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BECo 86-009

Mr. John A. Zwolinski, Director
BWR Project Directorate #1
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

License DPR-35
Docket 50-293

Subject: Pilgrim Nuclear Power Station Appendix R Exemption Request

References:
1) Meeting between the NRC (R. Ferguson, S. West and M. Thadani) and BECo (T. A. Venkataraman, R. Velez and M. J. DiMeo) on October 17 at the Philips Building in Bethesda
2) BECo Letter 83-130 dated 5/17/83
3) NRC Safety Evaluation dated 12/18/84

Dear Sir:

This letter is a followup to the meeting Boston Edison Company (BECo) had with your staff on October 17, 1985 at the Philips Building in Bethesda (Reference 1). During the meeting BECo presented to your Staff a modified design to the water curtain which was initially recommended by BECo in Reference 2 and approved by your Staff in Reference 3.

The modified design consists of installing a two branchline wet pipe sprinkler system over the 20 ft. separation zone between fire zones 1.11 and 1.12 at elevation 51'-0" and between fire zones 1.9 and 1.10 at elevation 23'-0" in the Reactor Building. As part of the discussion, the Staff recommended that the proposed modified design would be acceptable if supplemented by a draft curtain between the two branches sprinkler system along with metal shields for lower level sprinkler heads to shield them from water sprays from the ceiling level sprinkler heads.

Boston Edison presented to your Staff a marked up version of our initial exemption request (Reference 2) including the layout plan and elevation drawings for the sprinkler system. The attachments to this letter are BECo's formal submittal of the revised exemption request which is resubmitted pursuant to 10CFR50.12. Changes to the exemption request are indicated by vertical bars.

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Should you have any questions or concerns as a result of your review, please do not hesitate to contact us.

Boston Edison is, however, proceeding ahead with the implementation of the modified design to be in compliance with the Appendix R for this area by the RFO #7.

Very truly yours,

W D Harrington

TAV/ns

EXEMPTION REQUEST #7

Exemption Request For Fire Zones 1.9 and 1.10 (EL 23'-0" Rx Building)

Per the provisions of 10CFR50.12, Boston Edison Company requests exemption from the requirements of section IIIG.2 (b) of Appendix R for the Pilgrim Nuclear Generating Station. Specifically, exemption is requested from the requirement to have an automatic fire suppression system installed throughout fire zones 1.9 and 1.10 and from the requirements of having redundant trains of equipment required for safe shutdown separated by a horizontal distance of more than 20 feet with no intervening combustibles or fire hazards.

Boston Edison is proposing, as part of the modifications for these fire zones, to install sprinkler protection in the boundary area separating these fire zones as shown on figure #1. The exemption request is necessary to exempt Boston Edison Company from the requirements to provide total area sprinkler protection for both fire zones. The horizontal separation between redundant trains required for safe shutdown is much greater than the 20 feet required by section IIIG.2 (b) of Appendix R. However, there are cable trays in the separation area that are considered combustibles.

The technical bases which justify the exemptions are summarized below and the supporting fire zone data is given in tables 7.1 and 7.2. This information provides reasonable assurance that the public health and safety will be protected in a fashion equivalent to that resulting from compliance with the specific requirements of Appendix R.

1. Fire zones 1.9 and 1.10 are part of a fire area in the Rx Building. EL 23'-0". Fire zones 1.9 contains "A" train components required for safe shutdown. Fire zone 1.10 contains "B" train components required for safe shutdown. These fire zones are separated by a 3 hour boundary along their common boundary except for an area approximately 30 feet wide on the North side of the building.

2. Once modifications are implemented as described in tables 1.1 and 1.2, hot shutdown equipment in fire zone 1.9 will be separated from the redundant hot shutdown equipment in fire zone 1.10 by a horizontal distance of approximately 75 feet. Cold shutdown equipment in fire zone 1.9 will be separated from the redundant cold shutdown equipment in fire zone 1.10 by a horizontal distance of approximately 100 feet. These distances given are the closest dimensions between cables or components that are part of systems required for hot or cold shutdown.

3. The combustible loading between Fire Zones 1.9 and 1.10 is extremely low. These zones are separated by a volume that is essentially free of combustible materials.

The only fixed combustible material in the separating volume is cable insulation. The insulation is either IEEE Std. 383 qualified cable or the cables have been coated with an approved fire retardant material. There are only six trays within the separation volume. These trays are at least one foot apart. These factors will preclude a fire within any one of the six trays from interacting with the other trays and propagating across the separation volume.

Total automatic fire suppression would not enhance the protection of safe shutdown functions provided by the present configuration and proposed modifications.

The combustible loading in fire zones 1.9 and 1.10 creates a maximum theoretical fire exposure of only minutes. The nearest safe shutdown equipment is 75 feet apart and separated by a minimum 20 feet wide clear space. These factors coupled with the proposed sprinkler system within the separation clear space will assure at least one train of safe shutdown equipment will remain free of fire damage in this area.

4. Automatic smoke detection exists in both fire zones which alarms in the continuously manned Control Room.

5. The objectives for the protection of safe shutdown capability is to insure that at least one means of achieving and maintaining safe shutdown conditions will remain available during and after any postulated fire in the station. Modifications required to meet the requirements of Section III G. 2 of Appendix R would not enhance the fire protection safety of Pilgrim Station any better than the modifications proposed by Boston Edison Company for these two fire zones. The modification proposed for these two fire zones, as described in Table 1.1 and 1.2, will insure that at least one train of safe shutdown equipment will remain free of fire damage for any postulated fire in the area.

6. Modifications required to meet the requirements of Section III G. 2 of Appendix R would in fact be detrimental to overall facility safety. These fire zones are too large and porous to permit the installation of an effective gaseous suppression system. Additionally it is not possible to install a total area sprinkler system in either of the fire zones. There are many wide obstructions (i.e. cable trays, HVAC ducts, pipes, etc.) between the floor and ceiling such that ceiling level sprinklers would not be able to protect anything over several feet below the ceiling. Many additional levels of sprinklers would be needed. With the additional sprinkler pipes and sprinklers the probability of accidental discharge is substantially increased. The water damage to safety related equipment from real or inadvertent actuation represents an unacceptable risk to Boston Edison Company.

EXEMPTION REQUEST #8

Exemption Request for Fire Zone 1.11 and 1.12 (EL 51'-0" RX Building).

Per the provisions of 10CFR50.12, Boston Edison Company requests exemption from the requirements of Section III G.2 (b) of Appendix R for the Pilgrim Nu ear Generating Station. Specifically, exemption is requested from the requirements to have an automatic fire suppression system installed throughout fire zones 1.11 and 1.12 and from the requirements of having redundant trains of equipment required for safe shutdown separated by a horizontal distance of more than 20 feet with no intervening combustibles or fire hazards.

Boston Edison is proposing, as part of the modifications for these fire zones, to install sprinkler protection in the boundary area separating these fire zones as shown in Figure #2. The exemption request is necessary to exempt Boston Edison Company from the requirements to provide total area sprinkler protection for both fire zones. The horizontal separation between redundant trains required for safe shutdown is much greater than the 20 feet required by Section III G.2 (b) of Appendix R. However, there are cable trays in the separation area that are considered combustibles.

The technical bases which justify the exemptions are summarized below and the supporting fire zone data is given in Tables 8.1 and 8.2. This information provides reasonable assurance that the public health and safety will be protected in a fashion equivalent to that resulting from compliance with the specific requirements of Appendix R.

1. Fire zones 1.11 and 1.12 are part of a fire area in the RX Building, EL 51'-0". Fire zone 1.11 contains "A" train components required for safe shutdown. Fire zone 1.12 contains "B" train components required for safe shutdown. The fire zones are separated by a three hour fire boundary except in the following areas: (a) An area approximately 40 feet wide along the common boundary on the north side of the building, (b) An area approximately 11 feet wide along the common boundary on the south side of the building, and (c) through an open hatchway and stairwell to the elevation above these fire zones.

2. Once modifications are implemented as described in Tables 2.1 and 2.2, hot shutdown equipment in fire zone 1.11 will be separated from the redundant hot shutdown equipment in fire zone 1.12 by a horizontal distance of approximately 70 feet. Cold shutdown equipment in fire zone 1.11 will be separated from the cold shutdown equipment in fire zone 1.12 by a horizontal distance of 70 feet. These distances given are the closest dimensions between cables of components that are part of systems required for hot or cold shutdowns.

3. **The combustible loading between fire zones 1.11 and 1.12 of elevation 51 ft. is extremely low.**

   The only fixed combustible material in the north and south separation zones of elevation of 51 ft. is cable insulation. The insulation is either IEEE Std. 383 qualified cable or the cables have been coated with an approved fire retardant material. There are only five cable trays in the north separation volume and there are three trays in the south separation volume.

All trays are at least one foot apart in each direction. These factors will preclude a fire within any one of the five trays from interacting with the other trays and propagating across the separation volume.

The combustible loading in fire zone 1.11 or 1.12 creates a maximum theoretical fire exposure of only minutes. The nearest safe-shutdown equipment is 70 feet apart and separated by a minimum 20 ft. wide clear space. These factors coupled with the proposed sprinkler system within the separation clear space will assure at least one train of safe shutdown equipment will remain free of fire damage in this area.

4. Automatic smoke detection exists in fire zones 1.11 and 1.12 which alarms in the continuously manned Control Room.

5. Even though the ceilings of zones 1.11 and 1.12 do not have rated three hour boundaries, this does not present a safe shutdown problem because of the following existing conditions:

   a) All penetrations in the ceilings of the two areas are three hour rated expect for the hatchway and stairwells.

   b) The areas above these fire zones do not contain equipment or cables required for safe shutdown.

   c) The areas above these fire zones are equipped with automatic smoke detection, hose stations and portable fire extinguishers.

   d) The combustible loading is low as shown in Table 2.1

   e) The hatchway and stairwell that forms the boundary violation, is separated by a horizontal distance of approximately 80 feet.

6. The objectives for the protection of safe shutdown is to insure that at least one means of achieving and maintaining safe shutdown conditions will remain available during and after any postulated fire in the station. Modifications required to meet the requirements of Section III G.2 of Appendix R would not enhance the fire protection safety of Pilgrim Station any better than the modifications proposed by Boston Edison Company for these two fire zones. The modifications proposed for these two fire zones, as described in Table 2.1 and 2.2, will insure that at least one train of safe shutdown equipment will remain free of fire damage for any postulated fire in the area.

7. Modifications required to meet the requirements of Section III G.2 of Appendix R would in fact be detrimental to overall facility safety. These fire zones are too large and porous to permit the installation of an effective gaseous suppression system. The water damage to safety related equipment from real or inadvertent actuation of a sprinkler system represents an unacceptable risk to Boston Edison Company.

TABLE 7.1

FIRE ZONE 1.9: REACTOR BUILDING ELEVATION 23'-0", EAST SIDE
AREA DATA

A. AREA CONSTRUCTION

1. Walls - See Figure #1

   North - 27" concrete wall, plus 6" pre-cast panel; 3-hour rated with 3-hour penetration seals. (column Line-P)

   South - 42" concrete wall; 3-hour rated with 3-hour rated penetration seals. (column Line-H)

   East - 33" concrete wall; 3-hour rated with 3-hour rated penetration seals. (column Line-17)

   West - Bounded by (a) 42" concrete steam tunnel shield wall. Three hour rating is not required because the Steam tunnel is not a redundant area. (b) 60" concrete drywell shield wall. (c) The unenclosed portion of the boundary is shared with fire zones 1.10 at column line 11.

2. Floor - 24" concrete slab, three hour fire rated with three hour rated penetration seals with the exception of open stairwells to fire zone 1.8 and 1.1. These two fire zones are not redundant to fire zone 1.9.

3. Ceiling - 12" concrete slab; three hour rated with three hour rated penetration seals with the exception of an open stairwell to fire zone 1.11 which is not a redundant area to fire zone 1.9.

4. Ceiling height - 27 feet.

5. Area volume - Approximately 220,000 cubic feet.

6. Ventilation - See Figure #1 for directional arrows showing ventilation flow.

7. Congestion - Area is essentially free of floor congestion. General access for manual suppression is good.

B. SAFE SHUTDOWN EQUIPMENT

After the proposed modifications are implemented for this fire zone, only the "A" train of systems required for safe shutdown will remain in fire zone 1.9. All "B" train cables and components that are required to be operable for safe shutdown will not be located in this fire zone.

For a fire in fire zone 1.9, all "A" train components are assumed lost, and safe shutdown will be accomplished with the "B" train of systems. The opposite is true for fire zone 1.10 where all "B" train components are assumed lost, and safe shutdown will be accomplished with the "A" train of systems. Figure #1 shows the components and cables located in fire zone 1.9 that are required to be operable for a fire in fire zone 1.10. Listed below are the systems that will be used for safe shutdown if a fire occurs in fire zone 1.10. The components or cables are listed if they appear in fire zone 1.9. Figure #1 shows the location of the components and/or cables that are listed.

"A" TRAIN SYSTEMS	COMPONENTS/CABLES LOCATED IN FIRE ZONE 1.9.
Automatic Depressurization System	Alternate shutdown panel and control cables.
Core Spray System	MCC B17 which feeds power to core spray valves. Alternate shutdown panel for core spray. Power and control cables for the core spray system.
RHR System in the shutdown cooling mode	MCC B18 and B20 which feeds power to the RHR valves. Alternate shutdown panel for RHR. Power and control cables for RHR system.
Rx water level and Rx pressure	None
Torus temperature	Instrument cables for torus temperature.
Torus water level.	Instrument cables for torus water level.

C. COMBUSTIBLES

This item provides the technical justification for considering the space between Fire Zones 1.9 and 1.10 "free of fixed combustible material."

The 20 feet separation space between redundant safe shutdown equipment (SSE) contain six (6) horizontal cable trays. (See Figure #1). The separation zone is described below:

Separation Zone Between Redundant SSE	Quantity Combustibles Total lbs/ft^3–lbs.	Continuity of Combustibles Through Separation Zone	Area of Separation Zone sq. ft.	Equivalent Theoretical Fire Exposure Minutes	Fire Retardant Protection % Type
Reactor Building Elev. 23 ft. Between columms 9.1 to 11 and M.7 to P	19.9 — 388	Yes	900	0.4	IEEE 383-3trays/6(non IEEE 383 Cable Coated with fire Retardant 3trays/6 Material

The theoretical[1] equivalent fire exposure of the cable within this Separation Zone is only 0.4 minutes. This is extremely low. Realistically[1], the combination of fire retardant coating or the inherent fire retardant properties of IEEE 383 qualified cable and the large physical separation between the trays will prevent a fire that originates within one of these trays from generating sufficient heat to propagate a fire across the six trays in the prospective Separation Zone. An intense or large exposure fire might be able to propagate a fire across the prospective Separation Zone. However, there are no other installed combustible materials in the zone to provide the exposure fire.

Moreover, Administrative Controls were designed to limit transient combustible material on Elev. 23 feet of the Reactor Building to a maximum of 10 gallons of Class II and III liquids (i.e each) and one gallon of Class I liquids.[2] Combustible loading of this magnitude, or even several orders of magnitude larger, will not totally fill the 20 foot wide Separation Zone. Additionally, since the cable trays are 11 feet above the floor, the transient loads will not be able to impinge on the entire length of the tray.

1 See Appendix A for a more detailed description of the theoretical and realistic analysis methods.

2 Flammable/combustible liquids are required to be in approved containers.

BECo concludes that neither the limited installed combustible materials or potential transient materials would propogate a fire across the 20 foot fire Separation Zone. This zone can be considered "free of intervening combustibles as required in section IIIG.2 (b).

C.2 This item provides the technical justification for the proposed fire protection modifications.

The combustible materials installed in Fire Zone 1.9 and 1.10 are primarily cable insulation. The fire loading and the theoretical[1] fire exposure are described in the table [2] below:

Fire Zone	Quantity of Combustibles Type-Weight	Continuity of Combustibles through Fire Zone	Equivalent[1] Theoretical Fire Exposure Minutes	Fire Retardant Protection Type	%
No. 1.9 Reactor Building Elev. 23 ft. East Col. No. 11	Cable-16,731	No	29.5	IEEE 383	70%
				NonIEEE 383 Cable Coated with Fire Retardant Material	30%
No. 1.10 Reactor Building Elev. 23 ft. West of Col. No. 11 *3	Cable-14,078 Trainsient Combustible - 1036	No	22.8	IEEE 383 Cable	70%
				NonIEEE 383 Cable Coated with Fire Retardant Material	30%

There are two approaches to analyze fire spread potentials. The "theoretical"[1] method mathematically compares specific plant fire loads to a Standard Time-Temperature fire. The "realistic" [1] method evaluates the physical array of specific combustibles and the possibility of fire propagation within the array.

THEORETICAL ANALYSIS

BECo used the theoretical approach to identify the Standard Fire Exposure for comparison purposes and general understanding of the "order of magnitude of the worst case fire in this area. Any fires with a Standard exposure under 30 minutes are in the lowest severity category. Fire Zone 1.9 and 1.10 have Standard Fire Exposures 29.5 and 22.8 minutes respectively.

BECo believes that any further use of the theoretical approach is unwarranted since this method is heavily depended on defining a Design Basis Fire (DBF), and the correlation between a DBF and real fire has not been satisfactorily established. More importantly, BECo postulates this is unnecessary because the realistic approach is adequate to obtain an appropriate level of fire protection.

REALISTIC ANALYSIS

The realistic approach identifies that there are two potential paths for fire spread between zones 1.9 and 1.10. First, the fire could spread horizontally across the floor. Secondly, the fire could spread to a higher or lower elevation (e.g. 23 ft., 74 or 91) through a vertical opening and then back to the 23 ft. elevation through another vertical opening. These paths have been utilized in the completion of the realistic analysis below.

Conductive heat transfer and direct flame impingement are not possible across these paths since there is no continuity combustible materials in any of these paths (e.g. vertical or horizontal).

Radiant heat transfer can only be a factor in fire spread when there is a straight, unobstructed, i.e., "line of sight," path between the fire and the exposed material. There is either a floor or the Primary Containment between the combustible materials in fire zones 1.9 and 1.10. This eliminates the "line of sight" and will realistically prevent fire spread by radiant energy transfer.

Convective heat transfer is the one method of fire spread that is remotely realistic for Pilgrim Station. If a fire in the fire zone 1.9 (or 1.10) produced enough heat to raise the ambient air temperature on the entire 23 foot elevation to the auto-ignition point of cable insulation, the fire could spread from fire zone 1.9 to 1.10. BECo has conservatively assumed that there is a sufficient fire exposure in zone 1.9 (or 1.10) to accomplish the required ambient temperature. BECo has proposed to prevent the horizontal migration of the ambient temperature profile by installing two branchlines on a wet pipe sprinkler system over the 20 ft. Separation Zones (See Item C.1) between fire zone 1.9 and 1.10. This is the only protective system necessary.

BECo has not proposed any protection for the vertical openings in the Reactor Building floors. This is not necessary since convective heat transfer cannot occur downward until the entire volume at the higher elevation(s) has been heated. Hence, the exposure fire in the fire zone 1.9 (or 1.10) would have to heat the ambient atmosphere in the Reactor Building from 51 ft. to 134 ft. to the "higher" ambient temperature before it would migrate back down into fire zone 1.9 (1.10).

The fire loads on elevation 51 ft. (or any higher elevation in the Reactor Building) are not capable of producing a fire of this magnitude. Therefore, this is not realistic and special protection is not necessary for vertical penetration/(e.g. stairs or hatch).

1. See Appendix A for a more detailed description of the theoretical and realistic analysis methods.

2. Reprinted from Table I-1, Fire Protection System Review APCSB 9.5-1.

3. The equivalent Theoretical Fire Exposure for the Reactor Building elevations 74 ft. (fire zone 1.14), 91 ft. (Fire Zone 1.16) and 117 ft. (Fire Zone 1.24) are 11, 1.8, 7.8 and 12 minutes respectively. See Table I-1 from BECo Fire Protection System Review APCSB 9.5-1.

D. FIRE PROTECTION EXISTING

1. Fire Detection systems: 32 Photoelectric smoke detectors
   11 Ionization smoke detectors

2. Fire extinguishing systems: None

3. Hose stations/extinguishers: 2 hose reels
   1 portable extinguisher

4. Radiant heat shield: None

5. Propagation retardants: Cables are coated with flamemastic or qualified to IEEE-383.

E. PROPOSED MODIFICATIONS

Modification proposed for fire zone 1.9 will insure that one train of safe shutdown equipment will remain free of fire damage for any postulated fire in the area. The proposed modifications are of two types and together provide a defense in depth concept for fire protection as intended by the requirements of Section IIIG of Appendix R.

The first type of modification involves relocating, from fire zone 1.9, cables and equipment for the "B" train of systems required for safe shutdown. After these modifications are complete, fire zone 1.9 will only contain cables and components for the "A" train of systems required for safe shutdown. Some "B" train cables will remain in the fire zone, however, the loss of these cables is acceptable since operator action will provide the same function that the cable provided. The "B" train cables will be relocated from fire zone 1.9 by rerouting them in a ductline around the outside perimeter of the plant that leaves the control building and enters the fire zone containing the components for the "B" train of systems required for shutdown. This ductline is being added as part of the modifications to meet the requirements of Appendix R. One component for the "B" train of systems is currently located in fire zone 1.9 and will be relocated to the area where the "B" train components are located.

The second type of modification involves providing sprinkler protection in the boundary area that separates fire zone 1.9 from its redundant counterpart, fire zone 1.10. These two fire zones are separated by a three hour boundary along their common border except for an area approximately 30 feet long on the north side of the area. The sprinkler protection is provided to prevent a fire from propagating across the boundary area between redundant fire zones.

TABLE 7 .2
FIRE ZONE 1.10: REACTOR BUILDING ELEVATION 23'-0", WEST SIDE
AREA DATA

A. AREA CONSTRUCTION

1. Walls - See Figure #1

North - 27" concrete wall, plus 6" pre-cast concrete panel; 3-hour rated, with 3-hour penetration seals. (column Line-P)

South - 42" concrete wall; 3-hour rated with 3-hour rated penetration seals (column Line-H)

West - 33" concrete wall; 3-hour rated with 3-hour rated penetration seals (column Line-5)

East - Partial enclosure; bounded by 42" concrete steam tunnel shield wall (column Line-10), 60" (circumferential, column Line-10 to column Line-11) both 3-hour rated walls. The unenclosed portion of the boundary is shared with fire zone 1.9 at column Line-11.

2. Floor - 24" concrete slab; 3-hour rated with 3-hour rated penetration seals with the exception of open stairwells to fire zones 1.7 and 1.2 which are not redundant areas to fire zone 1.10.

3. Ceiling - 12" concrete slab; 3-hour rated with 3-hour rated penetration seals with the exception of an open stairwell, and hatchway to fire zone 1.12 which is not a redundant area to fire zone 1.10.

4. Ceiling Height - 22 feet

5. Area Volume - Approximately 195,500 cubic feet.

6. Ventilation - See Figure #1 for directional arrows showing ventilation flow.

7. Congestion - Area is essentially free of floor congestion. General access for manual suppression is good.

B. SAFE SHUTDOWN EQUIPMENT

1. After the proposed modifications are implemented for this fire zone, only the "B" train of systems required for safe shutdown will remain in fire zone 1.10. ALL "A" train cables and components that are required to be operable for safe shutdown will not be located in this fire zone.

For a fire in fire zone 1.10, all "B" train components are assumed lost, and safe shutdown will be accomplished with the "A" train of systems. The opposite is true for fire zone 1.9 where all "A" train components are assumed lost, and safe shutdown will be accomplished with the "B" train of systems. Figure #1 shows the components and cables located in fire zone 1.10 that are required to be operable for a fire in fire zone 1.9. Listed below are the systems that will be used for safe shutdown if a fire occurs in fire zone 1.9. The components or cables are listed if they appear in fire zone 1.10. Figure #1 shows the location of the components and/or cables that are listed.

"B" TRAIN SYSTEMS	COMPONENTS/CABLES LOCATED IN FIRE ZONE 1.10
Automatic Depressurization System	Alternate shutdown panel and control cables. MCC D8 which feeds power to the ADS system.
Core spray system	MCC B18 which feeds power to core spray valves. Alternate shutdown panel for core spray. Power and control cables for core spray system.
RHR system in the shutdown cooling mode	MCC B18 which feeds power to RHR valves. Alternate shutdown panel for RHR. Power and control cables for RHR system.
Rx water level and Rx pressure	None
Torus temperature	Alternate shutdown panel for monitoring torus temperature.
Torus water LVL	Alternate shutdown panel for monitoring torus water level.

C. COMBUSTIBLES

See Section (c) of Table 7.1.

D. FIRE PROTECTION EXISTING

1. Fire detection systems: 37 Photoelectric smoke detectors
   7 Ionization smoke detectors

2. Fire extinguishing systems: None

3. Hose stations/extinguishers: 2 Hose Reels
   1 Portable Extinguisher

4. Radiant heat shield: None

5. Propagation retardants: Cables are coated with flame-mastic or qualified to IEEE-383.

E. PROPOSED MODIFICATIONS

Modification proposed for fire zone 1.10 will insure that one train of safe shutdown equipment will remain free of fire damage for any postulated fire in the area. The proposed modifications are of two types and together provide a defense in depth concept for fire protection as intended by the requirements of Section III G of Appendix R.

The first type of modification involves relocating, from fire zone 1.10, cables and equipment for the "A" train of systems required for safe shutdown. After these modifications are complete, fire zone 1.10 will only contain cables and components for the "B" train of systems required for safe shutdown. Some "A" train cables will remain in the fire zone, however, the loss of these cables is acceptable since operator action will provide the same function that the cable provided. The "A" train cables will be relocated from fire zone 1.10 by rerouting them in a ductline around the outside perimeter of the plant that leaves the control building and enters the fire zone containing the components for the "A" train of systems required for shutdown. This ductline is being added as part of the modifications to meet the requirements of Appendix R.

The second type of modification involves providing sprinkler protection in the boundary area that separates fire zone 1.10 from its redundant counter part, fire zone 1.9. These two fire zones are separated by a three hour boundary along their common border except for an area approximately 30 feet long on the north side of the area. The sprinkler protection is provided to prevent a fire from propagating across the boundary area between redundant fire zones.

TABLE 8.1

FIRE ZONE 1.11: REACTOR BUILDING ELEVATION 51'-0", EAST SIDE

AREA DATA

A. AREA CONSTRUCTION

1. Walls - See Figure #2

North - 24" concrete wall, plus 6" pre-cast concrete panel; 3-hour rated with 3-hour penetration seals. (column Line-P)

South - 21" concrete wall, plus 6" pre-cast concrete panel; 3-hour rated with 3-hour penetration seals. (column Line-J)

East - 30" concrete wall, plus 6" pre-cast concrete panel; 3-hour rated with 3-hour penetration seals. (column Line-17)

West - Partial enclosure bounded by the 60" concrete drywell shield wall (circumferential); 3-hour rated with 3-hour penetration seals. The unenclosed portion of the boundary is shared with fire zone 1.12 at column Line-11.

2. Floor - 12" concrete slab; 3-hour rated with 3-hour rated penetration seals with the exception of an open stairwell to fire zone 1.9 which is not a redundant area to fire zone 1.11.

3. Ceiling - 12" concrete slab; 3-hour rated with 3-hour rated penetration seals with the exception of an open stairwell to fire zone 1.14 which does not contain equipment required for safe shutdown.

4. Ceiling height - 22'-0"

5. Area volume - Approximately 135,[illegible]0 cubic feet.

6. Ventilation - See Figure #2 for directional arrows showing ventilation flow.

7. Congestion - Area is essentially free of floor congestion. General access for manual suppression is good.

B. SAFE SHUTDOWN EQUIPMENT (1.11)

1. After the proposed modifications are implemented for this fire zone, only the "A" train of systems required for safe shutdown will remain in fire zone 1.11. All "B" train cables

and components that are required to be operable for safe shutdown will not be located in this fire zone.

For a fire in fire zone 1.11, all "A" train components are assumed lost, and safe shutdown will be accomplished with the "B" train of systems. The opposite is true for fire zone 1.12 where all "B" train components are assumed lost, and safe shutdown will be accomplished with the "A" train of systems. Figure #2 shows the components and cables located in fire zone 1.11 that are required to be operable for a fire in fire zone 1.12. Listed below are the systems that will be used for safe shutdown if a fire occurs in fire zone 1.12. Figure #2 shows the location of the components and/or cables that are listed.

"A" TRAIN SYSTEMS	COMPONENTS/CABLES LOCATED IN FIRE ZONE 1.11
Automatic Depressurization system	NONE
RHR system in the LPCI and shutdown cooling mode	Valve MO-1001-26A & Cables Valve MO-1001-23A & Cables
Instruments for RX water level and Rx vessel pressure	Instrument Rack C2205 and Cables.

C. COMBUSTIBLES

C.1 This item provides the technical justification for considering the space between fire zones 1.11 and 1.12 "free of fixed combustible material".

The 20 ft. separation space on the north side of the Reactor Building between redundant Safe Shutdown Equipment (SSE) contain five (5) horizontal cable trays and the south side contain three (see Figure #2). The separation zones are described below:

Separation Zone Between Redundant SSE	Quantity Combustible Total lbs/ft^3–lbs.	Continuity of Combustible Through Separation Zone	Area of Separation Zone sq. ft.	Equivalent Theoretical Fire Exposure Minutes	Fire Retardant Protection
Reactor Building Northside - Elev. 51 ft. Between columns 9.1 to 11 and M.7 to P	16.3 – 326	Yes	1,140	1.6	IEEE 383 - 2 trays non-IEEE 383 Cable Coated with Fire Retardant - 3 trays Material
Reactor Building Southside - Elev. 51. ft. - Between columns 10-13 and J to K	6.6 – 133	Yes	260	2.0	IEEE 383 - 2 trays Cable non-IEEE 383 Cable Coated with Fire Retardant - 1 tray Material

The theoretical[1] equivalent fire exposure of the cable with this Separation Zone is only 1.6 to 2.0 minutes. This is extremely low. Realistically,[1] the combination of fire retardant coating or the inherent fire retardant properties of IEEE 383 qualified cable and the physical separation between the trays will prevent a fire that originates within one of these trays from generating sufficient heat to propagate a fire across the other trays in the respective Separation Zone. An intense or large exposure fire might be able to propagate a fire across the respective Separation Zone. However, there are no other installed combustible materials in either zone to provide the exposure fire.

Moreover, Administrative Controls were designed to limit transient combustible material on Elev. 51 ft. of the Reactor Building to a maximum of 10 gallons of Class II and III Liquids (i.e. each) and one gallon of Class I Liquids[2]. Combustible loading of this magnitude, or even several orders of magnitude larger, will not totally fill the 20 ft. wide Separation Zone. Additionally, since the cable trays are 11 ft. above the floor, the transient loads will not be able to impinge on the entire length of the tray.

BECo concludes that neither the limited installed combustible materials or potential transient materials would propagate a fire across either the north or south 20 ft. fire Separation Zone an elevation of 51 ft. These zones can be considered "free of intervening combustibles as required in Section III G.2 (b).

C.2 This item provides the technical justification for the proposed fire protection modifications.

The combustible materials installed in fire zone 1.11 and 1.12 are primarily cable insulation. The fire loading and the theoretical[1] fire exposure are described in the table[2] below:

Fire Zone	Quantity of Combustibles Type — Weight	Continuity of Combustibles through Fire Zone	Equivalent Theoretical Fire Exposure Minutes	Fire Retardant Protection Type	%
No. 1.12 Reactor Building Elev. 51 ft. West Col. No. 11	Cable-1870 Transient Combustibles — 130	No	7.8	IEEE 383 Cable	70%
				non-IEEE 383 Cable Coated with Fire Retardant material	30%

1 See Appendix A for a more detailed description of the theoretical and realistic analysis methods.

2 Flammable/combustible liquids are required to be in approved containers.

Fire Zone	Quantity of Combustibles Type - Weight	Continuity of Combustibles through Fire Zone	Equivalent Theoretical Fire Exposure Minutes	Fire Retardant Protection Type	%
No. 1.11 Reactor Building Elev. 51. ft. East of Col. No.11	Cable-3065	No	11	IEEE 383 Cable	70%
				non-IEEE 383 Cable Coated with Fire Retardant material	30%

There are two approaches to analyze fire spread potentials. The "theoretical"[1] method mathematically compares specific plant fire loads to a Standard Time-Temperature fire. The "realistic"[1] method evaluates the physical array of specific combustibles and the possibility of fire propagation within the array.

THEORETICAL ANALYSIS

BECo used the theoretical approach to identify the Standard Fire Exposure for comparison purposes and general understanding on the "order of magnitude of the worst case fire in this area. Any fires with a Standard exposure under 30 minutes are in the lowest severity category. Fire zone 1.11 and 1.12 have Standard Fire Exposures 11 and 8 minutes respectively."

BECo believes that any further use of the theoretical approach is unwarranted since this method is heavily depended on defining a Design Basis Fire (DBF), and the correlation between a DBF and real fire has not been satisfactorily established. More importantly, BECo postulates this is unnecessary because the realistic approach is adequate to obtain an appropriate level of fire protection.

REALISTIC ANALYSIS

The realistic approach identifies that there are two potential paths for fire spread between Zones 1.11 and 1.12. First, the fire could spread horizontally across the floor. Secondly, the fire could spread to a higher or lower elevation (e.g. 23 ft., 74 or 91) through a vertical opening and then back to the 51 ft. elevation through another vertical opening. These paths have been utilized in the completion of the realistic analysis below.

> Conductive heat transfer and direct flame impingement are not possible across these paths since there is no continuity combustible materials in any of these paths (e.g. vertical or horizontal).

Radiant heat transfer can only be a factor in fire spread when there is straight, unobstructed, i.e. "line of sight," path between the fire and the expcsed material. There is either a floor or the Primary Containment between the combustible materials in Fire Zones 1.11 and 1.12. This eliminates the "line of sight" and will realistically prevent fire spread by radiant energy transfer.

Convective heat transfer is the one method of fire spread that is remotely realistic for Pilgrim Station. If a fire in the Fire Zone 1.11 (or 1.12) producted enough heat to raise the ambient air temperature on the entire 51 ft. elevation to the auto-ignition point of cable insulation, the fire could spread from Fire Zone 1.12 to 1.11. BECo has conservatively assumed that there is a sufficient fire exposure in Zone 1.11 (or 1.12) to accomplish the required ambient temperature. BECo has proposed to prevent the horizontal migration of the ambient temperature profile by installing two branchlines on a wet pipe sprinkler system within the 20 ft. Separation Zones (See Item C.1) between Fire Zone 1.11 and 1.12. This is the only protective system necessary.

BECo has not proposed any protection for the vertical openings in the Reactor Building floors. This is not necessary since convective heat transfer cannot occur downward until the entire volume at the higher elevation(s) has been heated. Hence, the exposure fire in Fire Zone 1.11 (or 1.12) would have to heat the ambient atmosphere in the Reactor Building from 74 ft. to 134 ft. to the "higher" ambient temperature before it would migrate back down into Fire Zone 1.12 (or 1.11).

The fire loads on elevation 51 ft. (or on any higher elevation in the Reactor Building) are not capable of producing a fire of this magnitude. Therefore, this is not realistic and special protection is not necessary for vertical penetrations (e.g. stairs or hatch.

[1] See Appendix A for a more detailed description of the theoretical and realistic analysis methods.

[2] Reprinted from Table I-1, Fire Protection System Review APCSB 9.5-1.

[3] The equivalent Theoretical Fire Exposure for the Reactor Building elevations 74 ft. (Fire Zone 1.14), 91 ft. (Fire Zone 1.16) and 117 ft. (Fire Zone 1.24) are 1.8, 7.8 and 12 minutes respectively. See Table I-1 from BECo Fire Protection System Review APCSB9.5-1.

D. FIRE PROTECTION EXISTING

1. Fire Detection Systems: 14 Photoelectric Smoke Detectors
   3 Ionization Smoke Detectors

2. Fire Extinguishing Systems: None

3. Hose Stations/Extinguishers: 1 Hose Reel
   2 Portable Extinguishers

4. Radiant Heat Shield: None

5. Propagation Retardants: Cables are coated with flamemastic or qualified to IEEE-383.

E. PROPOSED MODIFICATIONS

Modifications proposed for fire zone 1.11 will insure that one train of safe shutdown equipment will remain free of fire damage for any postulated fire in the area. The proposed modifications are of two types and together provide a defense in depth concept for fire protection as intended by the requirements of section IIIG of Appendix R.

The first type of modification involves relocating from fire zone 1.11 cables for the "B" train of systems required for safe shutdown. After these modifications are complete, fire zone 1.11 will only contain cables and components for the "A" train of systems required for safe shutdown. A few "B" train cables will remain in the fire zone, however, the loss of these cables is acceptable since operator action will provide the same function that the cable provided. The "B" train cables will be relocated from fire zone 1.11 by rerouting them in a ductline around the outside perimeter of the Plant that leaves the Control Building and enters the fire zone containing the components for the "B" train of systems required for shutdown. This ductline is being added as part of the modifications to meet the requirements of Appendix R.

The second type of modification involves providing sprinkler protection in the boundary area that separates fire zone 1.11 from its redundant counterpart, fire zone 1.12 as shown on Figure #2.

TABLE 8.2
FIRE ZONE 1.12: REACTOR BUILDING ELEVATION 51'-0", WEST SIDE
AREA DATA

A. AREA CONSTRUCTION

1. **Walls** - See Figure #2

North - 24" concrete wall, plus 6" pre-cast concrete panel; 3-hour rated with 3-hour penetration seals. (column Line-P)

South - 21" concrete wall, plus 6" pre-cast concrete panel; 3-hour rated with 3-hour penetration seals. (column Line-J)

East - Partial enclosure bounded by the 60" concrete drywell shield wall; (circumferential) 3-hour rated with 3-hour penetration seals. The unenclosed portion of the boundary is shared with fire zone 1.11 at column Line-11.

West - Filled masonary block wall 12" thick. (at column Line-7, bounded by column Line P & K) 24" concrete wall, plus 6" pre-cast concrete panel. (at column Line-5, bounded by column Lines-J &K) 3-hour rated with 3-hour rated penetration seals.

2. Floor - 12" concrete slab; 3-hour rated with 3-hour rated penetration seals with the exception of an open stairwell and hatchway to fire zone 1.10 which is not a redundant area to fire zone 1.12.

3. Ceiling - 12" concrete slab; 3-hour rated with 3-hour rated penetration seals with the exception of an open stairwell and hatchway to the 74'-0" elevation which does not contain equipment required for safe shutdown.

4. Ceiling height - 22'-3" (maximum)

5. **Area volume** - Approximately 87,840 cubic feet.

6. Ventilation - See Figure #2 for directional arrows showing ventilation flow.

7. **Congestion** - Area is essentially free of floor congestion. General access for manual suppression is good.

B. SAFE SHUTDOWN EQUIPMENT

After the proposed modifications are implemented for this fire zone, only the "B" train of systems required for safe shutdown will remain in fire zone 1.12. All "A" train cables and components that are required to be operable for safe shutdown will not be located in this fire zone.

For a fire in fire zone 1.12, all "B" train components are assumed lost, and safe shutdown will be accomplished with the "A" train of systems. The opposite is true for fire zone 1.11 where all "A" train components are assumed lost, and safe shutdown will be accomplished with the "B" train of systems. Figure #2 shows the components and cables located in fire zone 1.12 that are required to be operable for a fire in fire zone 1.11. Listed below are the systems that will be used for safe shutdown if a fire occurs in fire zone 1.11. The components or cables are listed if they appear in fire zone 1.12. Figure #2 shows the location of the components and/or cables that are listed.

"B" TRAIN SYSTEMS	COMPONENTS/CABLES LOCATED IN FIRE ZONE 1.12
Automatic Depressurization System	NONE
RHR system in the LPCI and shutdown cooling mode	NONE
Instruments for Rx water level and Rx vessel pressure	Instrument Rack C2206 A & B and Cables

C. COMBUSTIBLES

See section (c) of Table 8.1.

D. FIRE PROTECTION EXISTING

1. Fire Detection Systems : 10 Photoelectric Smoke Detectors
   3 Ionization Smoke Detectors

2. Fire Extinguishing Systems: None

3. Hose Stations/Extinguishers: 2 Hose Reels
   2 Portable Extinguishers

4. Radiant Heat Shield: None

5. Propagation Retardants: Cables are coated with flamemastic or qualified to IEEE-383.

E. PROPOSED MODIFICATIONS

Modifications proposed for fire zone 1.12 will insure that one train of safe shutdown equipment will remain free of fire damage for any postulated fire in the area. The proposed modifications are of two types and together provide a defense in depth concept for fire protection as intended by the requirements of section IIIG of Appendix R.

The first type of modifcation involves rerouting cables that are for shutdown components in fire zone 1.12. Fire zone 1.12 contain components for the "B" train of systems required for safe shutdown. The cables will be rerouted from fire zones that contain components for the "A" train of systems required for safe shutdown. The cables will be rerouted by a duct line that leaves the Control Building and enters the fire zone containing the components for the "B" train of systems required for shutdown. This duct line is being added as part of the modifications to meet the requirements of Appendix R.

The second type of modification involves providing sprinkler protection, as shown on Figure #2, in the boundary area that separates fire zone 1.12 from its redundant counterpart, fire zone 1.11.

APPENDIX A

THEORETICAL AND REALISTIC FIRE ANALYSIS

There are two approaches to analyze fire and its development - the "theoretical" and "realistic" methods.

The theoretical methods models the chemistry and physics of fire. This method manifests itself through laboratory testing and identifies standard or minimum developmental parameters for fire. These parameters are useful for comparison purposes and selection of materials, components or plant configurations during design. For example, the theoretical method converts all combustible material within a specific volume of the plant to its "equivalent" calorimetric heating value. The heat loads are totaled for all materials in that plant volume. Finally, the theoretical method assumes all the heat is released in a duration of time equivalent to the Standard ASTM E-119 Fire Test. The resultant is a theoretical maximum equivalent Standard Fire Severity. (The Tables in the exemption requests illustrate that the Standard Fire Severity is extremely low for each of the applicable fire zones. This analogy defines a specific air temperature profile over a standard time duration. This is very conservative because it does not consider the differences in the rate of combustion of the various materials. However, by comparing these factors for specific materials, an order of magnitude on fire severities can be estimated. The longer the "equivalent standard fire" the higher the expected severity for that combustible load. This information is also used in the realistic method where equivalent fire severity is used to determine the required fire resistance rating of building materials.

The realistic method evaluates the actual physical configuration between combustible material, non-combustible materials and building construction while applying the guidance gained from the theoretical method.

In this method, the experience obtained from plant inspection and fire investigation temper the theoretical predictions and estimates. The basic thermodynamics for fire development and spread from the foundation for the realistic approach. Fire can spread by one of the mechanisms.

They are:

1. Conductive heat transfer
2. Radiant heat energy transfer
3. Convective heat transfer

Realistically, combustible materials ignite only after they absorb a specific amount of heat energy. The required energy can be transferred from the burning material to the adjacent material directly, i.e. items 1 and 2, or indirectly (e.g. burning material to air to adjacent material), i.e. item 3. Fire spread involving direct contact is much faster than through the convective process. From this simple knowledge, the realistic method makes an even simpler, conservative presumption. When combustible materials are present, and their physical configuration appear conducive to one of the heat transfer mechanisms, some fire prevention or extinguishment must be provided.

Both methods have many limitations as fire protection is an emerging science with many answers yet to be reached. However, proper application of these methods will lead to solid treatment and protection for fire risk. BECo has and will continue to update their application of these methods to provide the highest level of fire protection for life safety and property conservation.

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