Mr. Mike Bellamy October 6, 2000
Site Vice President
Entergy Nuclear Generation Company
Pilgrim Nuclear Power Station
600 Rocky Hill Road
Plymouth, MA 02360

SUBJECT: PILGRIM NUCLEAR POWER STATION - ISSUANCE OF AMENDMENT RE: USE OF CONTAINMENT OVERPRESSURE (TAC NO. MA7295)

Dear Mr. Bellamy:

The Commission has issued the enclosed Amendment No. 185 to Facility Operating License No. DPR-35 for the Pilgrim Nuclear Power Station. This amendment is in response to your application dated November 22, 1999.

This amendment changes the Pilgrim Nuclear Power Station licensing basis. The requested change involves the use of containment overpressure to ensure sufficient net positive suction head for the emergency core cooling system pumps following a loss-of-coolant accident .

A copy of the related Safety Evaluation is also enclosed. Notice of Issuance will be included in the Commission's biweekly Federal Register Notice.

Sincerely,

/RA/

Alan B. Wang, Project Manager, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-293

Enclosures: 1. Amendment No. 185 to License No. DPR-35
2. Safety Evaluation

cc w/encls: See next page

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Accession Number: ML003749679 * SE input provided 8/22/00, no major changes made.

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ENTERGY NUCLEAR GENERATION COMPANY

DOCKET NO. 50-293

PILGRIM NUCLEAR POWER STATION

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 185
License No. DPR-35

1. The Nuclear Regulatory Commission (the Commission or the NRC) has found that:

   A. The application for amendment filed by the Entergy Nuclear Generation Company (the licensee) dated November 22, 1999, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance: (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, changes to the Updated Final Safety Analysis Report (UFSAR) to reflect an increase in the amount of containment overpressure needed to ensure sufficient net positive suction head for the emergency core cooling system pumps following a loss-of-coolant accident, as described in the attached safety evaluation, and as set forth in the application for amendment by Entergy Nuclear Generation Company dated November 22, 1999, are authorized. The licensee shall submit the revised description authorized by this amendment with the next update of the UFSAR.

3. This license amendment is effective as of its date of issuance and shall be implemented within 30 days from the date of issuance. Implementation of the amendment is the incorporation in the UFSAR of the changes to the description of the facility as described in the licensee's application dated November 22, 1999.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

James W. Clifford, Chief, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Date of Issuance: October 6, 2000

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 185 TO FACILITY OPERATING LICENSE NO. DPR-35

ENTERGY NUCLEAR GENERATION COMPANY

PILGRIM NUCLEAR POWER STATION

DOCKET NO. 50-293

1.0 INTRODUCTION

By letter dated November 22, 1999, (Reference 1), Entergy Nuclear Generation Company (Entergy/the licensee) submitted a request for changes to the Pilgrim Nuclear Power Station (Pilgrim) Technical Specifications (TSs). The requested changes would modify the Pilgrim licensing basis. The requested changes involve the use of containment overpressure to ensure sufficient net positive suction head (NPSH) for the emergency core cooling system (ECCS) pumps following a loss-of-coolant accident (LOCA).

2.0 BACKGROUND

By letter dated July 3, 1997, (Reference 2), the Nuclear Regulatory Commission (NRC) issued License Amendment No. 173 for Pilgrim which allowed the use of specified amounts of containment overpressure for the residual heat removal (RHR) and core spray pumps during the long term following a LOCA. However, due to new ECCS strainer head loss values caused by debris generated from a potential LOCA, the reliance on containment overpressure has increased since Amendment 173 was issued. Therefore, Entergy requested that the Pilgrim licensing basis be changed to address the increased reliance on containment overpressure for the long term following a LOCA. The proposed licensing basis change would apply to both the RHR and core spray pumps.

Pilgrim is a Boiling Water Reactor 3 (BWR/3) with a Mark I containment. The Pilgrim ECCS consists of a high pressure coolant injection (HPCI) pump, an automatic pressure relief system, two trains of core spray (CS), and two trains of low pressure coolant injection (LPCI). The HPCI system is designed to inject water from the emergency condensate storage tanks or suppression pool into the reactor vessel. The HPCI system provides makeup water to the reactor vessel in the event of a small break LOCA which does not result in a rapid depressurization of the reactor vessel. Containment overpressure is not required to ensure adequate NPSH for the HPCI pumps following a small break LOCA. The CS system injects water from the suppression pool to the reactor vessel via the core spray spargers located above the core. The LPCI system is designed to inject water from the suppression pool into one of the reactor recirculation loops. The LPCI system is an operating mode of the RHR system. Both the CS system and LPCI system provide makeup water to the reactor vessel at low pressure following a large break LOCA and depressurization of the reactor vessel.

3.0 EVALUATION

Based on the analyses described below, the licensee has proposed Table 1 to be incorporated into the Pilgrim Updated Final Safety Analysis Report (UFSAR).

Table 1

Time After Accident	Containment Overpressure (psig)
0 to 1200 seconds	0
1200 to 1800 seconds	1.9
1800 to 3600 seconds	3.0
1 to 16 hours	5.0
16 to 30 hours	2.5
30 to 48 hours	1.0
48 to 240 hours	0.0

3.1 Calculation of Minimum Containment Pressure

At Pilgrim, containment overpressure is defined as available pressure above 14.7 psia. For the design basis accident (DBA), the licensee postulated a reactor recirculation system line break (DBA-LOCA) which results in the rapid heatup of the suppression pool following the LOCA. The DBA-LOCA is the bounding analysis with respect to NPSH. The DBA-LOCA analysis is based on maximizing the suppression pool temperature while the containment atmosphere is assumed to be in thermal equilibrium with the suppression pool. The thermal equilibrium method used for calculating containment pressure and available NPSH (NPSHA) is consistent with the original Pilgrim UFSAR. The thermal equilibrium method assumes that the drywell steam space is in equilibrium with the suppression pool vapor pressure, such that these two terms cancel in the equation for NPSHA. The drywell airspace is assumed to pressurize as an ideal gas at the same temperature as the suppression pool. The minimum containment pressure analysis uses the same methodology reviewed and approved in Pilgrim Amendment 173. The licensee stated that the specific input changes from the analysis submitted for Amendment 173 include a new suppression pool temperature profile using a two-sigma adder and a higher runout flow rate of 4950 gpm for the core spray pump.

The containment heatup analysis that produced the suppression pool temperature profile was performed using General Electric (GE) SHEX computer code. SHEX has not been reviewed and approved by the NRC staff but has been approved for use by GE for containment temperature and pressure calculations for BWRs on the basis of comparison with pressure and temperature calculations performed by other computer codes. Pilgrim Amendment 173

discusses the assumptions and conservatism used in the Pilgrim SHEX containment analysis. The staff concluded, in Amendment 173, that the containment pressure analysis had been conducted using assumptions that were conservative for the particular purpose and that the methodology used by the licensee, which incorporated the SHEX computer code, maintains an adequate degree of conservatism relative to the original licensing basis methodology. Therefore, based on the use of assumptions which conservatively minimize the containment pressure, the staff finds the licensee's calculation of containment pressure to be acceptable for NPSH calculations.

3.2 NPSH Analyses

Entergy provided the relationship which was used to calculate the pressure required to provide adequate NPSH. This assumes that the NPSHA is equal to the required NPSH (NPSHR) for the specific ECCS pump being analyzed.

$$P_c req'd = P_{vp} + (NPSHR - H_z + H_{sl} + H_{debris}) \frac{\rho}{\left(144 \frac{inches^2}{feet^2}\right)}$$

where

P_cReq'd Containment pressure required for adequate NPSH, psia

P_{vp} Vapor pressure at suppression pool temperature, psia

NPSHR Net positive suction head required, feet

H_z Elevation head, feet

H_{sl} Suction line losses, feet

H_{debris} Head loss due to debris, feet

ρ Density of water, lb/ft^3

Entergy installed new large-capacity ECCS strainers to meet the requested actions under NRC Bulletin 96-03 (Reference 3). For the proposed licensing basis, the strainer head loss associated with the new strainers is included in the revised NPSH calculations. This additional head loss is represented by H_{debris} which is added to the H_{sl} term in the equation above. According to Entergy, additional credit for containment overpressure to maintain adequate NPSH is required due to their resolution of Bulletin 96-03.

3.2.1 ECCS Strainer Head Loss Calculations

Entergy has installed two stacked disk strainers at Pilgrim, one for each train of ECCS. Each train consists of two LPCI and one CS pump drawing suction from a common strainer. The

strainers are mounted in the bottom of the torus pool and are attached to the ring girders. The worst case single failure relative to debris clogging of the strainers would be to lose one train of ECCS during a large break LOCA, such that all debris would accumulate on one strainer.

Entergy performed an analysis to estimate the worst case debris loading on the strainer surface using the “Utility Resolution Guide for ECCS Suction Strainer Blockage” (Reference 4). The Utility Resolution Guide (URG) was approved by the staff in a safety evaluation report (SER) dated August 20, 1998 (Reference 5). Entergy performed their analysis by estimating the amount of debris generated for breaks at each piping weld on high energy pipes greater than 12 inches in diameter in the drywell. They included breaks inside the bioshield wall which would create two different debris types, reflective metal insulation (RMI) and fibrous insulation debris. By analyzing breaks in this way, Entergy stated that each pipe would be analyzed at several different locations giving confidence that the breaks meeting the criteria stated above would be captured in the analysis.

Entergy used URG Method 3 for determining the size and shape of the break zone of influence (ZOI), and the amount of insulation located in the ZOI. However, Entergy conservatively assumed that all breaks resulted in a double jet (steam flow from both ends of the broken pipe), and that all breaks except one are unrestrained with full separation. These assumptions maximize the amount of debris calculated for each break.

For breaks located outside the bioshield wall, Entergy used the NRC-approved URG combined destruction/transport factors. These factors are used to calculate the fraction of insulation in the ZOI that would become debris that is transported to the suppression pool. Entergy used a computer program called PIPES 2.0 to calculate the ZOI and debris generation analysis. The PIPES 2.0 program performs these calculations for each assumed break using an Autocad model of the plant and piping systems. However, the Autocad model does not include small bore piping. As a result, Entergy conservatively assumed that all small bore piping insulation was in the ZOI for all analyzed breaks, and factored the small bore piping debris quantities into the calculations. Combined destruction/transport fractions were applied as appropriate depending on whether the small bore piping was above or below the lowest grating in the drywell.

Entergy conservatively estimated the quantities of corrosion product (sludge) in the suppression pool based on actual quantities removed from the Pilgrim suppression pool during cleaning. On the basis of their actual sludge quantities removed during cleaning, Entergy estimated the Pilgrim sludge generation rate to be approximately 115 pounds (lbs) per year. For their analysis, Entergy assumed a suppression pool cleaning interval of two operating cycles (4 years) and utilized a sludge value of 500 lbs. The additional amount of sludge (approximately 40 lbs) assumed in the analysis provides an 8.7% margin, and was assumed to allow for potential uncertainties, such as incomplete removal of sludge during future suppression pool cleanings or increases in the sludge generation rate as the plant ages.

For miscellaneous debris in the suppression pool (e.g., dirt/dust, coatings, etc.) Entergy utilized generic NRC-approved values provided in the URG. The values assumed are shown in Table 2.

Table 2
Miscellaneous Debris Values Used in Pilgrim Analysis

Debris Type	Assumed Debris Quantity in the Suppression Pool
Dirt/Dust	150 lbs
Rust Flakes	50 lbs
Qualified Inorganic Zinc Top Coated with Epoxy	85 lbs
Unqualified Inorganic Zinc Top Coated with Epoxy	85 lbs[1]

Other key assumptions used in their analysis include the following:

1. All debris will accumulate on the strainer within the first 2 hours

2. No throttling of pump flows is assumed to ensure worst case head loss. In addition, both LPCI pumps are assumed running for 2 hours. Operators would probably secure one of the pumps sooner than this, but this is considered a bounding time that would conservatively maximize debris accumulation and head loss.

3. Fibrous insulation values for piping outside the bioshield were increased by 3% to account for valve body insulation.

4. For breaks outside the bioshield wall, shielding of insulation by structures, such as the bioshield wall, was not considered in the analysis. This conservatively maximized the amount of debris calculated from each break.

5. For breaks inside the bioshield wall, a 0.1 combined destruction/transport factor for fibrous insulation was assumed. This factor was assumed based on qualitative judgement regarding the torturous path that debris must follow to get from inside the shield wall to the suppression pool.

The staff reviewed Entergy's analysis of strainer debris loadings and estimated head loss caused by debris to determine if the methodology used was consistent with the approved URG. The staff also independently ran head loss calculations to confirm the values determined in the Entergy analysis. The staff determined that the selection of break locations used by Entergy is consistent with the approved URG guidance. Similarly, the staff concluded that Entergy appropriately determined the size and shape of the break ZOI, and the amount of insulation located in the ZOI consistent with Method 3 of the URG. To determine the amount of debris that would be transported from the drywell (outside the bioshield wall) to the wetwell, the staff determined that Entegy used appropriate URG values for combined destruction/transport fractions. These methodologies were approved in the URG SER and are, therefore, acceptable approaches to use.

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[1] . . . . . .

However, to estimate the amount of debris that would be created and transported from inside the bioshield wall to the wetwell, Entergy assumed a combined destruction/transport fraction of 0.1 for both fiber and RMI. This assumption was based on engineering judgement. The URG does not provide specific guidance on analyzing breaks within the bioshield wall and therefore should be considered on a plant-specific basis. To test the sensitivity of the calculation to this assumption, the staff estimated the amount of debris that would be transported to the suppression pool if 0.28[2] had been used for the destruction/transport fraction. For RMI, the assumed value of 0.1 did not factor into the final analysis because Entergy chose to use the saturation value of RMI for the strainer in determining the head loss. This would produce the largest expected head loss from RMI debris. The staff independently calculated head loss from a combined RMI/fiber debris bed. Our analysis shows that even with a 0.28 destruction/transport fraction and the saturation value of RMI, the breaks inside the bioshield would still be bounded by the limiting break located outside the bioshield wall. Therefore, Entergy's analysis of breaks within the bioshield wall is bounded by the limiting break outside the bioshield wall.

Entergy assumed that essentially all debris will accumulate on the strainer 2 hours into the accident. This assumption is reasonable because the suppression pool volume will have been turned over approximately three times by then.

Finally, the staff independently ran an analysis of the strainer head loss over time and compared our head loss estimates with the NPSH margin curve (including the requested credit for containment overpressure) provided in Entergy's submittal. The staff's calculations were consistent with those provided by the licensee. Therefore, the staff concludes that Entergy's analysis of head loss across the ECCS strainers is appropriate and acceptable.

3.2.2 NPSH Calculations

For analysis purposes, the licensee assumed that two RHR pumps are at runout flow of 5600 gpm each, and one CS pump is at runout flow of 4950 gpm following the DBA-LOCA. According to the licensee, the greatest debris generated head loss occurs when two RHR and one core spray pump are operating on one suction strainer. At 2 hours following the DBA-LOCA, operators transition to one LPCI pump in heat rejection mode to maximize the heat removal function of the RHR system. No operator actions are made to reduce the flow of the remaining RHR and CS pumps. These operator actions are consistent with Pilgrim's UFSAR description of the DBA-LOCA analysis.

The Entergy calculations state that the maximum suppression pool temperature of 182.3 degrees Fahrenheit occurs at approximately 5.4 hours following the DBA-LOCA. The licensee's calculations demonstrate that, at the flows described above, and a suppression pool

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temperature up to 182.3 degrees Fahrenheit, containment overpressure of 3.6 psig is required for the CS pump. Based on the licensee's calculations, containment overpressure of 2.9 psig is required for the RHR pumps at the maximum suppression pool temperature. However, the licensee's NPSH calculations also demonstrate that the maximum suppression pool temperature is not the limiting factor with regard to the containment overpressure requirements. The limiting factor for containment overpressure requirements is the LOCA-generated debris head loss assumptions.

According to the licensee, and as confirmed by staff confirmatory calculations, the assumption of three ECCS pumps (i.e., two RHR and one CS pump) operating for 2 hours on a common suction strainer provides the maximum debris accumulation and head loss on the strainer. This maximum head loss due to debris is approximately 9.9 feet right before the operators are assumed to transition to one LPCI pump in heat rejection mode. At this point, the calculated suppression pool temperature is 176.8 degrees Fahrenheit. At this suppression pool temperature and 9.9 feet of LOCA generated debris head loss, containment overpressure of 4.7 psig and 3.9 psig are required for the CS and RHR pumps, respectively. When the transition to one LPCI pump is complete, the head loss drops to approximately 5.4 feet due to the decrease in total flow through the common strainer. The calculated containment overpressure required at the reduced total flow and 176.8 degrees Fahrenheit suppression pool temperature is 2.7 psig, and 2.0 psig for the CS and RHR pumps, respectively. These containment overpressure requirements then increase with increased suppression pool temperature.

The staff also performed confirmatory calculations of the CS and RHR NPSH analyses. Our calculations resulted in similar conclusions as those by the licensee. Figure 1 of the licensee's submittal illustrates the minimum containment pressure available, the containment overpressure requested in this license amendment, and the containment overpressure required to ensure adequate NPSH for the core spray pumps. Entergy will incorporate Figure 1 into the Pilgrim UFSAR to depict the use of containment overpressure for the long term following the LOCA. The tabular data provided in ENGC Calculation M-734, Revision 2, and ENGC Calculation M-662, Revision 4 (References 6 and 7), was used to generate Figure 1. These calculations provide the time-dependent containment overpressure required for the RHR and the CS pumps, along with the suppression pool temperature and minimum containment pressure.

The licensee stated that the UFSAR limits, depicted in Figure 2 of the submittal, are not intended to include the additional 2 feet of NPSH margin allocated to uncertainty and pump inservice testing (IST) as described in Calculation M-662 and Pilgrim Amendment 173. Calculation M-662 assumes that the maximum pump suction pressure drop, as measured at the IST testing conditions, is based on the total suction head losses plus an additional fixed head loss of 2 feet at the accident conditions for wetwell temperature, pressure, and pump flow rate. The 2-foot head loss allocated to IST represents additional margin provided to account for uncertainty. The licensee considers it sufficient to demonstrate that this unused margin exists during the period of time that containment overpressure is credited. The staff's calculations demonstrated that the minimum margin between the minimum containment pressure available and the containment overpressure required for the CS pump is 1.75 psi or approximately 4 feet. Therefore, the staff concludes that the unused margin allocated for IST does exist during the period of time that containment overpressure is credited.

The staff has reviewed the containment analysis and has found that the requested containment overpressure will be available during the long-term following the DBA-LOCA. Based on these analyses, the staff finds the use of the containment overpressure as previously described is acceptable for the long term mitigation of the DBA-LOCA.

The staff has reviewed the licensee's minimum containment pressure, ECCS strainer head loss calculation, and NPSH analyses for the RHR and CS pumps. The staff finds that the use of the requested containment overpressure, as stated in Table 1, to ensure adequate NPSH for the RHR and CS pumps during the long term following a DBA-LOCA is acceptable. The maximum amount of containment overpressure required during the long term is approximately 4.7 psig for core spray and 3.9 psig for RHR. The time period of the containment overpressure credit for the long term is from 1200 seconds to 48 hours following the DBA-LOCA. Based on these analyses, the staff concludes that there is reasonable assurance that plant operation in this manner poses no undue risk to the public health and safety.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Massachusetts State Official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment (which reflects an increase in the amount of containment overpressure needed to ensure sufficient NPSH for the ECCS pumps following a LOCA in the UFSAR) changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (65 FR 12290). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

7.0 REFERENCES

1. Bellamy, M., Entergy Nuclear Generation Company, to USNRC, “Request for License Change Concerning ECCS NPSH and Bulletin 96-03 Submittal,” November 22, 1999.

2. Wang, A. B., USNRC, to E. T. Boulette, Boston Edison Company, “Issuance of Amendment No. 173 to Facility Operating License No. DPR-35, Pilgrim Nuclear Power Station (TAC No. M97789),” July 3, 1997.

3. U.S. Nuclear Regulatory Commission Bulletin 96-03, “Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors,” May 6, 1996.

4. General Electric Topical Report, “Utility Resolution Guide for ECCS Suction Strainer Blockage,” NEDO-32686-A, October 1998.

5. Essig, T. H., USNRC, to R. Sgarro, Pennsylvania Power and Light, “Safety Evaluation For NEDO-326896, Rev. 0, “Utility Resolution Guidance Document For ECCS Suction Strainer Blockage,” August 20, 1998.

6. ENGC Calculation M-734, Revision 2, “RHR and Core Spray Pump Suction Strainer Debris Head Loss NPSH Evaluation,” Septemper 30, 1999.

7. ENGC Calculation M-662, Revision 4, “RHR and Core Spray Pump NPSH and Suction Pressure Drop,” September 30, 1999.

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