Consumers Power
POWERING MICHIGAN'S PROGRESS

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS COVER SHEET

EA- FPP-95-050

Total Number of Sheets 17

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

INITIATION AND REVIEW

Calculation Status	Preliminary ☒	Pending ☐	Final ☐	Superseded ☐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	12/12/95		✔		[illegible]	1/17/96	[illegible]	1-19-96

1.0 OBJECTIVE

The purpose of this Engineering Analysis is to show the impact of a fire on the barrier forming the west wall of the Component Cooling Water Pump Room (EL. 590'-0"and 607'-6"). 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 the spread of fire from one area to another.

2.0 ANALYSIS INPUT

2.1 Consumers Power Co. Palisades Nuclear Plant Drawings:

M-2,	Rev. 19	Equipment Location - Aux. Bldg., Radwaste Modifications, Plan of EL. 590'-0"
M-6,	Rev. 14	Equipment Location, Reactor Building, Sections A-A, B-B, C-C, D-D & E-E
M-216, Sh. 5	Rev. 3	Fire Protection, Reactor Building, Plan of EL. 590'-0"
VEN 950*M66, Sh. 8/9	Rev. 2	"Automatic" Sprinkler Plans, Turbine Building

9602090075 960202
PDR ADOCK 05000255
Q PDR

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

Reference/Comment

2.3 Palisades Nuclear Plant Engineering Analysis EA-FPP-95-28, Analysis of Combustible Loading for Fire Area 16, Component Cooling Pump Room.

2.4 Palisades Nuclear Plant Engineering Analysis EA-FPP-95-16, Analysis of Combustible Loading for Fire Area 23B, Steam Generator Feedpump Area.

2.5 Palisades Nuclear Plant Final Safety Analysis Report (FSAR).

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

2.7 Palisades Nuclear Plant Fire Protection Implementing Procedure FPIP-7, Fire Prevention Activities, Revision 9.

2.8 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.

2.9 Palisades Nuclear Plant Fire Protection Program Report (FPPR), Volume 3, Section IX, #47.

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

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.

3.0 ASSUMPTIONS

None

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

Reference/Comment

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 across the barrier separating the Component Cooling Water Pump Room from the Turbine Building Feedwater Pump Area.

4.2 Description of the Fire Barrier

The Component Cooling Water (CCW) Pump Room includes three elevations; 590'-0" EL., 607'-6" EL., and 625'-0" EL. The west and southwest walls that contain the openings in question are a minimum thickness of 24" and provide a portion of the barrier separating the seismic Auxiliary Building from the non-seismic Turbine Building. A 5-1/2" thick reinforced concrete floor is qualified for 3-hour fire rating, therefore, the 24" thick reinforced concrete wall is of 3-hour fire rated barrier construction but has no rating because of openings.

A 7 ft. X 9 ft. pressure release opening is located in the west wall to the Turbine Building at the 590'-0" elevation. This opening is required to provide pressure relief capability for postulated main steam or main feedwater line breaks in the CCW Pump Room. The pressure release opening is partially covered by metal blowout panels that provide a continuous seal over the lower half of the opening up to 5 feet high from the floor. The blowout panels also provide a water tight seal for flood protection from the Turbine Building side only. The remaining upper portion of the pressure release area is open with metal bars to provide security protection.

There are two main steam lines and two main feedwater lines that penetrate through the west and southwest walls. One main feedwater penetration is located approximately 5 feet above the 590'-0" floor elevation, while the other main feedwater line is located over 10 feet above the floor elevation. The two main steam line penetrations through a wall blockout are located approximately 5 feet above the 607'-6" grating floor elevation. These pipe penetrations are

Reference/Comment

not sealed with fire rated material. The openings form gaps around the pipes that range from approximately 1-inch to 5-inches wide on the two feedwater pipes. The feedwater line penetration at the lowest elevation of approximately 5 feet above the 590'-0" elevation has Kaowool installed into the annular gap to provide a fire resistant seal, but this configuration does not meet the requirements for a rated fire seal. The main steam lines protrude through a single large opening that is blocked by massive steel supports on the Turbine Building side of the wall. The open spaces around the main steam pipes and supports range in size from approximately 2-inches to 9-inches wide.

The floor of the Turbine Building Steam Generator Feedpump Area adjacent to the CCW Pump Room is constructed of concrete. However, the Turbine Building area above, at the 607'-6" elevation, is metal grating. This allows any smoke or hot gases produced at the 590'-0" elevation to rise freely to the ceiling of the level above. There is a stairway opening in the ceiling of the 607'-6" elevation that opens into the upper level of the Turbine Building operating floor. This opening provides further venting of smoke and hot gases throughout the Turbine Building without allowing any significant buildup at the 590'-0" level.

In summary, the west and southwest wall of the CCW Pump Room provide either a 3-hour rated fire barrier or a radiant energy shield up to a 5 foot height above the 590'-0" elevation. The unsealed piping penetrations also provide an almost continuous line of sight radiant energy shield for a floor based fire at the 590'-0" elevation within 20 feet of the penetrations, due to the 24" wall thickness and size of the penetrating pipe filling most of the opening area.

4.3 Description of Combustible Loading

a. Component Cooling Pump Room

The fire loading in Fire Area 16, the CCW Pump Room, results in an Equivalent Fire Severity of less than one-minute. This area has a LOW Fire Loading Classification but realistically has a negligible fire loading. Reference 2.3

The in-situ combustible materials are located primarily at the 590'-0" elevation and consist of a small quantity of lube oil associated with the CCW pumps, four 1-gallon lube oil storage containers (NFPA 30 equivalent), and a small amount of cable insulation in cable trays located at the ceiling. The CCW pump lube oil is totally enclosed within the pump assembly and would not be expected to burn completely during a fire. The pumps are located approximately 21 ft. away from the pressure relief opening in the west wall based on field measurements. The lube oil storage containers are located at the east wall approximately 30 ft. away from the pressure relief opening. There are no significant combustibles located at the 607'-6" and 625'-0" elevations. Reference 2.1

Reference/Comment

Transient combustibles are administratively controlled throughout the plant. The amount of transients that may be brought into the CCW Pump Room for maintenance and operating activities would be minimal based on the type of equipment located in the room. Also, since this room does not provide an access path to surrounding rooms, there is further assurance that transients will be minimal. The area near the pressure relief opening is congested by components such as the CCW heat exchanger, associated piping and air operated valves. No clear floor access is available to the area immediately adjacent to the pressure relief opening. Therefore, it is physically impractical to place any significant transient combustibles in this area as there is no open floor space to use for storage.

b. Turbine Building Steam Generator Feedpump Area

The Turbine Building area adjacent to the CCW Pump Room is part of Fire Zone 23B, the Turbine Building Steam Generator Feedpump Area. The overall fire loading in this zone results in an Equivalent Fire Severity of 54 minutes. This results in a LOW Fire Loading Classification.

Reference 2.4

Based on field walkdowns, the primary in-situ combustibles in the Turbine Building Steam Generator Feedpump area include two 480-V MCC's with associated cable trays and two 750 gallon lube oil reservoir tanks. The minimum distance to the MCC's from the pressure relief opening is approximately 31 ft., while the lube oil reservoirs are greater than 60 ft. away from the pressure relief opening. The lube oil reservoir is also greater than 30 ft. away from the nearest feedwater pipe penetration in the southwest wall of the CCW Pump Room. Floor drains are located in this area around the lube oil reservoir tanks and in the space between the tanks and the pressure relief opening and feedwater line penetration. The floor is sloped away from the CCW wall and the drains would carry the lube oil to the Turbine Building Sump, away from the area of concern. There are no significant combustibles located above the floor level on the 590'-0" elevation adjacent to any of the openings. Also, there are no significant combustibles located on the grating elevation (607'-6") above the pressure relief opening and near the main steam line penetrations located on that elevation.

Transient combustibles are administratively controlled throughout the plant. The area adjacent to the pressure relief opening is blocked by the access stairway to the 607'-6" elevation. There is limited clearance around the stairway precluding storage of material. The remainder of the area near the pressure relief opening is the walkway to the stairway which would not be suitable for storage or staging of material as this would block an already limited access pathway. A feedwater heater and associated piping

Reference/Comment

generally blocks the area adjacent to the two feedwater pipe penetrations such that it would be impractical to store any significant amount of transient combustibles below these openings. A flammable liquids storage locker that meets NFPA 30 requirements is located within approximately 5 ft. of the southwest feedwater piping penetration to house chemicals used for water treatment. This condition does not cause an exposure hazard to this penetration due to the fire rated design of the storage locker. No additional transient combustible controls, above those already in place, are deemed necessary for this area due to the height of the pressure relief and piping penetration openings above the floor.

c. Combustible Loading Summary

The in-situ combustible loading of less than one-minute in the CCW Pump Room is negligible and does not pose a significant exposure hazard to the pressure relief opening or piping penetrations. The greater than 20 ft. distance separating the in-situ combustibles from the openings in the west wall will further decrease the concern for potential fire spread across the non-fire rated openings into the adjoining fire area. The equipment congestion and lack of open floor space near the pressure relief opening in the CCW Pump Room also ensures that credible transient combustibles used in this area will not present an exposure fire hazard to the adjacent fire area.

The in-situ combustible loading of 54 minutes in the Turbine Building Steam Generator Feedpump Area could pose a significant exposure hazard to the pressure relief opening and piping penetrations. However, the greater than 30 ft. separation of the in-situ combustibles from any of these openings combined with the floor slope away from the CCW wall and floor drains to limit pool fire spread significantly decreases the concern for potential fire spread across the non-fire rated openings into the adjoining fire area. The lack of significant combustibles on the CCW Pump Room side of the non-fire rated openings for over 20 ft. behind the openings further decreases the concern for potential fire spread or smoke and hot gas damage to equipment in the CCW Pump Room. The equipment located near the non-fire rated openings are substantial metal components that are not vulnerable to smoke and hot gas damage. These same factors ensure that credible amounts of transient combustibles located on the Turbine Building side of the pressure relief opening or piping penetrations would not present an exposure fire hazard to equipment located in the CCW Pump Room.

Reference/Comment

The largest credible Turbine Building fire near the CCW Pump Room would be a Main Feedpump lube oil fire. Such a fire would vent smoke and hot gasses throughout the Turbine Building without appreciable buildup near the CCW Pump Room openings. The remaining hazard would be from the radiant energy of such a postulated fire. Based on floor drains located in the area, a 10 foot diameter pool fire is analyzed in Attachment 'A' using data from Reference 2.12. The only CCW Pump Room opening which may directly expose cable located in conduit to the radiant energy of such a fire would be the pressure release opening. These cables were conservatively assumed to be unprotected by conduit and located at the opening versus a few feet inside the room. The results indicate that with conservative assumptions there would not be sufficient energy in such a fire to damage unprotected IEEE-383 cable located just inside the pressure release opening

4.4 Description of Suppression and Detection

a. Suppression

The CCW Pump Room is not equipped with automatic suppression. Manual hose stations are provided in the access hallway outside the Auxiliary Building entry door and in the Turbine Building outside the pressure relief opening.

The Turbine Building Steam Generator Feedpump Area contains partial automatic suppression above the 607'-6" elevation. The automatic suppression is provided over the combustible hazard areas such as the cable trays near the MCC's and the main feedpump lube oil reservoir area on the 590'-0" elevation. The floor grating at the 607'-6" elevation is open over the feedpump areas so there is no blockage of the sprinkler spray pattern from the ceiling of the 607'-6" elevation down to the floor of the 590'-0" elevation. The sprinkler spacing is consistent with that required of an extra hazard occupancy and the existing obstructions to the spray pattern are within NFPA-13 allowables, based on observations made during a plant walkdown.

Reference 2.1

The Turbine Building Steam Generator Feedpump Area is also supplied with two hose stations. These are capable of reaching the pressure release opening in the west wall of the CCW Pump Room. In addition, a wheeled dry chemical extinguisher is located close to the southwest CCW Pump Room wall near the flammable storage locker, and fire fighting foam equipment is located west of this area on the 590'-0" elevation. Outside access to the main feedpump area is provided by a roll-up door on the south side of the Turbine Building. This opening provides the fire brigade access from a hydrant hose house.

Reference/Comment

b. Detection

The detection system in the CCW Pump Room provides partial coverage as the detectors are installed only above the 590'-0" elevation. The smoke detectors are considered adequately positioned to take into account the potential fire sources in the room and will perform satisfactorily to provide early warning of a fire. The adequacy of the partial detection has been reviewed and approved by the NRC in a letter dated March 30, 1989, that closed Unresolved Item 255/86022-04.

The partial area automatic suppression system in the Turbine Building Steam Generator Feedpump Area includes a waterflow switch. The switch provides an alarm signal to the Control Room, thus providing indication of a fire in this area.

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 nearby the CCW Pump Room west wall in the Turbine Building. As mentioned above, the area also contains fire fighting foam equipment for a potential lube oil fire.

Reference/Comment

4.5 Description of HVAC for Each Area

a. CCW Pump Room

The Penetration and Fan Room HVAC System provides ventilation requirements for all three levels of the CCW Pump Room (Fire Area 16). This system, as described in Design Basis Document 1.07, provides a balanced ventilation air flow of 10,000 CFM supply and exhaust. The supply and exhaust fans operate as a single unit and start or stop at preset thermostat settings. During fan operation the system is designed to be air balanced for neutral air flow to or from adjacent areas.

b. Turbine Building Area

Per the System Operating Procedure (SOP-24), the Turbine Building ventilation is adjusted to be air balanced during normal plant operation, similar to the CCW Pump Room. However, the Turbine Building is a large area served by several independently controlled fans and the individual cycling may periodically cause the Turbine Building to be at a positive or negative pressure with respect to the CCW Pump Room. The Turbine Building ventilation system is designed, with all fans operating, to provide a negative pressure condition due to an excess of 30,000 CFM exhaust flow. The likelihood of operating the Turbine Building at a positive pressure, due to independent fan cycling, is a low probability event.

c. HVAC Summary

The CCW Pump Room ventilation system is designed to ensure an air balanced condition at all times with respect to adjacent areas. For the purposes of this evaluation, the Turbine Building will be assumed to be air balanced with respect to air exchanges with the CCW Pump Room, since this is the normal proceduralized mode of operation. The design of the Turbine Building ventilation is to provide a negative pressure, but this would be non-conservative with respect to the concern for a fire spreading from the Turbine Building to the CCW Pump Room. The only realistic concern is for a Turbine Building fire to spread into the CCW Pump Room based on the fire loading and type of combustible materials in each area, as described in Section 4.3, above. Although the operation of the Turbine Building in a positive pressure mode is conservative for the purposes of this calculation, it is considered a low probability event that would not provide a realistic measure of the risks involved.

Reference/Comment

5.0 CONCLUSION

The CCW Pump Room boundary with the Turbine Building Steam Generator Feedpump Area provides reasonable assurance that a realistic in-situ or transient combustible material fire on either side of this wall will not propagate across the pressure relief opening or various piping penetrations such that equipment will be damaged in both fire areas from a single exposure fire. The key factors that ensure the defense-in-depth protection for this area includes:

- The construction features of the pressure relief opening with water tight metal plates on the lower 5 feet of the opening and physical location of the piping penetrations at least 5 feet above floor level,
- the location of in-situ combustibles at least 20 feet away from these openings on both sides (greater than 40 feet overall separation) and location of floor drains in the intervening space to remove the most likely fuel source on the Turbine Building side,
- the large area volume and ceiling height above the openings on the Turbine Building side to dissipate smoke and hot gases from the relatively larger fire loading on this side,
- practical limitations on the location and amount of transient combustibles that may be stored near the barrier openings,
- reasonable assumptions on the lack of forced air flow between the two areas of concern,
- and lack of significant intervening combustible materials or smoke and hot gas sensitive equipment within 20 feet on either side of the boundary wall.

6.0 ATTACHMENTS

Attachment A - Radiant Energy Calculation for a Lube Oil Fire Near the CCW West Wall

ATTACHMENT A

Radiant Energy Calculation for Lube Oil Fire Near CCW West Wall

The largest single fire load potential near the CCW Pump Room west wall is a Main Feedwater Pump lube oil spill on the Turbine Building side. The radiant energy from such a fire could directly expose conduit located inside the CCW Pump Room near the pressure relief opening. The other openings do not provide a line of sight target from a such a floor based fire to conduit inside the CCW Pump Room. The distance from the closest Main Feedwater Pump lube oil tank to the pressure relief opening is greater than 60 feet. Assuming a 10 foot diameter lube oil spill for a practical fire size would leave 50 feet of separation from the edge of the postulated fire to the pressure relief opening. Using Table 2 data from Reference 2.12, the Heat Release Rate (HRR) of a 10 foot diameter fuel oil fire (this is more conservative than lube oil) would be:

10 ft. X 0.3048 m/ft. = 3.1 meters; Area = $((\pi)d^2)/4 = (3.1416 \text{ X } (3.1)^2)/4 = 7.5 \text{ m}^2$

HRR from Heavy Fuel Oil from Table 2 = 1,251 kW/ m^2

Therefore, the total HRR would be = 1,251 kW/ m^2 X 7.5 m^2 = 9,383 kW

The target of concern is a cable inside a conduit near the pressure release opening that is greater than 50 feet from the edge of a 9,383 kW fire. From Table 1 of Reference 2.12, the critical flux to cause damage to a cable that is not protected by a conduit is conservatively set at 10 kW/ m^2 for IEEE-383 cable. Equation (56) of Reference 2.12, can be rearranged to solve for the Heat Release Rate required to reach a 10 kW/ m^2 critical flux at a distance of 50 feet (15.2 m) as follows:

$q_R = (X_R Q_f)/(4\pi R^2)$ can be rearranged to $Q_f = (q_R(4\pi R^2))/X_R$ where:

Q_f = Heat Release Rate
R = Radius (15.2 m)
q_R = Critical Flux (set at 10 kW/ m^2)
X_R = 0.4 from Fig. 13 (Percent of HRR that is Radiant Energy)

$Q_f = (10 \text{ kW/ m}^2(4\pi(15.2 \text{ m})^2))/0.4 = 29{,}033 \text{ kW}/0.4 = 72{,}583 \text{ kW}$

The amount of energy required to damage unprotected cable is 72,583 kW, while the amount of energy available is only 9,383 kW. Therefore, the radiant energy of a postulated lube oil fire near the Main Feedwater Pump lube oil tank would not have sufficient energy to damage unprotected cables located at the pressure release opening in the CCW Pump Room.

Pages 12 through 17 have been intentionally omitted