U.S. NUCLEAR REGULATORY COMMISSION
REGION I

REPORT/DOCKET NO.	50-293/94-01
LICENSE NO.	DPR-35
LICENSEE:	Boston Edison Company
FACILITY NAME:	Pilgrim Nuclear Power Station
INSPECTION AT:	Plymouth, Massachusetts
INSPECTION DATES:	January 19 - 25, 1994

INSPECTOR _____ 2-21-94
Alfred Lohmeier, Sr. Reactor Engineer — Date
Materials Section, EB, DRS

APPROVED BY: _____ 2/24/94
Michael C. Modes, Chief — Date
Materials Section, EB, DRS

Areas Inspected: Evaluation of engineering and technical support effectiveness in primary component transient operation monitoring including comparison of actual transient cycles with the numbers of cycles for which the components were designed to determine whether the fatigue life of components will be expended within the 40 year life of the operating license.

Results: A transient and operating cycle monitoring procedure consistent with Technical Specification Section 6.10.B.7 is being implemented to provide assurance that the primary system components and piping remain within the updated final safety analysis report design bases. Pilgrim Nuclear Power Station (PNPS) is comprehensively evaluating the transient cyclic operation of the plant to date and finds that the numbers of several operating transients exceed those for which components were designed. A comprehensive program is being implemented by PNPS engineering to re-evaluate the assumptions used in determining the fatigue life usage of the components. Results of this re-evaluation will be addressed in the resolution of unresolved item 50-293 URI 94-01-01. PNPS has a comprehensive set of procedures for monitoring plant performance. A quality assurance program is in effect which audits and provides surveillance of procedural implementation and adherence to technical specification requirements.

DETAILS

1.0 SCOPE OF INSPECTION (Inspection Procedure 37700)

The scope of this inspection includes evaluation of engineering and technical support effectiveness in primary component transient operation monitoring including comparison of actual transient cycles with the numbers of cycles for which the components were designed to determine whether the fatigue life of components will be expended within the 40 year life of the operating license.

2.0 FINDINGS

2.1 Transient Operating Cycle Monitoring

2.1.1 Background

The primary system components are designed to meet the requirements of Section III of the ASME Boiler and Pressure Vessel Code for Nuclear Vessels. The Code requires a design by analysis approach to evaluate whether the components can sustain the prescribed steady state pressure and thermal loadings and the cyclic application of these loadings.

The utility (owner of the components) specifies the types and numbers of application of loadings which are anticipated during the plant lifetime. Components are designed in accordance with these specifications. Therefore, in the case of cyclic loading, the specification will state the numbers and types of transient operation that can be anticipated throughout the plant life. These transients are described in the Updated Final Safety Analysis Report (UFSAR) for the nuclear power plant. Operation beyond the specified numbers of cycles is outside the design bases described in the UFSAR.

Since primary system components are designed to sustain limited numbers of transients, the plant technical specifications (TS) reflect the requirement that records and documents relating to the cyclic operation of the plant must be maintained throughout the plant lifetime. These data identify critical areas of the components subject to the operating transients for monitoring to determine whether the design fatigue life of the component has been expended.

The criteria for exhaustion of fatigue life are reflected in a cumulative usage factor (CUF), which is a summation of the ratio of expected numbers of cycles, at the applied strain range, to the cycles at that strain range necessary to cause fatigue failure. An appropriate factor of safety in terms of strain level or cycles, is utilized in the same manner as a factor of safety for stress level in relation to fracture stress.

2.1.2 Updated Final Safety Analysis Report and Technical Specification Requirements

The inspector reviewed the UFSAR for Plymouth Nuclear Power Station (PNPS) which specifies the number and types of reactor coolant system (RCS) transients for which each component and piping has been designed over the duration of its 40 year operating license.

The number and type of transients are listed in Figures C.3-1,2,3,4,5,6,7,and 8 of UFSAR Appendix C. These include general operating transients, and reactor nozzle thermal transients.

Review of the TS by the inspector indicated that Section 6.10.B.7 requires that records of transient or operational cycles for those facility components designed for a limited number of transients or cycles shall be retained for the lifetime of the facility license.

As a result of this review, the inspector found that PNPS is required to operate the RCS within the limits of the design basis expressed in the UFSAR and that the records of cyclic operation be retained for the life of the license. Operation of the primary system components and piping must be within these cyclic operating limitations.

2.1.3 **Retention of Operational Cycle Records**

The inspector examined the system used by PNPS to collect, retain, and disseminate operational data records. Operational records have been collected and retained by PNPS since the beginning of plant operation in control room log books. From these logs, histograms of operational power levels are constructed of power level changes during operation. At each disturbance of power level, notations are made of references to reports describing the cause of each change in power level. Details of reactor SCRAMS are described in a SCRAM Report and also in greater detail in Licensee Event Reports. Studies of the histograms are in process at PNPS to provide for data breakdowns of transient operation necessary in fatigue evaluation of components.

The inspector reviewed a compilation of actual transients experienced as compared with the cycles indicated in the GE Specifications for the reactor design. These records cover the operating transients since the beginning of operation. Included in the compiled transients are bolt-up, hydro, cold startup, hot standby startup, 50 percent power reduction, loss of feedwater heaters, loss of feedwater pump with main steam isolation valves (MSIVs) closed, TG trips with MSIV open, other scrams, full power recirculation startup, power reduction hot standby, hot standby to ambient, stuck open safety relief valve, hot flood up, unbolt head, and full cooldown. The inspector finds this to be a comprehensive effort which will facilitate future assessments of remaining and extended plant life.

The inspector found the transient and operating cycle monitoring procedure to be consistent with TS Section 6.10.B.7. It is also consistent with the recommendation of the primary system component vendor in General Electric Service Information Letter (GE SIL) No. 318 "BWR Reactor Vessel Cyclic Duty Monitoring" to monitor the duty cycles, cycle frequency rate and to extrapolate the duty cycles to a 40 year life. Monitoring of transient cycles provides assurance that the primary system components and piping remain within the UFSAR design bases by identifying those operating transients which approach or have exceeded the original design specification values.

2.1.4 Engineering Review of Operating Transients

The inspector reviewed a contractor's specification for structural analysis of the PNPS reactor vessel that provided the number of transients actually experienced by PNPS in 21 years of operation as compared to the design transient frequencies expected over 40 years life. Projecting the actual frequency of transient occurrence for 40 years operating life, a comparison was made with the design frequency. The results of this comparison were reviewed by the inspector. It was noted by the inspector (in the shaded blocks in the table below) that all transients, if continued at the same rate of application until the end of the licensed period, will exceed the number anticipated during design of the plant components. The inspector also noted that several transients have already exceeded the design number of transients for 40 year operation. These include startup, power increase, loss of feedwater pumps, and safety relief valve blowdown.

Transient Description	Design Cycles 40 years	Cycles to-date 21 years	Projected Cycles 40 years
Startup	120	187	368
Power Increase	120	133	264
T/G Trips	40	26	49
Other Scrams	147	134	346
Loss of FW Pumps	10	26	64
SR Valve Blowdown	2	13	23

PNPS, aware that the design cycles have been exceeded, has contracted for structural analysis of the reactor vessel such that fatigue life usage can be re-evaluated. The operating transients specified in the equipment specification, to which the components have been designed, are conservative in nature. In evaluating the significance of the high number of cycles achieved over the 21 years of operation, the inspector recognizes that a conservative definition of a transient cycle has been used such that, for example, scrams from any power level have been considered as occurring from full load. For other transients, such as startup, the resulting cumulative usage factor in many components due to increased numbers of cycle application may remain small. Nevertheless, it becomes necessary for PNPS to carefully evaluate the reactor pressure vessel structure to provide assurance that the cumulative usage

factors of the reactor components will not exceed 1.0 through the end of their operating lives. Toward this end, PNPS must provide for fatigue evaluation of those structural components already having exceeded the design number of cycles or projected to exceed the design cycles prior to the end of the operating license lifetime.

In cases where the projected cumulative usage factor is greater than 1.0 prior to the end of licensed lifetime, consideration must be given by PNPS to changes in transient frequency or severity, focused inspection of component regions, or replacement of component parts.

Resolution of the aforementioned uncertainties related to excessive transient cycles is important to protection of the health and safety of the public and will be considered an unresolved item 50-293 URI 94-01-01. The schedule for re-evaluation was reviewed by the inspector and the schedule stated that results would be forthcoming in a report to be issued the end of July, 1994.

2.1.5 **Fatigue Usage Factors of Primary System Components**

The inspector reviewed the original analytic report for the Pilgrim Reactor Vessel, Report No. CENC 1139, February 15, 1971. The cumulative usage factors for reactor vessel components resulting from design analysis are shown in the following table for components having significantly high cumulative usage factors:

Reactor Component	Design Usage Factor 40 year life
Bottom Head - Support Skirt	.309
Basin Seal Skirt	.859
Feedwater Nozzle	.372
Core Spray Nozzle	.437
CRD Hydr Return Nozzle	.613
Recirculation Inlet Nozzle	.970
Recirculation Outlet Nozzle	.751
Reactor Bolt Stress	.493
Shroud Support and Attachments	.374

From review of the PNPS UFSAR, the inspector noted that the cumulative usage factors reported in the UFSAR for critical regions of the reactor vessel were similar to that of the original fatigue evaluation, but excluded some components which were re-evaluated or replaced. Results of the fatigue analysis at critical parts of the reactor vessel for 40 year life shown in the UFSAR are as follows:

Reactor Component	Cumulative Usage Factor 40 years
Vessel Shell in Core Region	.301
Closure Studs	.786
Closure Flanges	.650
Bottom Head - Support Skirt Jct	.306
Shroud Support	.374
Feedwater Nozzle	.713
Recirc Inlet Nozzle Sleeve	.360
CRD Housing - Stub Tube Junct	.105

After review of the fatigue evaluation results reflected in the original reactor analytic report and those reflected in the UFSAR, the inspector found that, for the design transients predicted over the 40 year licensed lifetime, the level of cumulative usage factors at several critical regions of the reactor vessel warrants concern, in light of the fact that some of the applied numbers of transients have already exceeded the level for which the components have been designed. On the other hand, the definition of the operating transients has been shown to be conservative in defining transients of mild severity to be of the same severity as those of the severity implied in the design transient specifications. The resolution of whether the re-evaluated cumulative usage factors will be reduced sufficiently under less conservative assumptions of transient severity is a necessary justification to be made in addressing unresolved item 50-293 URI 94-01-01.

The inspector reviewed results of stress analysis and fatigue evaluations of PNPS recirculation loops A and B. The cumulative usage factors determined in both recirculation loops was below 0.1.

2.2 Quality Assurance

The inspector reviewed the Quality Assurance Department Audit Report No. 90-17, Administrative Controls, June/July 1990, to determine whether records retention requirements of the technical specification are being implemented. The audit report indicated that the retention of records consistent with section 6.10.B.7 is being implemented. The PNPS audit plan indicated surveillances to be performed of records retention for the life of the operating license in 1992 and 1994.

The inspector reviewed several monitoring and surveillance procedures and found them to indicate a comprehensive program is in place at PNPS, for monitoring plant performance. These include Procedure No. 1.3.38 - Plant Performance Monitoring Program, Procedure No. 2.1.15 - Daily Surveillance Log (Technical Specifications and Regulatory Agencies), Procedure No. 2.1.7 - Vessel Heatup and Cooldown, and Procedure No. 1.3.37 - Post-Trip Reviews.

Although there was no specific procedure in place for distribution and dissemination of cyclic monitoring data and trends, the inspector found that there is a comprehensive program in effect to collect and evaluate operating transient data by operations and engineering.

3.0 SUMMARY OF FINDINGS

- A transient and operating cycle monitoring procedure consistent with TS Section 6.10.B.7 is being implemented to provide assurance that the primary system components and piping remain within the UFSAR design bases.

- PNPS is comprehensively evaluating the transient cyclic operation of the plant to date and finds that the numbers of several operating transients exceed those for which components were designed. A comprehensive program is being implemented by PNPS engineering to re-evaluate the assumptions used in determining the fatigue life usage of the components. Results of this re-evaluation will be addressed in resolution of unresolved item 50-293 URI 94-01-01.

- PNPS has a comprehensive set of procedures for monitoring plant performance. A quality assurance program is in effect which audits and provides surveillance of procedural implementation and adherence to technical specification requirements.

4.0 MANAGEMENT MEETINGS

The inspector met with PNPS engineering and licensing personnel at the entrance meeting on January 19, 1994, and at the exit meeting on January 25, 1994, at the PNPS in Plymouth, Massachusetts. The names of personnel contacted during the inspection are shown on Attachment A. The findings of the inspection were discussed with management personnel at the January 25, 1994, exit meeting. The licensee did not disagree with the findings of the inspector.

ATTACHMENT A

The following persons were contacted at the entrance meeting on January 19, 1993, at the exit meeting on January 25, 1993, and during the course of the inspection:

Boston Edison Power Company

* G.J. Basilesco	Acting Manager, Compliance Division
* D.W. Ellis	Senior Compliance Engineer
R.V. Fairbank	Manager, RA & EPD
L.L. Schmeling	Manager, Plant Department
* W.R. Kline	Manager, Civil/Structural Division
E.S. Kraft, Jr.	Vice President Nuclear Operations/Station Director,
* P.L. Markson	Nuclear Information
H.V. Oheim	Manager, Nuclear Engineering Systems Division
* W.C. Rothert	Technical Director
* T.A. Sullivan	Manager, Operations Section
* T.A. Venkataraman	Manager, Service Division
* M.E. Williams	Senior Quality Assurance Engineer

U.S. Nuclear Regulatory Commission

* D. Kern	Resident Inspector
* J. MacDonald	Senior Resident Inspector

An asterisk (*) indicates attendance at the exit meeting.