

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of) Docket No. 50-293
BOSTON EDISON COMPANY)
PILGRIM NUCLEAR POWER STATION)

EXEMPTION

I.

The Boston Edison Company (BECO), the licensee, is the holder of Operating License No. DPR-35, which authorizes operation of Pilgrim Nuclear Power Station. The license provides, among other things, that the Pilgrim Nuclear Power Station is subject to all rules, regulations, and Orders of the Commission now or hereafter in effect.

The plant is a boiling water reactor located at the licensee's site in Plymouth County, Massachusetts.

II.

On November 19, 1980, the Commission published a revised Section 50.48 and a new Appendix R to 10 CFR Part 50 regarding fire protection features of nuclear power plants (45FR76602). The revised Section 50.48 and Appendix R became effective on February 17, 1981. Section III of Appendix R contains 15 subsections, lettered A through O, each of which specifies requirements for a particular aspect of the fire protection features. One of these subsections, III.G, is the subject of this exemption request.

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Section III.G.1 of Appendix R requires fire protection to be provided for structures, systems and components important to safe shutdown and capable of limiting fire damage so that:

- a. One train of systems necessary to achieve and maintain hot shutdown conditions from either the control room or emergency control station(s) is free of fire damage; and
- b. Systems necessary to achieve and maintain cold shutdown from either the control room or emergency control station(s) can be repaired within 72 hours.

Section III.G.2 of Appendix R requires that one of the redundant trains of systems necessary to achieve and maintain hot shutdown be maintained free of fire damage by one of the following means:

- a. Separation of cables and equipment and associated non-safety circuits of redundant trains by a fire barrier having a 3-hour rating. Structural steel forming a part of or supporting such fire barriers shall be protected to provide fire resistance equivalent to that required of the barrier;
- b. Separation of cables and equipment and associated non-safety circuits of redundant trains by a horizontal distance of more than 20 feet with no intervening combustibles or fire hazards. In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area; or
- c. Enclosure of cable and equipment and associated non-safety circuits of one redundant train in a fire barrier having a 1-hour rating. In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area.

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If the above conditions are not met, Section III.G.3 requires that there be alternative or dedicated shutdown capability independent of the fire area of concern. Appendix R Section III.G.3 also requires that fire detection and a fixed fire suppression system be installed in the fire area of concern. These alternative requirements are not deemed to be equivalent; however, they provide equivalent protection for those configurations in which they are accepted.

Because it is not possible to predict the specific conditions under which fire may occur and propagate, design basis protective features rather than the design basis fire are specified in the rule. Plant-specific features may require protection different from the measures specified in Section III.G. In such a case, the licensee must demonstrate, by means of a detailed fire hazards analysis, that existing protection, or existing protection in conjunction with proposed modification, will provide a level of safety equivalent to the technical requirements of Appendix R Section III.G.

In summary, Section III.G is related to fire protection features provided for structures, systems and components important to safe shutdown by ensuring these features are capable of limiting fire damage.

Fire protection features must meet the specific requirements of Section III.G. or an alternative fire protection configuration must be justified by a fire hazards analysis. Generally the staff will accept an alternative fire protection configuration if the following criteria, to the extent applicable to the requested exemption, are satisfied:

- ° The alternative ensures that one train of equipment necessary to achieve hot shutdown from either the control room or emergency control station(s) is free of fire damage,
- ° The alternative ensures that fire damage to at least one train of equipment necessary to achieve cold shutdown is limited so that it can be

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repaired within a reasonable time (minor repairs using components stored on the site),

- ° Fire-retardant coatings are not used as fire barriers, and
- ° Modifications required to meet Section III.G would not significantly enhance fire protection safety levels above that provided by either existing or proposed alternatives, or the modifications would be detrimental to overall facility safety.

III.

By letter dated November 16, 1983 (BEC0 83-281), the licensee requested four exemptions from the technical provisions of Section III.G. of Appendix R to 10 CFR Part 50. The four exemptions requested were: Nos. 11 and 12, which pertain to the lack of rated fire barriers between the reactor building torus compartment and the control rod drive quadrant rooms; No. 13, which pertains to unprotected structural steel in the reactor building torus compartment; and No. 14, which pertains to unprotected structural steel in the reactor building steam tunnel. To simplify the review, exemptions 11 and 12 were considered together as one, and exemptions 13 and 14 were considered separately.

The requests for exemptions were clarified and modified to reflect both improvements in separation of redundant features and refinements in calculating the effects of varying combustible loadings. This supplementary information was furnished in letters dated December 27, 1984 (BEC0 84-214), July 28, 1986 (BEC0 86-110), November 14, 1986 (BEC0 86-176), April 21, 1987 (BEC0 87-062), August 4, 1987 (BEC0 87-132), and in a meeting on November 24, 1987. In addition NRC Region I fire protection engineers visited Pilgrim on April 1, 1986 to inspect fire protection improvements and to examine the fire areas where the exemptions from Appendix R were requested. A site fire protection inspection and audit was also conducted by the Region I fire protection engineer, assisted by NRR and contractor personnel on May 11-15, 1987.

Tables 1, 2 and 3 consolidate the information gathered to date and reflect the Pilgrim Plant configuration as it will be modified prior to restart in 1988. The information in the tables and the other information presented in the text were used in the staff evaluation leading to the conclusion that these exemptions should be granted.

Exemptions 11 and 12 pertain to the lack of 3-hour rated fire barrier separation between redundant trains of safe shutdown equipment. The most obvious location for those barriers is in the doorways between the reactor building torus compartment and surrounding compartments as described below.

The torus compartment is a circular shaped room having an outer wall of roughly 150 ft in diameter. This compartment is enclosed in a square section of the reactor building measuring about 160 ft on a side. The cutoff corners of the square outside the torus compartment house some safe shutdown components and connect to other areas also containing safe shutdown equipment. Redundant trains of safe shutdown equipment and cables are segregated so that only one train is in any one quadrant. The location of affected safe shutdown equipment is shown in Table 1. The torus compartment is designated fire zone (FZ) 1.30A and is about 40 ft high. Doorways to three of the four corner equipment rooms have been placed about half way up the 3 ft thick walls. The doorways connect to FZ 1.2 at the northwest corner, FZ 1.6/1.8 at the northeast corner, FZ 1.1 on the southeast corner, and FZ 1.5/1.7 on the southwest corner. FZ 1.2 and 1.1 are each 40 ft high. FZ 1.6 below/1.8 above, and 1.5 below/1.7 above are each 20 ft high. The relationship between redundant trains and interconnected fire zones is given in Table 2. Table 3 gives the combustible loadings in the affected fire zones along with the burning times for "standard fires."

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Tables 1 and 2 reveal that the only common point between trains A and B is FZ 1.30 A, the torus compartment. Access from the torus compartment to train A is through the FZ 1.1 and 1.8 doorways; access to train B components is through the FZ 1.2 doorway. Therefore, with two exceptions, the analysis can be simplified to an evaluation of the torus compartment (FZ 1.30 A).

The first exemption is that train B cables for both the High Pressure Coolant Injection (HPCI) system and the Reactor Core Isolation Cooling (RCIC) system run in a cable tray about 8 feet above the fire zone 1.8 doorway. While both HPCI and RCIC are safe shutdown systems for other situations, they are not depended upon, and no credit is taken for them when considering a fire in fire zone 1.30A or other zones connected to FZ 1.30A.

The second exception is the presence of trains A and B of torus instrumentation (torus water level and torus water temperature) inside the torus compartment. The alternative torus instruments and cables are also located in FZ 1.30A. However, they are fully protected with a one-hour fire-rated wrapping inside FZ 1.30 A, and the train A, train B and alternative system cables are located approximately 120° apart from each other on the torus compartment wall. (This arrangement was the subject of Exemption Request No. 5 and has already been reviewed and approved by the staff.)

The minimum horizontal distance between train A and train B safe shutdown components, considering the path through the torus compartment, is over 100 feet and involves doorways between the torus compartment and the corner rooms on opposite sides of the torus compartment. Automatic fire detection and suppression throughout the torus compartment is not required because:

- ° the combustible fuel load in the torus compartment is low;

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- ° Automatic fire detection capability in three of the four corner rooms is expected to detect any fire of significance in the torus compartment;
- ° the Fire Brigade will be notified promptly of any fire in the area (torus compartment or corner rooms); and
- ° portable extinguishers and manual hose stations (hoses are equipped with combination spray/straight stream nozzles) located in the corner rooms are adequate for manual suppression of any anticipated fire in the torus compartment or the corner rooms.

In summary, we have concluded that the licensee's requests 11 and 12, which request exemption from the provisions of III.G.2.a, should be granted based on:

- (1) No combustibles within 20 ft horizontally of the doorways to FZ 1.2 and 1.1,
- (2) Combustible loads in FZ 1.30A (torus compartment) do not exceed 1500 Btu/ft²,
- (3) Combustibles are located where they do not interfere with fire fighting activities, and
- (4) Available fire fighting equipment is effective for fighting fires anywhere in the torus compartment or the corner rooms.

TABLE 1

Location of Affected Redundant
Safe Shutdown Components

<u>SYSTEM</u>	<u>TRAIN A</u>	<u>TRAIN B</u>
Reactor Heat Removal	FZ 1.1, 1.9, 1.8	FZ 1.2, 1.10
Core Spray	FZ 1.1, 1.9	FZ 1.2, 1.10
Reactor Building Closed Cooling Water	FZ 1.1, 1.9	FZ 1.2, 1.10
Area Coolers	FZ 1.1, 1.9	FZ 1.2, 1.10
High Pressure Coolant Injection	— —	FZ 1.30A
Reactor Core Isolation Cooling	— —	FZ 1.30A
Torus Water Level	FZ 1.30A	FZ 1.30A
Torus Water Temperature	FZ 1.30 A	FZ 1.30A

Fire Access/Protection Features

Train	Fire Zone	Adjoining Fire Zones/ <u>Fire Propagation Paths</u>	Fire Protection/ <u>Fighting Features</u> 1
B	1.30A	<ul style="list-style-type: none"> - 1.1 by open doorway - 1.2 by open doorway - 1.8 by open doorway - Also is connecting paths between Tains A and Train B Components 	<p>None except covered by portable fire extinguishers and manual hose stations in other adjoining</p>

¹A - Smoke Detectors

B - Portable Fire Extinguishers

C - Manual Hose Stations

TABLE 2

Fire Access/Protection Features

<u>Train</u>	<u>Fire Zone</u>	<u>Adjoining Fire Zones/ Fire Propagation Paths</u>	<u>Fire Protection/ Fighting Features</u> 1
A	1.1	- 1.9 above by open stairwell - 1.30 A by open doorway	A, C
A	1.9	- 1.1 below by open stairwell - 1.1, 1.10 adjoining	A, B, C Water curtain between 1.10
A	1.6	- 1.8 above by open stairwell	A, B, C
A	1.8	- 1.9 above by open stairwell - 1.6 below by open stairwell - 1.30A by open doorway	A, B, C
B	1.2	- 1.10 above by open stairwell - 1.30A by open doorway	A, B, C
B	1.10	- 1.2 below by open stairwell - 1.9 adjoining - Also has alternate shutdown panel	A, B, C Water curtain between 1.9

TABLE 3

Fuel and Fire Data

<u>Fire Zone</u>	<u>Combustible</u>	<u>Quality</u> <u>(Btu/ft²)</u>	<u>Fire Duration</u> <u>(in minutes)</u>
1.1	Cable, Lube oil	15,300	12
1.9	Cable	39,200	30
1.6	Cable, Lube oil	11,000	8
1.8	Cable	1,600	1
1.2	Cable, Lube oil	14,900	11
1.10	Cable	36,400	28
1.30A	Cable	1,400	1
1.32	Cable	5,800	4

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BECO exemption request 13 is for relief from the requirements of Appendix R Section III.G.2.a to the extent that it requires structural steel forming a part of or supporting 3-hour rated fire barriers to be protected to provide fire resistance equivalent to that required of the barrier. The barrier in question is the ceiling of the torus compartment (FZ 1.30A), which forms the floor of fire zones 1.9 and 1.10.

BECO surveyed the structural steel in the torus compartment and found that six types of beams were required to maintain the integrity of the FZ 1.30A ceiling as a fire barrier. BECO analyzed the unprotected steel for potential failure caused by exposure to burning cable in trays. BECO demonstrated an adequate margin of safety for the structural steel and indicated that additional protection for the steel, either in the form of fire proofing applied directly to the steel, or tray covers installed on the cable trays in the area, is not required.

BECO first considered all of the fuel (cable insulation and jacket material) in the torus compartment to be burning, and evaluated the effect of the heat released on the unprotected structural steel. BECO calculated the average fuel loading per square foot of area in the locality of the exposed cable tray in the torus compartment to be about 1400 Btu/sq ft with an equivalent fire severity of less than 2-minutes. Existing fire test results have already shown these six beam types can survive a "Standard" fire for 14 to 21 minutes before failure. Therefore, a fire lasting less than 2-minutes will not lead to failure even if all of the heat released by the burning cables is assumed to heat only the steel.

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BECo also assumed that the cable tray crossed under the structural steel at an angle of 90° and about 12-inches below the beam. The combustible insulation and jacket material in the cable tray is assumed to burn completely and release 100% of its potential heat of combustion. This heat of combustion was assumed to consist equally of radiant heat and convective heat in the fire plume. The final assumption is that 100% of the convective heat in the fire plume is absorbed in the steel section directly above the cable tray with no losses into the air, the surrounding concrete or by axial conduction into the remainder of the structural steel beam. Each of these assumptions is individually conservative. The temperatures calculated using those assumptions for the six beam types (or sizes) ranged from 685°F for the heaviest beam to 970°F for the lightest; these temperature are well below the critical failure temperature of 1100°F for this type of steel.

Based on the above evaluation the staff concludes that no additional fire protection features are required in FZ 1.30A for the structural steel supporting the floor forming the fire barrier between FZ 1.30A and fire zones 1.9 and 1.10 above it. Therefore; the licensee's request 13, which requests exemption from the provisions of III.G.2.a, should be granted.

Exemption request 14 sought relief from Section III.G.2.a to the extent that it requires structural steel forming a part of or supporting the floor which forms the fire barrier between the reactor building steam tunnel, FZ 1.32, and fire zone 1.11 and 1.12 to be protected to provide fire resistance equivalent to that required of the barrier.

BECo performed an analysis to determine the quantity of combustible material that would be required to raise the temperature of the steel to the yield temperature, above which it would fail to support the floor. The analysis indicated that a combustible loading of 21,500 Btu per square foot

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would be required. The combustible contents of FZ 1.32 consist of exposed electrical cables that could yield approximately $5,800 \text{ Btu/ft}^2$, for an equivalent fire severity of approximately four minutes. The majority of cables in this fire zone are routed in conduits and no other combustible materials are present. Fire protection consists of a portable fire extinguisher and a manual hose station in an adjacent area.

The licensee's analysis indicates that the structural steel would not fail even if it instantaneously absorbed the entire heat of combustion of the materials present in fire zone 1.32. Although the licensee did not consider the effect of a fire plume impinging directly on a structural member as in FZ 1.30A, the negligible combustible loading makes it unlikely that such a fire exposure would be significant. Therefore, reasonable assurance exists that a fire originating in this fire zone will not prevent the plant from safely shutting down.

Based on the above evaluation, the staff concluded that the existing fire protection features for the structural steel in fire zone 1.32, which supports the floor of fire zones 1.11 and 1.12, provide an acceptable level of protection for the redundant trains of cables and equipment located in fire zone 1.11 and 1.12. Therefore; the licensee's request 14, which requests exemption from the provisions of III.G.2.a, should be granted.

Conclusion

Based on the evaluations described above, the staff concluded that the level of fire safety in fire zones 1.30 and 1.32 is equivalent to that achieved by compliance with the technical requirements of Section III.G of Appendix R to 10 CFR Part 50 and literal compliance would not significantly enhance fire protection safety levels, therefore; the licensee's requests for exemption in these zones (requests 11, 12, 13 and 14) should be granted.

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IV.

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), (1) the exemptions as described in Section III are authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security and (2) in this case, special circumstances are present in the configuration of the plant and the quantities of combustible materials present to achieve the underlying purpose of Appendix R to 10 CFR Part 50. Therefore, the Commission hereby grants the exemptions from the requirements of Section III.G.2.a of Appendix R to 10 CFR Part 50 regarding fire barriers and protection of structural steel as follows:

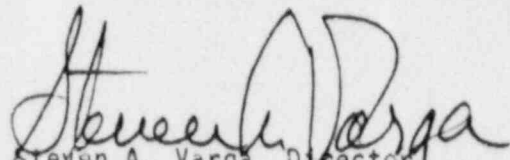
- (1) 3-hour rated fire barrier separation between redundant trains of safe shutdown equipment located in fire zones 1.2, 1.1, 1.8, which are connected through FZ 1.30A.
- (2) 3-hour fire proofing for structural steel in the reactor building torus compartment, elevation 17 feet, fire zone 1.30A.
- (3) 3-hour fire proofing for structural steel in the reactor building steam tunnel, elevation 23 feet, fire zone 1.32.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of these exemptions will not result in any significant environmental impact (52FR35603 September 22, 1987). A copy of the licensee's request for exemption dated November 16, 1983 and subsequent documents are available for public inspection at the Commission's Public Document Room, 1717 H Street, NW, Washington, D.C. and at the Plymouth Public Library, 11 North Street, Plymouth, Massachusetts 02360. Copies may be obtained upon written request addressed to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Division of Reactor Projects I/II.

These Exemptions are effective upon issuance.

Dated at Rockville, Maryland, this 14th day of July, 1988.

FOR THE NUCLEAR REGULATORY COMMISSION



Steven A. Varga, Director
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation

Dist:
Docket 50-293
PD I-3 Reading
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DOCKET NO. 50-293
MEMORANDUM FOR: Rules and Procedures Branch
Division of Rules and Records
Office of Administration
FROM: Office of Nuclear Reactor Regulation
SUBJECT: BOSTON EDISON COMPANY - PILGRIM NUCLEAR POWER STATION

One signed original of the *Federal Register* Notice identified below is enclosed for your transmittal to the Office of the Federal Register for publication. Additional conformed copies (6) of the Notice are enclosed for your use.

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- Notice of Receipt of Partial Application for Construction Permit(s) and Facility License(s); Time for Submission of Views on Antitrust Matters.
- Notice of Consideration of Issuance of Amendment to Facility Operating License.
- Notice of Receipt of Application for Facility License(s); Notice of Availability of Applicant's Environmental Report; and Notice of Consideration of Issuance of Facility License(s) and Notice of Opportunity for Hearing.
- Notice of Availability of NRC Draft/Final Environmental Statement.
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- C. der.
- Exemption.
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Office of Nuclear Reactor Regulation

Enclosure:
As stated

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