U.S. NUCLEAR REGULATORY COMMISSION
REGION I

DOCKET/REPORT NO.	50-289/94-03
LICENSE NO.	DPR-50
LICENSEE:	General Public Utilities Nuclear Corporation
FACILITY NAME:	Three Mile Island Nuclear Power Station, Unit No. 1
INSPECTION AT:	Middletown, Pennsylvania
INSPECTION DATES:	February 7 - 11, 1994

INSPECTOR: Herbert Kaplan for — 3/3/94
Alfred Lohmeier, Sr. Reactor Engineer — Date
Materials Section, EB, DRS

APPROVED BY: Michael C. Modes — 3/2/94
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, monitored status of the resolution of unresolved item 50-289 URI 93-016-001, ISI surveillance.

Results: A transient and operating cycle monitoring procedure consistent with TS Section 6.10.2 (f) is being implemented to provide assurance that the primary system components and piping remain within the UFSAR design bases. TMI-1 is evaluating the transient cyclic operation of the plant to date and finds that the cumulative usage factors of the primary RCS components are within acceptable limits. Review of ISI surveillance will be complete after reorganization of the assessment group is complete in September 1994.

DETAILS

1.0 SCOPE OF INSPECTION

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. The inspection scope also includes review of the status of unresolved item 50-293 URI 93-016-001.

2.0 FINDINGS

2.1 Transient Operating Cycle Monitoring (IP 37700)

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 evaluating whether components can sustain the prescribed steady state pressure, thermal loadings, and cyclic application of these loads.

The 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. In the case of cyclic loading, the specification will state the number and types of transient operation that should be anticipated during 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.

Because primary system components are designed to sustain a limited number of transients, the plant technical specifications (TS) requires that records and documents relating to the cyclic operation of the plant be maintained throughout the plant lifetime. This data identifies critical areas of the components subject to the operating transients for monitoring to determine whether the design fatigue life of the component has been exceeded.

The criteria for exhaustion of fatigue life is reflected in a cumulative usage factor (CUF), which is an 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 sense 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 Three Mile Island Unit 1 (TMI-1) which specifies the number and types of reactor coolant system (RCS) transients for which each component and piping has been designed. The number and type of transients are listed in Table 4.1-1 of the UFSAR. These include the following design transient cycles: heatup and cooldown, plant loading and unloading, step loading increase and decrease of 10 percent full power, step load reduction from full power to auxiliary load or turbine trip, reactor trip from full power, rapid depressurization, rod withdrawal accidents, drop of one control rod, and hydrotests at 3125 psi. In addition, the steam generator is also designed to withstand cyclic loads from loss of feedwater flow and loss of station power.

Review of the TS by the inspector indicated that Section 6.10.2(f) requires records of transient or operational cycles for components which affect nuclear safety for a limited number of transients or cycles, as defined in the final safety analysis report, shall be retained for the duration of the operating license.

As a result of this review, the inspector found that TMI-1 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 TMI-1 to collect, retain, and disseminate operational data records. Operational records have been retained by TMI-1 since the beginning of plant operation in control room log books. For the most part, the transients to be logged are obtained from the functional specifications of the components. Other transients considered significant are also monitored. An engineer, stationed in the control room has responsibility for recording the observed operational transients into a log book. In the log book, a log sheet is maintained for each transient. The inspector examined a data collection matrix for transients in the transient cycle logbook and found it to be a comprehensive compilation of measurements taken during the transients, including temperatures, pressures, flow, and fluid levels in the components during the transient. The operations surveillance procedure requires yearly review of the log book, at which time the numbers of cycles for each transient are counted and compared with the design cycles for that transient. The inspector found the transient and operating cycle monitoring procedure to be consistent with TS Section 6.10.2 (f).

2.1.4 **Engineering Review of Operating Transients**

The inspector reviewed a summary of the 1993 monitored transients. This summary represented ten effective full power years (EFPY) of operation. In the following table, these cycles are compared to the design cycles predicted for ten EFPY and the number of cycles predicted at the end of 40 years (32 EFPY); if they continued to occur at the same frequency as they did during the first ten EFPY:

Event	Design Cycles to 1993	Design Cycles 40 year life	Percent of Design Cycles Used after 10 EFPY	Percent of Design Cycles Used after 40 years (32 EFPY)
Reactor Trip	35	308	11%	36%
RCS Heatup	40	240	17%	53%
RCS Cooldown	39	240	16%	52%
OTSG Hydrotest	2	25	8%	26%
MFW Nozzle	3	80	4%	12%
EFW Nozzle	4	40	10%	2%
Core Flood Nozzle	21	240	9%	28%

The inspector concluded from this table that the number of transients experienced for operation to-date is only a fraction of that predicted. The number of transients predicted to occur over the 40 year plant lifetime is significantly below the limit for which the reactor cooling system was designed.

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

The inspector reviewed results of the component vendor analytic computations of 40 year life cumulative usage factors (CUFs) for components having CUFs greater than 0.22. These are shown in the following tables:

Reactor Vessel and Closure Head

Component	CUF
RV Closure Studs	.726
RV Inlet Nozzles	< .672
RV Outlet Nozzles	.672
Core Flood Nozzle Venturi Sleeve Weld	.280
Venturi Sleeve Slotted Cylinder	.802
Reactor Instrumentation Tube Nozzle Weld	.570

Pressurizer

Component	CUF
Pressurizer Surge Nozzle Safe End	.325
Surge Nozzle/Pressure Head Juncture	.316
Pressurizer Internal Spray Piping	.330
Heater Tube to Sleeve Weld	.560
Heater Diaphragm	.410
Heater Bundle Closure Studs	.300

Reactor Coolant Piping

Component	CUF
Hot Leg Surge Nozzle Corner	.410
Hot Leg Surge Nozzle Taper	.620
Surge Line Elbow "B"	.400
Surge Line Elbow "C"	.290
Surge Line Elbow "D"	.330
1 inch Surge Line Drain Nozzle	.250
Makeup and HPI Nozzles	1.000
Spray Line - Main/Bypass Reducing Tee	.400
Spray Line - Main/Auxiliary Reducing Tee	.240
1 inch Hot Leg Vent Nozzles	.452

Reactor Coolant Pumps

Component	CUF
RC Pump Main Flange Bolts	.435
RC Pump Impeller Cover Plate Weld	.338
RC Pump Diffuser Bolts	.308

The inspector reviewed the calculations of design lifetime CUFs and found them to be within the design limit of 1.0 reflected in the ASME Boiler and Pressure Vessel Code for Nuclear Vessels - Section III.

In the case of the reactor coolant piping makeup and high pressure core injection (HPCI) nozzles, the inspector noted the CUF, shown shaded in the foregoing table, was calculated to equal the limiting value of 1.0 after 40 years operation. The inspector reviewed a fatigue evaluation study which found that the CUF was a function of two transients: HPCI test and HPCI initiations. In order to keep the CUF below 1.0, the RCS vendor developed a relationship providing a choice between these two transients as an operating guideline.

The inspector reviewed a supplemental fatigue evaluation analysis of the auxiliary feedwater (AFW) nozzle thermal sleeve and found the thermal sleeve to be capable of withstanding AFW injection events and vibration loads.

In another supplemental analysis reviewed by the inspector, it was noted that parts of the main feedwater (MFW) nozzle closure CUFs exceeded 1.0 when revised operating procedures resulted in a partially filled nozzle, thereby causing increases in thermal stress not previously considered in the design stress analysis. It was determined that the CUF was largely a function of hot standby and power loading/unloading. The analysis showed that reducing the number of cycles of these two transients would keep the CUFs below the limiting 1.0.

From review of the fatigue evaluations conducted for TMI-1, the inspector concluded that TMI-1 comprehensively demonstrated that the CUFs for 40 years operation were within the limiting value of 1.0 for most RCS components. Where operating changes warranted reanalysis, and it was found that some component parts had CUFs exceeding 1.0, changes in operation provided for amelioration of the transient severity or frequency such that the CUF could be reduced to below the limiting value. TMI-1 demonstrated it had available the means to perform comprehensive analyses to evaluate extraordinary transients beyond those in the original functional design basis and provide for appropriate corrective actions.

2.2 Open Item Review (IP 73753)

The inspector reviewed unresolved item 50-289 URI 93-016-01, related to absence of a surveillance program for inservice inspection (ISI). TMI-1 stated that there was little progress to report on resolution of this URI. The delay is due to a reorganization of the assessment group which will be completed in April 1994. The URI resolution is expected to be completed by September 30, 1994.

3.0 SUMMARY OF FINDINGS

- A transient and operating cycle monitoring procedure consistent with TS Section 6.10.2 (f) is being implemented to provide assurance that the primary system components and piping remain within the UFSAR design bases.

- TMI-1 comprehensively evaluated the transient cyclic operation of the plant to date and finds that the cumulative usage factors of the primary RCS components are within acceptable limits.

- TMI-1 demonstrated it has available the means to perform comprehensive analyses to evaluate extraordinary transients beyond those in the original functional design basis and provide for appropriate corrective actions.

- There was little progress to report on resolution of unresolved item 50-289 URI 93-016-01, related to absence of a surveillance program for inservice inspection (ISI). The delay is due to a reorganization of the assessment group which will be completed in April 1994. The URI resolution is expected to be completed by September 30, 1994.

4.0 MANAGEMENT MEETINGS

The inspector met with TMI-1 engineering and licensing personnel at the entrance meeting on February 7, 1994, and at the exit meeting on February 11, 1994, at TMI-1 in Middletown, Pennsylvania. 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 February 11, 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 February 7, 1993, at the exit meeting on February 11, 1993, and during the course of the inspection:

General Public Utilities

*	J. Abramovici	Manager, Mechanical Components
	T. Basso	Acting Manager, Plant Engineering
*	H. C. Crawford	Manager, Plant Analysis
*	M. Fitzwater	Engineer, Plant Engineering
*	M. R. Knight	TMI Licensing
	D. Ruhl	TMI STA
	N. Shah	Engineer, E&D
	G. R. Steillman	Director, Site Technical Functions
	S. Williams	Nuclear Safety Compliance

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	M. Evans	Senior Resident Inspector

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