U.S. NUCLEAR REGULATORY COMMISSION
REGION I

REPORT/DOCKET NO. 50-410/93-04

LICENSE NO. NPF-69

LICENSEE: Niagara Mohawk Power Company

FACILITY NAME: Nine Mile Point Station Unit No. 2

INSPECTION AT: Lycoming, NY, and Salina Meadows, NY

INSPECTION DATES: March 22-26, 1993

INSPECTOR: [signature] 4-14-93
A. Lohmeier, Sr. Reactor Engineer Date
Materials Section, EB, DRS

APPROVED BY: [signature] 4/15/93
E. Harold Gray, Chief, Materials Section Date
Engineering Branch, DRS

Areas Inspected: Engineering and technical support effectiveness in monitoring transient operation of components and piping and evaluating the effect of transient operation on the remaining life of these components and piping.

Results: Engineering and technical support staff effectively monitored transient operation of components and piping and evaluated the effect of transient operation on the remaining life of these components and piping. Engineering staff has identified the fact that the number of start up and shutdown cycles to date has been at a rate greater than that anticipated for the design of the components and piping under fatigue loading. An action plan is under consideration to ameliorate the potential problem of primary components and piping operating beyond the design basis for fatigue strength before the 40-year anticipated plant lifetime.

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. Also included is a review of computed lifetime usage factors for primary components and piping.

2.0 FINDINGS - TRANSIENT OPERATING CYCLE MONITORING

2.1 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 not only whether the components can sustain the prescribed steady state pressure and thermal loadings, but also the cyclic application of these loadings in view of the fatigue strength of the component materials.

The utility (owner of the components) specifies the types and circumstances of loadings that 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 through the plant lifetime. These data identify critical areas of the components subject to the operating transients for monitoring to determine whether the design life of the component has been expended.

The criteria for exhaustion of fatigue life are reflected in a cumulative usage factor (CUF), which is an integrated 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.

2.2 Updated Final Safety Analysis Report and Technical Specification Requirements

The inspector reviewed the UFSAR for Nine Mile Point Unit 2 (NMPU2) that 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 Section 3.9 of the UFSAR in Table 3.9A-1 (Transients and the Number of Associated Cycles Considered in the Design and Fatigue Analyses of Class 1 Piping) and Section 3.9.1.1B (Design Transients for GE Components). The General Electric (GE) components, for which number and types of transients are given, include control rod drive, control rod drive and incore housing, hydraulic control unit, core support and reactor internals, main steam system, recirculation system, reactor assembly (reactor pressure vessel, support skirt, shroud support, and shroud plate), main steam isolation valve, safety/ relief valve, recirculation flow control valve, recirculation pump, and recirculation gate valve.

Review of the TS by the inspector indicated that Section 6.10.1.2(e) requires that records of transient or operational cycles for those unit components identified in Table 5.7.1-1 be maintained. Table 5.7.1-1 provides for 120 heatup and cooldown cycles, 80 step change cycles (from loss of feedwater heaters), 198 reactor trip cycles, and 130 hydrostatic pressure and leak tests.

As a result of this review, the inspector found that the licensee 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 transient limitations.

2.3 Retention of Operational Cycle Records

The inspector examined the system used by the licensee to collect, retain, and disseminate operational data records. It was found that the licensee had established a comprehensive system for the collection, retention and dissemination of operational records. The responsibilities and controls for the collection, processing, storage and retrieval of quality assurance records are described in Reactor Engineering Procedure N2-REP-07, Revision 00, Plant Event Log, 8/28/91. The purpose of the procedure is to maintain a log of events which significantly contribute to stress cycles on the reactor vessel and major piping systems described in Section 3.9 of the NMPU2 UFSAR.

The inspector found that procedure N2-REP-07 provides for a list of 14 transient operating events together with the applied number of cycles derived from the UFSAR. The recording, review and disposition is the responsibility of Reactor Engineering. At the beginning of each calendar year, a copy of the previous year's Plant Event Log is forwarded to the Fuels Engineering Department. During the week proceeding the inspection, on March 16, 1993, the licensee provided for a change in procedure which forwarded the Plant Event Log to the Supervisor of Fuels Engineering and the Supervisor of Structural Design. It has been determined that the review responsibility should also be given to the structural engineering department, such that they remain aware of the cyclic operation history of the primary components and piping. Evaluations can be made, as necessary, when the component's cyclic operational history approaches the numbers of cycles for which the components were designed.

The inspector found the transient and operating cycle monitoring procedure to be consistent with TS Section 6.10.1.2(e). It is also consistent with the recommendation of the primary system component vendor in General Electric Service Information Letter (GE SIL) No. 318, December 1979, "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.

2.4 Engineering Review of Transients

The inspector compared the numbers of cycles of the actually experienced transients with the number of cycles used in the design of components and piping for 40 years operation. The results of this review are shown in Table 2.4 of this report.

The present operational life (6.4 years) is approximately 16% of the plant design life (40 years). Shaded transients in Table 2.4 are those transients that have occurred more frequently than the design numbers of transients acting uniformly over the 40-year life. If these transients continue to occur at the same rate, the number of transients for which the components have been designed will be exceeded prior to 40 years. In these cases, the licensee must review the cumulative usage factor of the component elements affected by these transients to determine whether the cumulative usage factor will exceed 1.0.

Recognition of the fact that the rate of startup/shutdown transients experienced by the plant were more frequent than that estimated for the 40-year design life of the plant was documented in a Deviation/Event Report (DER) No. 2-92-4190, "Potential to Exceed UFSAR Design Limits," on December 15, 1992. A discussion of the issue was developed by structural engineering within the DER that provided for a recommended disposition of the issue.

The DER recognized the high rate of startup/shut down cycle usage and predicted that the design cycles would be expended within seven years from the date of the DER. The DER also recognized that this issue is one that was discussed in GE SIL-318. The GE study indicated, at that time, that the 21 GE plants studied used an average of 97% of the design cycles in 12 years of operation. It was also determined by the licensee from GE that the reevaluation of the NMPU2 Class 1 piping and components would require a major expenditure of resources.

NMPU2 engineering suggested a plan of action in resolution of the excessive startup cycle issue. The plan includes revising thermal transient histograms and using them to revise class 1 snubber calculations. Prior to using 65% of the 119 startup cycles, the licensee will begin revising class 1 equipment calculations, completing the revised studies before 75% of the design cycles have been expended. This effort would start in January 1995.

The inspector found that the licensee had comprehensively evaluated the transient cyclic operation of the plant to date. The licensee had recognized an issue in plant operation relating to startup and shutdown cycle frequency, provided for an engineering evaluation of the issue, and made appropriate recommendations to management toward resolution of the issue.

Table 2.4 Comparison of Actual Cycles to Date with 40-Year Design Cycles

No.	Event	Design Cycles 40 years	Actual Cycles To Date	Ratio of Actual Cycles to Design Cycles
1	Boltup	123	5	4.0%
2	Unbolt	123	4	3.3%
3	Hydrotest	130	12	9.2%
4	Reactor Startup	120	61	50.8%
5	Reactor Shutdown	111	60	54.1%
6	C/R Sequence Change	400	7	1.8%
7a	Power Change < 25%	10,000	44	0.4%
7b	Power Change > 50%	2,000	16	0.8%
7c	Power Change >75%	2,000	13	0.7%
8	Loss Feedwater Heating	80	4	5.0%
9	Scram	190	50	26.3%
10	Seismic	10	0	0.0%
11	SR Valve Discharge	5,200	11	0.2%
12	CCS/RCIC Injection	N/A	21	N/A
13	Emergency Events	1	0	0.0%
14	Faulted Events	1	0	0.0%

2.5 Component and Piping Stress Report Review

The inspector reviewed the primary component supplier document GE:NEDC - 32015 (NMPC:STRS 16.010-5058/00) that provided the fatigue analysis results for primary component elements for a 6% power upgrade analysis. The results of cumulative usage factor analyses at a 6% increased operating power level area have little effect on the CUF values reported in the UFSAR. The values of CUF reported in this document are as follows:

Component Element	**40-Year Design CUF**
Steam Outlet Nozzle	**.540**
Feedwater Nozzle	
Thermal Sleeve Primary Seal	**.981**
Carbon Steel Section	**.954**
Feedwater Nozzle (at safe end)	**.950**
Reactor Vessel Support Equipment	
Orificed Fuel Supports	.047
Reactor Vessel and Shroud Support Assembly	
Support Skirt	.248
Shroud Support (at knuckle - Inconel)	.047
Shroud Support (alloy steel section)	.050
CRD Penetration (at stub tube)	**.645**
Reactor Vessel Internals and Associated Equipment	
Top Guide (Beam with highest stress)	.170
Core Plate (ligament in top plate at studs)	**.930**
Differential Pressure and Liquid Control Lines	.020
Head Cooling Spray Nozzle	**.910**
Suction Valves	
Body and Bonnet	.002
Recirculation Flow Control Valve	.000
Recirculation Piping and Pipe Mounted Equipment	.270
Main Steam Line Isolation Valves	.005

The inspector noted that some of the component elements (those shown in bold print) have 40-year design CUFs approaching 1.0. The 40-year design CUFs reported for each component are calculated using all the appropriate transients shown in Table 2.4 (including the shaded transients). If the actual numbers of cycles experienced in plant operation exceeds the 40-year design cycles, the resulting CUF will be higher. For the component elements with 40-year design CUFs approaching 1.0, the actual CUFs realized after 40 years will exceed the allowable 1.0 if the total number of applied cycles exceeds the number of cycles for which the component element was designed. Alternately, the CUF of these components elements can be expected to exceed 1.0 prior to 40 years if the total number of

applied cycles exceeds the number of cycles for which the component element was designed. These component elements warrant careful consideration by the licensee to preclude operation with CUFs beyond 1.0.

The inspector reviewed the results of a stress report for the Control Rod Drive provided in the report by General Electric 22A6254, dated April 21, 1987. The CUF reported therein for elements of the CRD analyzed were as follows:

Control Rod Drive Component	40-Year Design CUF
Main Flange	.150
Ring Flange	.000
Indicator Tube Cap Weld	.038
Lower Piston Tube Threads	.000
Flange Plug No. 1	.000
Flange Plug No. 2	.000

Review of these results by the inspector indicated a low level of CUF which would not be affected by reasonable increases in life cycles.

The inspector reviewed results of Stone and Webster computer based primary piping stress analysis which provided the cumulative usage factor at many pipe locations within the containment. The results are shown in comparison with the allowable lifetime CUF. The allowable CUF for the break exclusion area (piping between the inboard and outboard isolation valves) is reduced from 1.0 to 0.1 because of the critical nature of this area. (The criteria for design in the break exclusion area is defined in UFSAR Section 3.14-A.) The following design CUF results were noted:

Pipe Section Location	40-yr Design CUF	ALLOW CUF
Main Steam System Inside Containment (Loop A)		
Pipe not in Break Exclusion Area	.017	1.0
Pipe in Break Exclusion Area	**.090**	**0.1**
SVV Sweepolets - Break Exclusion Area	.038	0.1
Main Steam System Inside Containment (Loop B)		
Pipe not in Break Exclusion Area	.101	1.0
Pipe in Break Exclusion Area	**.074**	**0.1**
SVV Sweepolets not in Break Exclusion Area	.053	1.0
SVV Sweepolets - Break Exclusion Area	**.053**	**0.1**
ICS Steam Supply Line (RCIC)		
Pipe not in Break Exclusion Area	.076	1.0
Pipe in Break Exclusion Area	.021	0.1
Main Steam System Inside Containment (Loop C)		
Pipe not in Break Exclusion Area	.099	1.0

Pipe in Break Exclusion Area	**.097**	**0.1**
SVV Sweepolets not in Break Exclusion Area	.099	1.0
SVV Sweepolets - Break Excluqion Area	.004	0.1
Main Steam System Inside Containment (Loop D)		
Pipe not in Break Exclusion Area	.071	1.0
Pipe in Break Exclusion Area	**.068**	**0.1**
SVV Sweepolets not in Break Exclusion Area	.044	1.0
SVV Sweepolets - Break Exclusion Area	.002	0.1

Pipe Section Location	**40-yr Design CUF**	**ALLOW CUF**
Reactor Pressure Vessel Vent Line		
Pipe not in Break Exclusion Area above 330 ft El	.008	1.0
Pipe not in Break Exclusion Area below 330 ft El	.068	1.0
Main Steam System Drain Piping	.175	1.0
Containment Penetration Piping		
Penetration 2MSS*Z1A	.040	0.1
Penetration 2MSS*Z1B	.040	0.1
Penetration 2MSS*Z1C	.043	0.1
Penetration 2MSS*Z1D	.037	0.1
Floor Penetration RPV Vent Line	.055	1.0
Penetration 2ICS*Z21A	**.100**	**0.1**
Penetration 2MSS*Z2	.075	1.0

Review of these results by the inspector indicated that the piping CUFs were within allowable values of 1.0 and 0.1. Because of the low acceptance value of CUF equal to 0.1, several of the areas within the break exclusion area are of a level approaching 0.1. This could result in the CUF exceeding 0.1 before the 40-year lifetime has been expended if the present rate of cycle application continues.

3.0 SUMMARY OF FINDINGS

A transient and operating cycle monitoring procedure consistent with TS Section 6.10.1.2(e) is being implemented to provide assurance that the primary system components and piping remain within the UFSAR design bases.

The licensee has comprehensively evaluated the transient cyclic operation of the plant to date and recognized an issue in plant operation relating to startup and shutdown cycle frequency, provided for an engineering evaluation of the issue, and made appropriate recommendations to management for resolution of the issue.

Some of component elements have significant levels of CUF approaching the limits of 1.0 and 0.1. If the transients continued at the same rate, the CUF could reach a level above 1.0 prior to the end of 40-year life. These elements warrant careful consideration by the licensee to preclude operation with components having CUFs beyond the respective CUF limits.

Piping CUFs were within the maximum allowable values of 1.0 and 0.1. Because of the low acceptance value of CUF equal to 0.1, several of the areas within the break exclusion area are of a level approaching the limit of 0.1. This could result in the CUF exceeding 0.1 before the 40-year lifetime has been expended if the present rate of cycle application continues.

4.0 MANAGEMENT MEETINGS

An entrance meeting was held on March 22, 1993, with Nine Mile Point Unit 2 personnel to discuss the scope of the inspection. An exit meeting to discuss the inspection findings with licensee personnel was held on March 26, 1993. Attendees are listed in Attachment A.