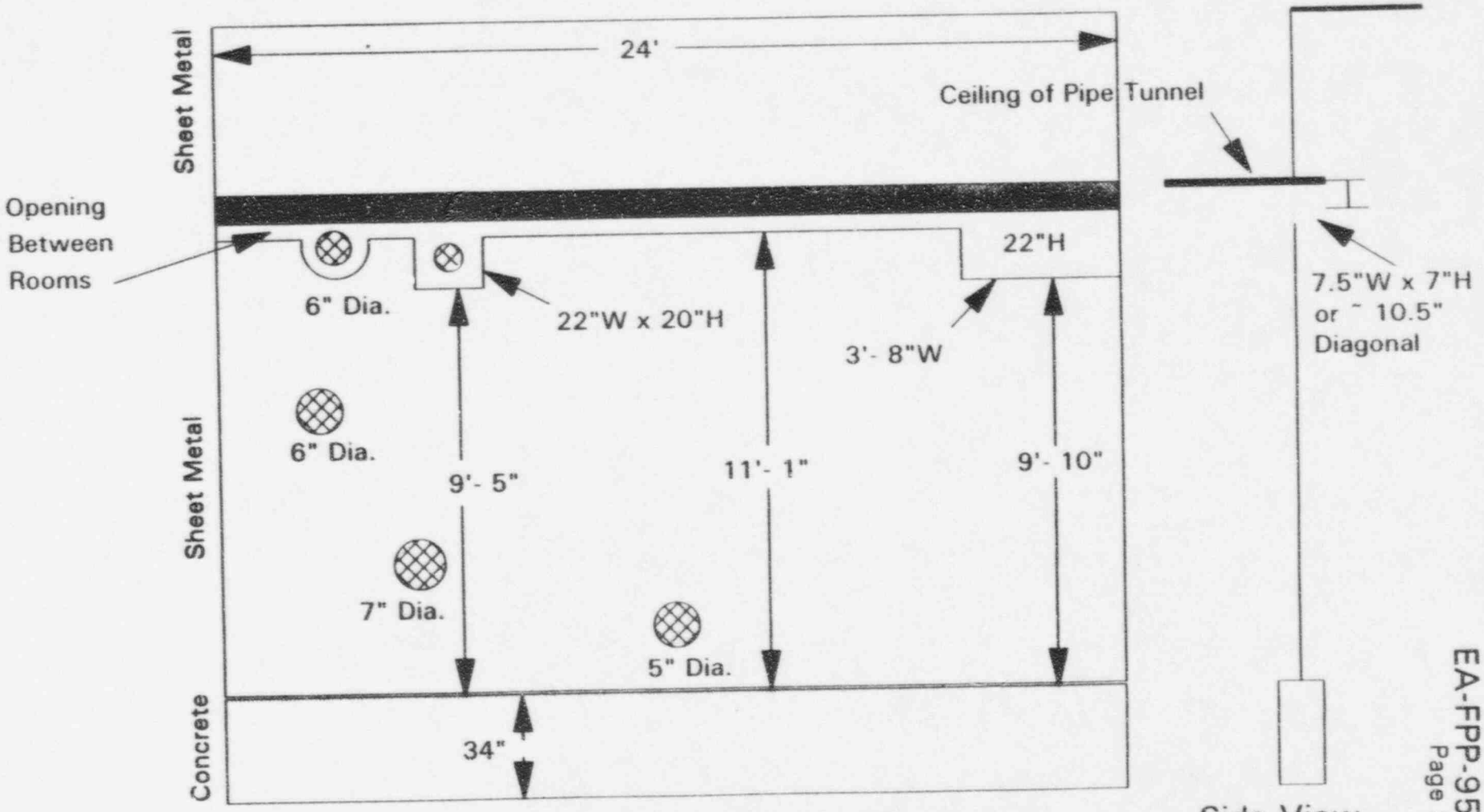
Turbine Lube Oil Room

West Wall

and Surface Area of Interior Walls

Estimation of Vent Area for Turbine Lube Oil West Wall

Not To Scale



EA-FPP-95-054
Page 2 of 4

Vent Area Calculation

The upper portion of the sheet metal wall is located 7.5" horizontally away from the pipe tunnel ceiling I-beam and 7" below the lower flange of the I-beam. The air flow through this opening will be across the diagonal area calculated as follows:

$$\text{Diagonal} = \sqrt{((7.5")^2 + (7")^2)} = \sqrt{(56.25 + 49)} = \sqrt{105.25} = 10.26 \text{ or conservatively } 10.5"$$

The diagonal opening along the majority of the west wall progresses for 20'-4" (24' minus 3'-8") The area of this portion of the opening is calculated as A_1 below:

$$A_1 = (10.5"/12) \text{ ft. X } (20' + 4"/12) \text{ ft.} = 0.875 \text{ ft. X } 20.34 \text{ ft.} = 17.80 \text{ ft}^2$$

The semi-circular cutout for a pipe is conservatively assumed to be completely open without a pipe and the area is calculated as A_2 below:

$$A_2 = 1/2 \text{ X } ((\pi(6/12)^2)/4) = 1/2 \text{ X } (3.14 \text{ X } 0.25)/4) = 0.098 \text{ ft}^2$$

The rectangle cutout for a pipe is conservatively assumed to be completely open without a pipe and the area is calculated as A_3 below:

$$A_3 = (22"/12) \text{ ft. X } (20"/12) \text{ ft.} = 1.83 \text{ ft. X } 1.67 \text{ ft.} = 3.06 \text{ ft}^2$$

The right most diagonal opening is located 7.5" horizontally away from the pipe tunnel I-beam and 22" below the lower flange of the I-beam. The air flow through this opening will be across the diagonal area calculated as follows:

$$\text{2nd Diagonal} = \sqrt{((7.5")^2 + (22")^2)} = \sqrt{(56.25 + 484)} = \sqrt{540.25} = 23.25"$$

The rectangle cutout for the remaining 3'-8" of the west wall is calculated as A_4 below:

$$A_4 = (23.25"/12) \text{ ft. X } (3' + 8"/12) \text{ ft.} = 1.94 \text{ ft. X } 3.67 \text{ ft.} = 7.12 \text{ ft}^2$$

The area of the three pipe penetrations, which are essentially filled with the pipes, are conservatively assumed to be completely open and the area is calculated as A_5 below:

$$A_5 = ((\pi(6"/12)^2)/4) + ((\pi(7"/12)^2)/4) + ((\pi(5"/12)^2)/4) = 0.196 + 0.267 + 0.136 = 0.60 \text{ ft}^2$$

The conservative total vent area is the sum of A_1 through A_5 as follows:

$$\text{Total Area} = 17.80 + 0.098 + 3.06 + 7.12 + 0.60 = 28.68 \text{ ft}^2$$

To further compensate for field measurement errors a 10% safety factor will be added to the Total Area to conservatively estimate the amount of air available to support combustion as follows:

Total Area = 28.68 X 1.10 = 31.55, the area to be used in FPETOOL will be **32 ft²**

Turbine Lube Oil Room

Surface Area of Interior Walls

The FPETOOL calculation of average upper level temperature includes an evaluation of the heat sink provided by the surrounding enclosure materials. The Turbine Lube Oil Room is constructed of 8" concrete block on three sides, a reinforced concrete ceiling that is also 8" thick and a reinforced concrete floor that is greater than 8" thick. Conservatively, the 8" thickness will be used for all the enclosure concrete surfaces. The room is approximately 21 ft. high, but due to obstructions to air flow caused by the steel beams supporting the ceiling a conservative value of 20 ft. is used for the wall height. The lower number will provide both a higher temperature for a given fire size and a lower heat sink value than is realistically available. Based on the floor area of 24 ft. by 80 ft. the interior wall surface area is calculated as follows:

Floor/Ceiling = 80' Long X 24' Wide X 2 surfaces = 3,840 $ft.^2$

N & S Walls = 80' Long X 20' High X 2 surfaces = 3,200 $ft.^2$

East Wall = 20' High X 24' Long X 1 surface = 480 $ft.^2$

Total Surface Area = 7,520 $ft.^2$

Conservatively, the structural steel is not included in the heat sink values used for calculating the upper level smoke temperature in the room.

ATTACHMENT B

FPETOOL Summary

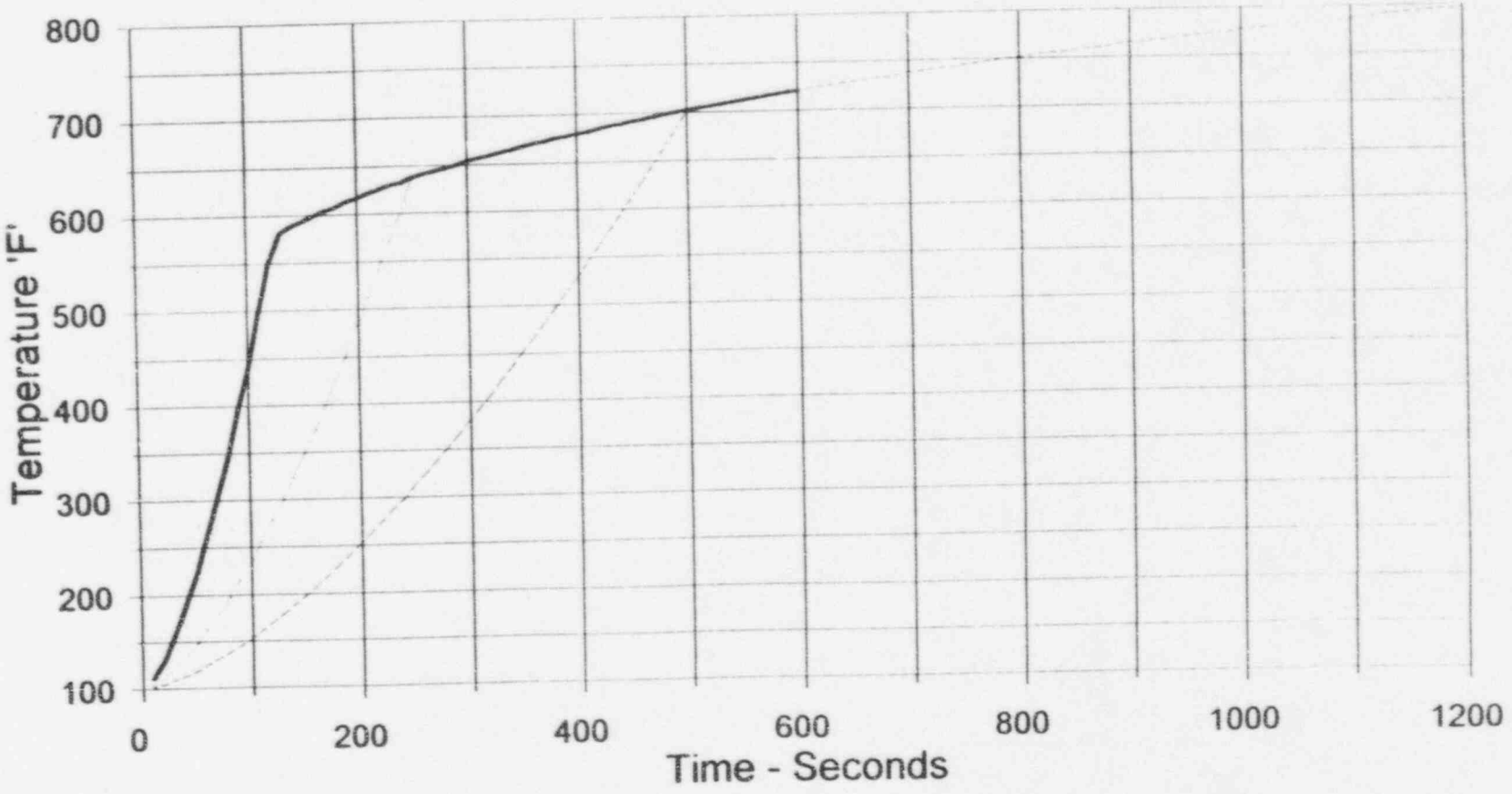
of Upper Level Temperatures

for the

Turbine Lube Oil Room

Turbine Lube Oil Room

FPETOOL Upper Level Temperature



Sheet 2 of 11

UTEMP version 1.1 - average upper level smoke temperature.

Moderate Fire File - Turbine Lube Oil Room 12-10-1995
Room surfaces are:
Surface No. 1 7520 Sq. ft. of 8 inch thick CONCRETE
Fire room openings:
Door is closed.
Window is open to a height of 1.333 ft. and a width of 24 ft.

Time (sec)	Rate of heat release (BTU/sec)	(kW)	Upper level smoke temperature (degrees F)	(degrees C)
10	1	1	102	39
20	4	5	105	40
30	10	11	109	43
40	18	19	114	45
50	28	29	119	48
60	40	42	125	52
70	54	57	132	55
80	71	75	139	59
90	90	95	146	63
100	111	117	154	68
110	134	142	162	72
120	160	168	171	77
130	188	198	180	82
140	218	229	189	87
150	250	263	199	93
160	284	300	209	98
170	321	338	219	104
180	360	379	230	110
190	401	422	241	116
200	444	468	252	122
210	490	516	264	129
220	537	566	276	135
230	587	619	288	142
240	639	674	300	149
250	694	731	313	156
260	750	791	326	163
270	809	853	339	171
280	870	917	352	178
290	934	984	366	186
300	999	1,053	380	193
310	1,067	1,124	394	201
320	1,137	1,198	408	209
330	1,209	1,274	423	217
340	1,283	1,353	438	225
350	1,360	1,433	453	234
360	1,439	1,516	468	242
370	1,520	1,602	483	251
380	1,603	1,689	499	259
390	1,688	1,780	515	268
400	1,776	1,872	531	277
410	1,866	1,967	547	286
420	1,958	2,064	564	295
430	2,052	2,163	580	305
440	2,149	2,265	597	314
450	2,248	2,369	614	323
460	2,349	2,476	631	333

470	2,452	2,585	649	343
480	2,558	2,696	667	353
490	2,665	2,809	684	362
500	2,775	2,925	702	372

The burning rate and resulting upper level temperature is limited by the ventilation capacity of the room openings. From this point on the amount of energy that can be released within the room is limited to 2778.595 BTU/sec. Room temperature may continue to rise.

510	2,779	2,929	705	374
520	2,779	2,929	707	375
530	2,779	2,929	709	376
540	2,779	2,929	711	377
550	2,779	2,929	712	378
560	2,779	2,929	714	379
570	2,779	2,929	716	380
580	2,779	2,929	718	381
590	2,779	2,929	720	382
600	2,779	2,929	721	383
610	2,779	2,929	723	384
620	2,779	2,929	725	385
630	2,779	2,929	726	386
640	2,779	2,929	728	387
650	2,779	2,929	730	388
660	2,779	2,929	731	389
670	2,779	2,929	733	389
680	2,779	2,929	734	390
690	2,779	2,929	736	391
700	2,779	2,929	738	392
710	2,779	2,929	739	393
720	2,779	2,929	741	394
730	2,779	2,929	742	394
740	2,779	2,929	743	395
750	2,779	2,929	745	396
760	2,779	2,929	746	397
770	2,779	2,929	748	398
780	2,779	2,929	749	398
790	2,779	2,929	751	399
800	2,779	2,929	752	400
810	2,779	2,929	753	401
820	2,779	2,929	755	401
830	2,779	2,929	756	402
840	2,779	2,929	757	403
850	2,779	2,929	759	404
860	2,779	2,929	760	404
870	2,779	2,929	761	405
880	2,779	2,929	762	406
890	2,779	2,929	764	406
900	2,779	2,929	765	407
910	2,779	2,929	766	408
920	2,779	2,929	767	408
930	2,779	2,929	768	409
940	2,779	2,929	770	410
950	2,779	2,929	771	410
960	2,779	2,929	772	411
970	2,779	2,929	773	412
980	2,779	2,929	774	412
990	2,779	2,929	775	413
1,000	2,779	2,929	777	414
1,010	2,779	2,929	778	414
1,020	2,779	2,929	779	415

1,030	2,779	2,929	780	416
1,040	2,779	2,929	781	416
1,050	2,779	2,929	782	417
1,060	2,779	2,929	783	417
1,070	2,779	2,929	784	418
1,080	2,779	2,929	785	419
1,090	2,779	2,929	786	419
1,100	2,779	2,929	787	420
1,110	2,779	2,929	788	420
1,120	2,779	2,929	789	421
1,130	2,779	2,929	791	421
1,140	2,779	2,929	792	422
1,150	2,779	2,929	793	423
1,160	2,779	2,929	794	423
1,170	2,779	2,929	795	424
1,180	2,779	2,929	796	424
1,190	2,779	2,929	796	425
1,200	2,779	2,929	797	425

UTEMP version 1.1 - average upper level smoke temperature.

Fast Fire File - Turbine Lube Oil Room 12-10-1995
Room surfaces are:
Surface No. 1 7520 Sq. ft. of 8 inch thick CONCRETE
Fire room openings:
Door is closed.
Window is open to a height of 1.333 ft. and a width of 24 ft.

Time (sec)	Rate of heat release (BTU/sec)	(kW)	Upper level smoke temperature (degrees F)	(degrees C)
10	4	5	104	40
20	18	19	112	45
30	40	42	122	50
40	71	75	134	57
50	111	116	148	64
60	159	168	163	73
70	217	228	179	82
80	283	298	197	92
90	358	377	216	102
100	442	466	235	113
110	535	564	256	125
120	637	671	278	137
130	747	788	301	149
140	867	913	324	162
150	995	1,049	349	176
160	1,132	1,193	374	190
170	1,278	1,347	400	204
180	1,432	1,510	427	219
190	1,596	1,682	454	235
200	1,769	1,864	483	250
210	1,950	2,055	512	267
220	2,140	2,255	542	283
230	2,339	2,465	572	300
240	2,547	2,684	603	317
250	2,763	2,913	635	335

The burning rate and resulting upper level temperature is limited by the ventilation capacity of the room openings. From this point on the amount of energy that can be released within the room is limited to 2778.595 BTU/sec. Room temperature may continue to rise.

260	2,779	2,929	641	338
270	2,779	2,929	644	340
280	2,779	2,929	647	342
290	2,779	2,929	650	344
300	2,779	2,929	654	345
310	2,779	2,929	657	347
320	2,779	2,929	660	349
330	2,779	2,929	662	350
340	2,779	2,929	665	352
350	2,779	2,929	668	353
360	2,779	2,929	671	355
370	2,779	2,929	673	356
380	2,779	2,929	676	358
390	2,779	2,929	678	359
400	2,779	2,929	681	360
410	2,779	2,929	683	362
420	2,779	2,929	686	363

430	2,779	2,929	688	364
440	2,779	2,929	690	366
450	2,779	2,929	692	367
460	2,779	2,929	694	368
470	2,779	2,929	697	369
480	2,779	2,929	699	370
490	2,779	2,929	701	372
500	2,779	2,929	703	373
510	2,779	2,929	705	374
520	2,779	2,929	707	375
530	2,779	2,929	709	376
540	2,779	2,929	711	377
550	2,779	2,929	712	378
560	2,779	2,929	714	379
570	2,779	2,929	716	380
580	2,779	2,929	718	381
590	2,779	2,929	720	382
600	2,779	2,929	721	383

UTEMP version 1.1 - average upper level smoke temperature.

UFast Fire File - Turbine Lube Oil Room 12-10-1995
m surfaces are:
face No. 1 7520 Sq. ft. of 8 inch thick CONCRETE
Fire room openings:
Door is closed.
Window is open to a height of 1.333 ft. and a width of 24 ft.

Time (sec)	Rate of heat release (BTU/sec)	(kW)	Upper level smoke temperature (degrees F)	(degrees C)
10	18	19	111	44
20	71	75	131	55
30	160	169	156	69
40	284	300	187	86
50	444	469	221	105
60	640	675	259	126
70	871	918	300	149
80	1,138	1,199	345	174
90	1,440	1,518	392	200
100	1,778	1,874	442	228
110	2,151	2,268	495	257
120	2,560	2,699	550	288

The burning rate and resulting upper level temperature is limited by the ventilation capacity of the room openings. From this point on the amount of energy that can be released within the room is limited to 2778.595 BTU/sec. Room temperature may continue to rise.

130	2,779	2,929	582	305
140	2,779	2,929	588	309
150	2,779	2,929	593	312
160	2,779	2,929	599	315
170	2,779	2,929	604	318
180	2,779	2,929	608	320
190	2,779	2,929	613	323
200	2,779	2,929	617	325
210	2,779	2,929	622	328
220	2,779	2,929	626	330
230	2,779	2,929	630	332
240	2,779	2,929	633	334
250	2,779	2,929	637	336
260	2,779	2,929	641	338
270	2,779	2,929	644	340
280	2,779	2,929	647	342
290	2,779	2,929	650	344
300	2,779	2,929	654	345
310	2,779	2,929	657	347
320	2,779	2,929	660	349
330	2,779	2,929	662	350
340	2,779	2,929	665	352
350	2,779	2,929	668	353
360	2,779	2,929	671	355
370	2,779	2,929	673	356
380	2,779	2,929	676	358
390	2,779	2,929	678	359
400	2,779	2,929	681	360
410	2,779	2,929	683	362
420	2,779	2,929	686	363

430	2,779	2,929	688	364
440	2,779	2,929	690	366
450	2,779	2,929	692	367
460	2,779	2,929	694	368
470	2,779	2,929	697	369
480	2,779	2,929	699	370
490	2,779	2,929	701	372
500	2,779	2,929	703	373
510	2,779	2,929	705	374
520	2,779	2,929	707	375
530	2,779	2,929	709	376
540	2,779	2,929	711	377
550	2,779	2,929	712	378
560	2,779	2,929	714	379
570	2,779	2,929	716	380
580	2,779	2,929	718	381
590	2,779	2,929	720	382
600	2,779	2,929	721	383

UTEMP version 1.1 - average upper level smoke temperature.

Moderate Fire - Turbine Lube Oil Room (50% of Concrete Heat Sink) 12-10-1995
Room surfaces are:
Surface No. 1 3760 Sq. ft. of 8 inch thick CONCRETE
Fire room openings:
Door is closed.
Window is open to a height of 1.333 ft. and a width of 24 ft.

Time (sec)	Rate of heat release (BTU/sec)	(kW)	Upper level smoke temperature (degrees F)	(degrees C)
30	10	11	111	44
60	40	42	132	55
90	90	95	158	70
120	160	168	189	87
150	250	263	225	107
180	360	379	264	129
210	490	516	307	153
240	639	674	352	178
270	809	853	401	205
300	999	1,053	453	234
330	1,209	1,274	507	264
360	1,439	1,516	564	295
390	1,688	1,780	623	328
420	1,958	2,064	684	362
450	2,248	2,369	748	398
480	2,558	2,696	814	434

The burning rate and resulting upper level temperature is limited by the ventilation capacity of the room openings. From this point on the amount of energy that can be released within the room is limited to 2778.595 BTU/sec. Room temperature may continue to rise.

510	2,779	2,929	862	461
540	2,779	2,929	869	465
570	2,779	2,929	876	469
600	2,779	2,929	883	473
630	2,779	2,929	889	476
660	2,779	2,929	895	480
690	2,779	2,929	901	483
720	2,779	2,929	907	486
750	2,779	2,929	913	489
780	2,779	2,929	918	492
810	2,779	2,929	923	495
840	2,779	2,929	928	498
870	2,779	2,929	933	500
900	2,779	2,929	938	503
930	2,779	2,929	942	506
960	2,779	2,929	947	508
990	2,779	2,929	951	511
1,020	2,779	2,929	955	513
1,050	2,779	2,929	959	515
1,080	2,779	2,929	963	517
1,110	2,779	2,929	967	520
1,140	2,779	2,929	971	522
1,170	2,779	2,929	975	524
1,200	2,779	2,929	979	526

UTEMP version 1.1 - average upper level smoke temperature.

Moderate Fire - Turbine Lube Oil Room 1.5X Vent Area 12-10-1995
Room surfaces are:
Surface No. 1 7520 Sq. ft. of 8 inch thick CONCRETE
Fire room openings:
Door is closed.
Window is open to a height of 2 ft. and a width of 24 ft.

Time (sec)	Rate of heat release (BTU/sec)	(kW)	Upper level smoke temperature (degrees F)	(degrees C)
30	10	11	107	42
60	40	42	120	49
90	90	95	138	59
120	160	168	158	70
150	250	263	181	83
180	360	379	206	97
210	490	516	234	112
240	639	674	264	129
270	809	853	295	146
300	999	1,053	329	165
330	1,209	1,274	364	184
360	1,439	1,516	400	205
390	1,688	1,780	439	226
420	1,958	2,064	479	248
450	2,248	2,369	520	271
480	2,558	2,696	562	295
510	2,887	3,043	607	319
540	3,237	3,412	652	344
570	3,607	3,801	698	370
600	3,996	4,212	746	397
630	4,406	4,644	795	424
660	4,835	5,097	846	452

The burning rate and resulting upper level temperature is limited by the ventilation capacity of the room openings. From this point on the amount of energy that can be released within the room is limited to 5106.521 BTU/sec. Room temperature may continue to rise.

690	5,107	5,382	879	471
720	5,107	5,382	885	474
750	5,107	5,382	890	477
780	5,107	5,382	895	480
810	5,107	5,382	900	482
840	5,107	5,382	905	485
870	5,107	5,382	910	488
900	5,107	5,382	914	490
930	5,107	5,382	919	493
960	5,107	5,382	923	495
990	5,107	5,382	927	497
1,020	5,107	5,382	931	500
1,050	5,107	5,382	936	502
1,080	5,107	5,382	939	504
1,110	5,107	5,382	943	506
1,140	5,107	5,382	947	508
1,170	5,107	5,382	951	510
1,200	5,107	5,382	954	512

Pages 27 through 31 have been intentionally omitted

ATTACHMENT 3

CONSUMERS POWER COMPANY
PALISADES PLANT
DOCKET 50-255

Analysis of the Effects of a Fire on the West Wall of the Component Cooling Pump Room (Fire Area 16)