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April 18, 1994
C311-94-2040

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Dear Sir:

Subject: Three Mile Island Nuclear Station Unit I, (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
LER 94-002-00

This letter transmits Licensee Event Report (LER) No. 94-002-00 concerning an event on March 17, 1994 when during control rod trip insertion time testing, 12 control rods exceeded the drop time of 1.66 seconds specified in Technical Specification 4.7.1.1.

This LER is being submitted pursuant to 10 CFR 50.73. NRC Form 366 contains an abstract which provides a brief description of the event. For a complete understanding of the event, refer to the text of the report provided on Form 366A.

Sincerely,

T. G. Broughton
Vice President & Director, TMI

WGH

Attachment

cc: Administrator, Region I
TMI Senior Resident Inspector
TMI-1 Senior Project Manager

JE22

NRC FORM 366 (5-92) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 5/31/95

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
THREE MILE ISLAND, UNIT 1	05000-289	1 OF 5

TITLE (4)
CONTROL ROD DROP TIMES EXCEED TS SECTION 4.7.1.1 LIMITS

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 05000
03	17	94	94	-- 002 --	00	04	18	94	FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9):

POWER LEVEL (10): 0%

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.402(b)		20.405(c)		50.73(a)(2)(iv)		73.71(b)
	20.405(a)(1)(i)		50.36(c)(1)		50.73(a)(2)(v)		73.71(c)
	20.405(a)(1)(ii)		50.36(c)(2)		50.73(a)(2)(vii)		OTHER
	20.405(a)(1)(iii)		50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		(Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iv)	X	50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		
	20.405(a)(1)(v)		50.73(a)(2)(iii)		50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
W. G. HEYSEK, TMI LICENSING ENGINEER	717 - 948 - 8191

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
AC	AB	AA	D150	Y					

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On March 17, 1994 while TMI-1 was in a hot shutdown condition for the purpose of repairing the pressurizer spray valve, control rod drop time testing was performed in accordance with Surveillance Procedure 1303-11.1. Twelve control rods [AB/AA] exceeded the trip insertion time limit, of 1.66 seconds from fully withdrawn to 3/4 insertion, designated by the TMI-1 Technical Specifications. The control rod drop time data was evaluated with BW Nuclear Technologies and it was concluded that the longer drop times were caused by blockage of the thermal barrier check valves in combination with reduced clearance in the thermal guide bushing caused by crud deposition resulting from the low pH conditions in the reactor coolant system.

Past experience had shown that this blockage could be reduced by subsequent control rod drops. The control rods were dropped until the drop times improved and were within the specified limit. In addition, the lithium concentration in the reactor coolant system was increased to raise pH to reduce the rate of corrosion.

The event was reported per 10CFR50.72(b)(2)(i).

I. PLANT OPERATING CONDITIONS BEFORE THE EVENT

The plant was at hot shutdown at the time of the event.

II. STATUS OF STRUCTURES, COMPONENTS OR SYSTEMS THAT WERE INOPERABLE AT THE START OF THE EVENT AND THAT CONTRIBUTED TO THE EVENT.

No systems, structures or components were out-of-service that contributed to this event.

III. EVENT DESCRIPTION

On March 17, 1994 control rod drop time testing found 12 control rods that exceeded the trip time of 1.66 seconds from fully withdrawn to 3/4 insertion, designated by the TMI-1 Technical Specification section 4.7.1. The out of specification times ranged from 2.06 to 2.89 seconds. The testing (not required by Technical Specifications at this time) was being performed as a follow-up to drop times exceeding 1.66 seconds that occurred for three control rods during the previous outage's (10R in October 1993) post refueling testing. The three rods that exceeded 1.66 seconds in 10R were among the 12 rods that exceeded the limit during this event. Since this condition could have existed during plant operation, it is being reported under 10CFR50.73(a)(2)(ii).

Refueling Outage 10R Testing and Evaluation (October 1993)

Initially, three control rods had out-of-spec drop times of 1.83, 1.72, and 1.81 seconds at the end of 10R. These times were attributed to stuck-closed check valves in the thermal barrier of the Control Rod Drive Mechanism (CRDM). This conclusion was reached after discussing the problem with BW Nuclear Technologies (BWNT) who indicated that the drop times for these three rods were consistent witn the increased drop times for a CRDM when all four check valves in the thermal barrier were intentionally blocked for testing at a research facility. After several drops, times obtained for TMI-1's three rods returned to values within the specified limit. A postulated cause for the check valve sticking was corrosion product deposits (crud).

Early boration prior to refueling, and the exposure of the CRDMs to air while the reactor vessel head was on the storage stand during 10R were discussed as possible causes for check valve sticking. An evaluation of the increased drop times was initiated. It involved a plan to repeat rod trip insertion time testing of the slow rods after four months of operation was established. The potential for recurrence of check valve sticking was recognized but was not considered likely because of the clean condition of the CRDM inspected in 10R (Group 7 rod from core location H-12).

March 1994 Testing

During the March 1994 testing, BWNT was again consulted. Evaluation of the drop time data, CRDM design, and the analog position signal from each of the 12 slow rods led to the conclusion that the longer drop times are caused by blockage of the thermal barrier check valves combined with reduced clearance in the thermal barrier guide bushing. This conclusion was reached after evaluation of the CRDM, plenum, control rod, and fuel assembly clearances. The velocities for a control rod with normal drop time and one with longer drop time were calculated from the analog position traces. The velocity curve of the rod with increased drop time is consistent with increased hydraulic drag based on dynamic modeling. This supports the hypothesis of crud deposits in the thermal barrier bushing and stuck closed check valves.

The cause for increased crud deposits is believed to be the precipitation of corrosion products in the CRDM thermal barrier. This may have been the result of lower pH conditions in the reactor coolant system at the beginning of extended fuel cycles. Lithium is used to buffer boric acid and to maintain pH in the allowable range. At TMI-1, primary chemistry is maintained by varying boron and lithium within a control band. The higher pH limits the rate of corrosion product formation and increases crud solubility at the operating temperatures of the RCS. With higher boron concentrations experienced at the beginning of Cycles 9 and 10, and a B&W recommended upper limit for lithium, the system pH was lower than it had been in the previous three cycles. Under these conditions crud may have become insoluble as temperature decreased. Contributing factors to deposits in the thermal barrier may be lower temperature in the CRDM than in the RCS and relatively stagnant reactor coolant in the CRDM housing except during periods of rod motion.

During 10R, a group 7 CRDM from core location H-12 was disassembled and inspected for wear. The CRDM was clean with no abnormal deposits and the check valves were free. The internal diameter of the thermal barrier bushing was 0.007 inches under the minimum specified by drawing. It is not known whether this was the result of deposits since the as-built internal diameter of the bushing is not available. The Group 7 CRDMs exhibit little change in drop times in either the 10R insertion trip test or the subsequent March 1994 testing. The reliable performance of Group 7 may be because of their additional motion resulting from their regulating group function. This increased motion may reduce the crud formation as a result of the exchange of reactor coolant displaced by leadscrew motion.

By March 20 all rods except Group 1 Rod 3, Core Location L-14 had returned to within the Technical Specification limit of 1.66 seconds after multiple tests. Analysis was performed that determined that trip times of up to 3.0 seconds for all 61 rods could be accommodated without exceeding accident acceptance criteria if the

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

overpower trip setpoint was reduced during startup and shutdown. Technical Specification Change Request No 242 was submitted to the NRC to increase the allowable trip time to 3.0 seconds. Additionally, an analysis of as-found rod drop times for all rods determined that the total reactivity addition rate was within the original design basis.

A lithium addition was made on March 22 to raise the lithium concentration higher in the allowable control band in order to increase pH and decrease corrosion product formation. Drop tests were repeated on March 23, 1994 to determine whether there had been any degradation in drop times since the previous test. No degradation had occurred and the previously out of specification CRDM (Group 1 Rod 3) now met the Tech Spec requirement.

On March 25, 1994, the NRC staff was briefed on the apparent cause for the long drop times, the acceptability of longer drop times in meeting the accident analyses and the planned corrective actions. Subsequent to the briefing, TSCR 242 was withdrawn and the planned actions were documented in letter C311-94-2147 dated March 26, 1994. The unit was restarted on March 26, 1994.

IV. COMPONENT FAILURE DATA

Shim Control Rod Drive Mechanism, Royal Industries model 120J255.

EQUIPMENT MALFUNCTION

Evaluation of the March 17, 1994 control rod drop time strip charts with a BWNT analytical model for predicting control rod drop times indicated that the slow times were hydraulically induced. The CRDM thermal barrier area was determined to be the only place where sufficient hydraulic drag could be produced to result in the slow rod drop times experienced at TMI-1. Two effects were distinguished in the control rod drop times: with subsequent drops, small improvement in the drop times, followed by a sharp decrease of approximately .4 to .5 seconds. These changes relate respectively to improvement in the hydraulic resistance by removal of crud deposition from the surfaces and the freeing of the thermal barrier ball check valves. The observation of crud on thermal barriers removed from other operating plants suggests crud buildup is a primary factor in the slow drop times.

V. AUTOMATIC OR MANUAL INITIATED SAFETY SYSTEM RESPONSES

There were no safety system actuations.

VI. ASSESSMENT OF THE SAFETY CONSEQUENCES AND IMPLICATIONS OF THE EVENT

Increased drop times have the potential to increase the severity of transients or accidents requiring reactor trip; however, the as found drop times did not result in a condition where the acceptance criteria for any design basis accidents would be exceeded.

VII. PREVIOUS EVENTS OF A SIMILAR NATURE

There have been no previous reportable events of a similar nature.

VIII. CORRECTIVE ACTION

The control rods were restored to the drop times of ≤1.66 seconds as specified in Technical Specifications.

Among the corrective actions identified in letter C311-94-2147 are the following:

1. Increase lithium concentration in the Reactor Coolant System to raise pH to reduce the rate of corrosion.

2. Control rod drive mechanisms will be exercised every two weeks during the remainder of Cycle 10 to reduce the likelihood of crud buildup in the gap between the lead screw and the thermal barrier bushing. (Clarifying note: CRDMs are currently exercised biweekly. The extent of movement will be increased for the remainder of Cycle 10).

3. Control rod drop times will be obtained within three months of reactor startup.

4. Within six months GPU Nuclear will provide a long term plan to address necessary actions to improve control rod drive mechanism performance and reliability.

* The Energy Industry Identification System (EIIS), System Identification (SI) and Component Function Identification (CFI) Codes are included in brackets, "[SI/CFI]", where applicable, as required by 10 CFR 50.73(b)(2)(ii)(F).