Docket file

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 12, 1994

Docket No. 50-289

LICENSEE: GPU Nuclear Corporation

FACILITY: Three Mile Island Nuclear Station, Unit 1 (TMI-1)

SUBJECT: SUMMARY OF MAY 3, 1994, MEETING WITH GPU NUCLEAR CORPORATION RE[illegible]DING CONTROL ROD DROP TIME CRITERIA AT THREE MILE ISLAND N[illegible]AR STATION, UNIT 1 (TMI-1)(TAC NO. M89053)

On Tuesday, May 3, 1994, a public meeting was held at the U.S. Nuclear Regulatory Commission (NRC) offices located at One White Flint North, Rockville, Maryland with GPU Nuclear Corporation (GPUN), the licensee for TMI-1. The purpose of the meeting was to discuss the criteria proposed by GPUN in a letter dated April 22, 1994 (Enclosure 3), for judging whether or not control rod drop times have improved since March 1994 in response to corrective action taken since then. The criteria are to be applied to drop time test results to be obtained during a special shutdown and surveillance test scheduled to start on June 1, 1994. Enclosure 1 is the list of participants at the meeting. Enclosure 2 is a copy of the handouts used during the meeting.

The first time that contro[illegible]op times exceeded the Technical Specification (TS) limit o[illegible]conds was October 1993, at the conclusion of the 10R refueling outage [illegible]hat time three rods exceeded the requirement and were brought back within the TS requirement by additional testing. During a scheduled outage in March 1994, surveillance testing indicated that 12 of 61 rods exceeded the TS requirement. All rods were again brought below the TS requirement by additional testing. However, following a meeting with GPUN on March 25, 1994, the staff issued a confirmatory action letter (CAL) to GPUN on March 29, 1994, requiring GPUN to establish a program of periodic control rod monitoring, development of evaluation criteria, a contingency plan, and a long term plan for corrective action. The licensee's April 22 letter informed the staff of the proposed evaluation criteria and contingency plan and requested the staff's approval prior to the testing to occur in June 1994.

GPUN has concluded that the root cause of the lengthened control rod drop times is deposition of crud in the thermal barrier of the control rod drive mechanisms (CRDMs) that control rod position. GPUN further stated that the crud buildup has probably been aggravated by operating at a lower reactor coolant system (RCS) pH than normal as a result of higher boric acid concentrations required for the extended-life cores. Corrective action proposed in March 26 letter from GPUN, and repeated in the staff's CAL, consists primarily of raising pH and litnium hydroxide levels in the RCS, and exercising control rods through 10% of their total travel on a biweekly basis. GPUN expects that these actions will result in an improvement in rod drop time. If they do not result in an improvement, then removal of at least one CRDM is indicated. See proposed criteria in Enclosures 2 and 3.

DF01

The staff expressed some concerns regarding pre-approving the proposed criteria without having the opportunity of reviewing the actual as-found test data. GPUN has proposed an acceptance criterion above the current TS (2.11 sec vs. 1.66 sec) for the 12 rods that exceeded the TS in March 1994. Although a basis for the higher number was provided, the staff would have to further review the basis before any agreements could be reached. GPUN was advised, however, that the staff would consider a temporary revision to the TS limit if it could be justified by GPUN from a safety standpoint and GPUN was encouraged to submit a TS change request as soon as possible so that the request could be noticed in the Federal Register.

Original signed by:

Ronald W. Hernan, Senior Project Manager
Project Directorate I-4
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
1. List of Attendees
2. GPUN "CRD Retest Plan"
3. GPUN letter of April 22, 1994.

cc w/enclosures:
See next page

Distribution w/enclosures 1,2, & 3:
Docket File
NRC & Local PDRs
PDI-4 Memo
RHernan
JRogge, RI
RJones
TCollins
LPhillips
HRichings

Distribution w/enclosure 1 only:
TMurley/FMiraglia
Acting, ADPR
SVarga
JCalvo
JStolz
OGC
EJordan
SNorris
VMcCree
ACRS (10)

OFFICE	LA:PDI-4	PM:PDI-4	D:PDI-4		
NAME	SNorris	RHernan:cn	JStolz		
DATE	5/12/94	5/12/94	5/12/94	/ /	/ /

OFFICIAL RECORD COPY
Document Name: G:\HERNAN\5-3-94.SUM

The staff expressed some concerns regarding pre-approving the proposed criteria without having the opportunity of reviewing the actual as-found test data. GPUN has proposed an acceptance criterion above the current TS (2.11 sec vs. 1.66 sec) for the 12 rods that exceeded the TS in March 1994. Although a basis for the higher number was provided, the staff would have to further review the basis before any agreements could be reached. GPUN was advised, however, that the staff would consider a temporary revision to the TS limit if it could be justified by GPUN from a safety standpoint and GPUN was encouraged to submit a TS change request as soon as possible so that the request could be noticed in the Federal Register.

Ronald W. Hernan

Ronald W. Hernan, Senior Project Manager
Project Directorate I-4
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
1. List of Attendees
2. GPUN "CRD Retest Plan"
3. GPUN letter of April 22, 1994.

cc w/enclosures:
See next page

cc w/enclosures:

Michael Ross
O&M Director, TMI-1
GPU Nuclear Corporation
Post Office Box 480
Middletown, Pennsylvania 17057

John Fornicola
Director, Licensing & Reg. Affairs
GPU Nuclear Corporation
100 Interpace Parkway
Parsippany, New Jersey 07054

Jack S. Wetmore
TMI Licensing Manager
GPU Nuclear Corporation
Post Office Box 480
Middletown, Pennsylvania 17057

Ernest L. Blake, Jr., Esquire
Shaw, Pittman, Potts & Trowbridge
2300 N Street, NW.
Washington, DC 20037

Chairman
Board of County Commissioners
of Dauphin County
Dauphin County Courthouse
Harrisburg, Pennsylvania 17120

Chairman
Board of Supervisors
of Londonderry Township
R.D. #1, Geyers Church Road
Middletown, Pennsylvania 17057

Michele G. Evans
Senior Resident Inspector (TMI-1)
U.S. Nuclear Regulatory Commission
Post Office Box 311
Middletown, Pennsylvania 17057

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, Pennsylvania 19406

Robert B. Borsum
B&W Nuclear Technologies
Suite 525
1700 Rockville Pike
Rockville, Maryland 20852

William Dornsife, Acting Director
Bureau of Radiation Protection
Pennsylvania Department of
Environmental Resources
Post Office Box 2063
Harrisburg, Pennsylvania 17120

Mr. T. Gary Broughton, Vice President
and Director - TMI-1
GPU Nuclear Corporation
Post Office Box 480
Middletown, Pennsylvania 17057

ENCLOSURE 1

LIST OF ATTENDEES
MAY 3, 1994 MEETING WITH GPU NUCLEAR CORPORATION
REGARDING CRD RETEST PLAN

TITLE	AFFILIATION	TITLE
Ronald W. Hernan	NRC/NRR/PDI-4	Senior Project Manager
Larry Phillips	NRC/SRXB	Section Leader
Howard Richings	NRR/SRXB	Senior Reviewer
Michael Ross	GPUN	O&M Director, TMI
T. Gary Broughton	GPUN	VP and TMI Director
Pat Walsh	GPUN	Manager, Plant Engineering
Charles Hartman	GPUN	Manager, Electrical Engrg
G. Richard Skillman	GPUN	Manager, Tech. Support
Jack S. Wetmore	GPUN	Manager, Licensing
W. M. Drendall	GPUN	Tech Functions
John F. Rogge	NRC, Region I	DRP, Section Leader 4-B
B. Connor	GPUN	Matl. Engrg., Parsippany
Dr. Branch Elam	GPUN	Engrg. & Design, Parsippany

ENCLOSURE 2

CRD Retest Plan

NRC Meeting, May 3, 1994

I.	Introduction	T. G. Broughton
II.	Background - History - Root Cause	P. S. Walsh
III.	Actions Taken - Rod Exercise - Lithium	P. S. Walsh
IV.	Chemistry Considerations - RCS Hot pH - Lithium Control for HSD	W. Conner
V.	Test Plan - Schedule and Plan - Evaluation Criteria	P. S. Walsh
VI.	Contingency Plan	
VII.	Potential Future Action	P. S. Walsh
VIII.	Conclusion	T. G. Broughton

Trip History

- Technical Specification Limit is 1.66 seconds
  - 3/4 insertion
  - Hot, Full Flow Conditions
- Control Rod Insertion assures sufficient negative reactivity to terminate analyzed transients
- Prior to 10R all drop times at TMI met the Tech Spec limit
- 10 R, October 1993
  Three Control Rods Exceed Tech Spec
- 10-U2, March 1994
  Twelve Control Rods Exceed Tech Spec
- Subsequent analysis confirm that the as-found trip times provide ample reactivity insertion to terminate all analyzed transients

Root Cause

- Low RCS pH
  - During Fill and Vent of CRDM
  - During trip test at BOC
  - Early in Cycle 10 due to high boron conc
  - At beginning of 10R for CRUD removal

- Low pH resulted from:
  - Longer fuel cycles and higher boron concentrations
  - Lithium limit
    - From BWFC (fuel warranty)
    - Concern for effect on Alloy 600
  - Need to maintain pH at hot shutdown was not previously identified

- Minimal Coolant Exchange between RCS and CRDM
  - Low pH coolant in CRDM slow to mix with bulk coolant

- Corrosion Product Deposits in Thermal Barrier
  - Blocks Ball Check Valves
  - Reduces Thermal Barrier Bushing clearance

- Hydraulic Drag slows Control Rod Descent

Corrective Actions

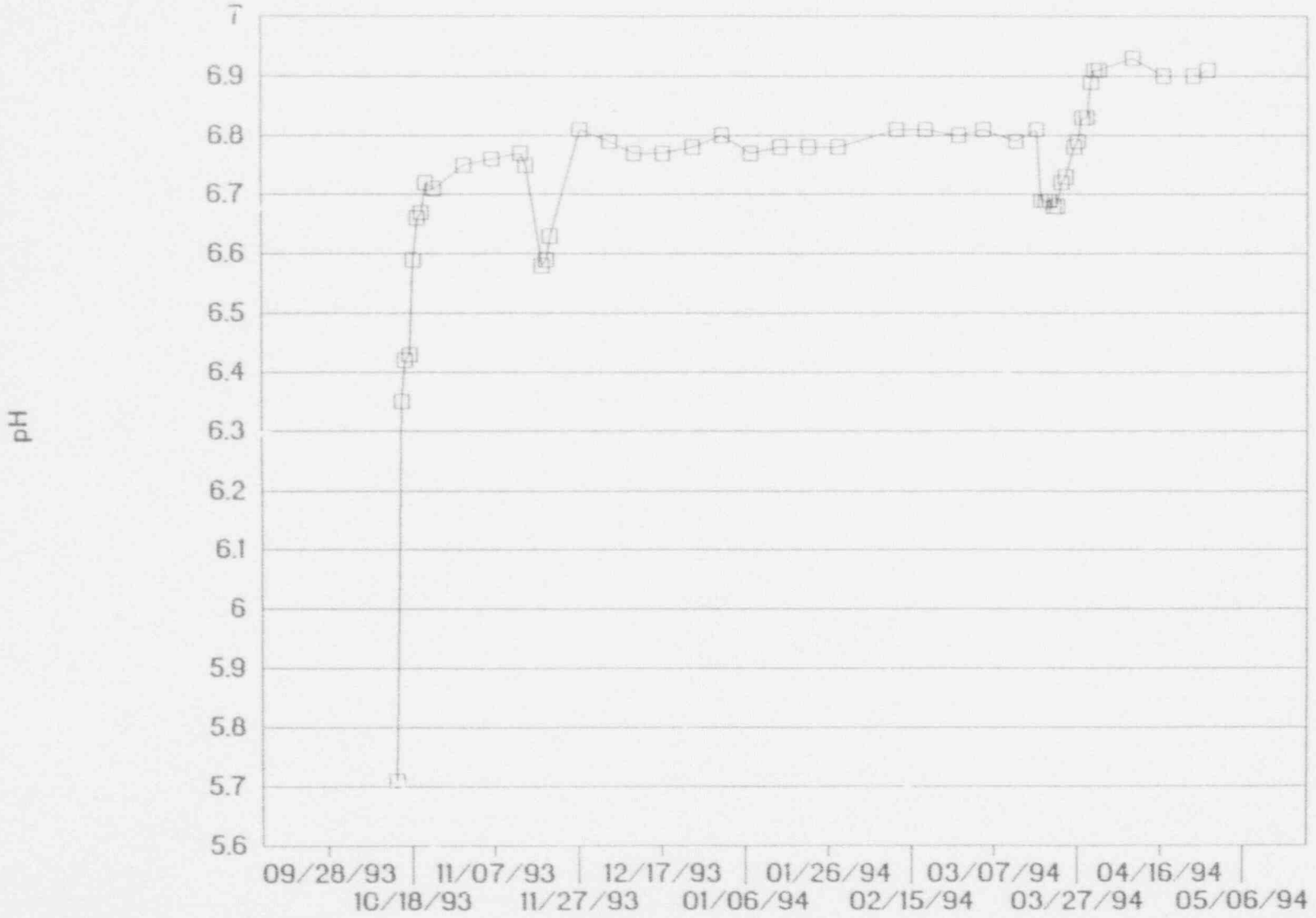
- Raised Lithium Limit after evaluation of effect on fuel and Alloy 600
- Increased Lithium Concentration to raise RCS at temperature pH to at least 6.9
- Increased Control Rod Travel during biweekly Movement Test

Chemistry Considerations

- **RCS At-temperature pH**
- **Lithium Control for Hot Shutdown**

CYCLE 10 pH

AT 305 C



Test Plan

- Hot Shutdown scheduled for June 1
- Verify At-temperature pH is 6.9 or greater
- Trip Test all 61 Rods
- Evaluation Criteria
  - All < 1.66 seconds
    Restart
  - Rods > 1.66 seconds but Improved
    Exercise to achieve 1.66 seconds
    Restart
    Retest in fall 1994
  - Not improved
    Cooldown and inspect selected CRDM(s)
- Criteria for Improved
  - No new rod exceeds 1.66 seconds
  - No drop time exceeds 2.14 seconds
- Seeking NRC Preapproval of Criteria
  to exercise and restart

Contingency Plan

- Schedule Retest for fall 1994 if:
  - Average time of 49 rods previously within specification increases by > 0.1 sec
  - Any rod exceeds 1.66 sec but inspection is not required

- If Not Improved, Perform Inspection of:
  - Check Valves
    Determine if debris is blocking valves or causing ball to adhere to seat
  - Guide Bushing
    Measure Crud thickness
    Measure bushing internal diameter
  - Analyze Crud Samples for composition

- If Inspection is Required
  - Replace Thermal Barrier
  - Use Barrier with larger check valve clearances

- If Inspection does not Confirm Root Cause
  - Redirect the Inspection

Potential Future Actions

- Evaluate tripping all rods additional times to improve chemistry conditions in drive
  - One tenth volume exchange per trip

- Seek inspection results from
  - Crystal River
  - Oconee

- Connect 75% insertion position switch to Plant Computer
  - Allows verification of drop times for all reactor trips

- Modify Cycle 12 Fuel Design to reduce boron concentration

- Review CRUD removal procedures performed at beginning of refueling for dose reduction
  - Minimize control rod motion

Requested Action

- To support testing on June 1, requests NRC approval of:

- 1. Proposed Testing Plan and Evaluation Criteria

- 2. Additional Drops of rods with times > 1.66 seconds if IMPROVED from 10U2

- Approval requested by May 27

ENCLOSURE 3

Nuclear

GPU Nuclear Corporation
Route 441 South
P.O. Box 480
Middletown, Pennsylvania 17057-0480
(717) 944-7621
Writer's Direct Dial Number:
(717) 948-8005

April 22, 1994
C311-94-2055

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

Gentlemen:

Subject: Three Mile Island Nuclear Station Unit I (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Control Rod Drive Testing Contingency Plan

Reference: 1. March 26, 1994, GPU Nuclear letter to NRC
2. March 29, 1994, NRC Confirmatory Action Letter to GPUN

In our letter of March 26, 1994, GPU Nuclear committed to performing additional control rod drop time testing within three months of reactor startup. We also committed to submitting our evaluation criteria for the testing and a contingency plan. The purpose of this letter is to submit our evaluation criteria and contingency plan and to notify you that we currently plan to shut down TMI-1 on June 1, 1994, to perform this testing.

The purpose of the testing is to determine whether the actions we have taken to increase the pH of the reactor coolant system and to periodically exercise the rods to a greater length of travel have been effective in improving the performance of the control rods. The criteria for determining this are contained in the enclosure.

We request prior approval of our plan to perform additional drops of control rods that show improvement in as-found drop times but nevertheless still exceed the 1.66 second time limit specified in the Technical Specifications. If all control rod as-found drop times meet the TMI-1 Technical Specification limit, we plan to restart without delay. In no case would we start up without NRC approval if any as-left drop times exceed 1.66 seconds.

9405020071 6pp.

We request your review and approval of our plan and evaluation criteria prior to May 27, 1994, to support testing on June 1, 1994. If you have any questions, please let us know.

Sincerely,

T. G. Broughton
Vice President and Director, TMI

JSS/emf

Attachment

cc: M. Evans - Senior Resident Inspector
R. Hernan - Senior Project Manager
T. Martin - Administrator, Region I

CONTROL ROD DRIVE TESTING EVALUATION CRITERIA AND CONTINGENCY PLAN

I. BACKGROUND

TMI-1 Technical Specification (T.S.) 4.7.1 specifies that the maximum control rod trip insertion time from the fully withdrawn position to 3/4 insertion (104 inches travel) shall not exceed 1.66 seconds. Control Rod Drive (CRD) drop times ("trip time" and "drop time" are used interchangeably) for hot, full flow conditions have historically been less than 1.35 seconds at Three Mile Island (TMI). Post-refueling testing in the 10R outage (October 1993) was the first occurrence of a TMI control rod exceeding the T.S. limit. Three rods had trip times of 1.83, 1.72, and 1.81 seconds. This was unexpected because a mechanism examined during 10R as part of the B&W Owners' Group life extension program was found to be in very good condition. As a result of finding the three slow rods, a decision was made to repeat rod drop tests at any shutdown following four months of operation.

On March 17, 1994, during a shutdown for valve repair (10U2), rod drop time testing found 12 control rods that exceeded the TMI-1 T.S. limit. Details of these results are contained in LER 94-02 dated April 18, 1994.

The slow drop times are believed to have been caused by corrosion product (crud) build-up in the CRDM thermal barriers. The thermal barrier is a large machined component which essentially separates the base of the CRD motor tube from the upper reactor vessel fluid region at the top of the reactor vessel head and is intended to keep the CRD motor tube components at temperatures well below the reactor coolant fluid temperature. Our conclusion that crud deposits are the most likely cause is based upon previous internal examinations of three CRDMs which are: a 1.78 second Oconee-2 CRDM with significant crud deposition, a 1.32 second Oconee-1 CRDM with minor crud deposition, and a 1.26 second TMI CRDM (10R exam) with no evidence of crud deposition. The crud is believed to restrict water flow into the CRDM motor tube during trip motion principally by not allowing the ball check valves to function (either to not open at all or to partially open) and/or by restricting the clearance between the lead screw and the thermal barrier bushing, thereby causing hydraulic drag. Dynamic modeling of a dropping rod with restricted water flow results in predicted drop times that match TMI rod velocity profiles. This supports the applicability of this known problem to TMI.

GPU Nuclear has taken the following corrective actions to minimize crud buildup within the CRDM:

A. The lithium concentration of the reactor coolant system (RCS) was increased to raise pH to reduce the rate of corrosion.

B. Bi-weekly control rod movement testing was changed to move the rods to a greater length of travel to promote a better interchange of RCS water inside the thermal barrier bushing.

The purpose of the drop time testing to be performed on or about June 1, 1994, is to determine if the condition of the CRDMs has improved since March 1994 when the above corrective actions were instituted.

II. TESTING PLAN

All 61 non-APSR rods will be drop tested on or about June 1, 1994, to determine as-found drop times. These results will then be compared to the as-found data obtained in March 1994 to determine further action.

III. EVALUATION CRITERIA AND PLANNED ACTIONS

A. As-Found Drop Times For All Rods <1.66 Seconds

If the as-found drop time of all rods is ≤1.66 seconds, it will indicate that the corrective actions taken have been effective. In this case, GPU Nuclear plans to restart TMI-1 without delay.

There is some variability in rod drop times from test to test even without any physical changes in the CRDM. This variability is estimated to be no greater than 0.1 seconds. Therefore, if the average as-found drop time of all rods that were <1.66 seconds in March 1994 has not increased >.1 second, TMI will operate through the remainder of cycle 10 without conducting a shutdown for the express purpose of testing rod drop times. If this additional requirement is not met, TMI will retest all rods in the fall of 1994. Furthermore, if during the remainder of cycle 10 TMI is shut down for any reason at a point greater than four months after startup, rod drop time testing will be conducted.

B. As-Found Drop Times For One Or More Rods >1.66 Seconds

1. Evaluation Criteria

If the as-found drop times for one or more rods are greater than 1.66 seconds, GPU Nuclear will take action based upon a comparison of drop time data taken in March 1994 and June 1994. The comparison will determine if the drop times have improved using the evaluation criteria defined below:

a. no rod which had an as-found drop time <1.66 seconds in March 1994 has an as-found drop time >1.66 seconds in June 1994, and

b. no rod which had an as-found drop time of >1.66 seconds in March 1994 has a drop time >2.14 seconds in June 1994.

An improvement in rod drop times indicates that GPU Nuclear has identified the cause of the slower drop times and is taking the proper action to correct them.

The criterion of 2.14 seconds was chosen based upon the results of dynamic modeling discussed above which calculated a drop time of 2.14 seconds for a mechanism with stuck ball check valves but with nominal clearances in the leadscrew-thermal barrier bushing area.

2. GPU Nuclear Action If As-Found Rod Drop Times For One Or More Rods Are >1.66 Seconds But Are Improved From March 1994

Given that rod drop times are showing improvement as defined above, GPU Nuclear will perform multiple drops of these rods to free ball check valves to reduce drop times to less than 1.66 seconds.

If multiple drops result in all rod drop times <1.66 seconds, TMI-1 will return to power, and the next drop time test will be scheduled for the fall of 1994.

If it is not possible to obtain as-left rod drop times less than 1.66 seconds for all rods, GPU Nuclear will not restart TMI-1 without obtaining NRC approval.

3. GPU Nuclear Action If As-Found Rod Drop Times For One Or More Rods Are >1.66 Seconds And Do Not Show Improvement From March 1994

If as-found drop times are not improved as defined above, as a minimum, one CRDM for a slow rod will be disassembled and inspected. Based on the results of the inspection, specific remedial actions will be developed which may include replacement of the thermal barrier(s).

Contingency plans are in place for what is believed to be the problem component, the thermal barriers. GPU Nuclear will have replacement barriers available. These replacement thermal barriers have larger ball check valve clearances which would be expected to provide less sensitivity to crud deposition.

ROD DROP TIMES
PER B&W DYNAMIC MODEL

	MARCH 25	REVISED
4 BALLS FREE	1.39	1.35
3 BALLS FREE	1.40	1.36
2 BALLS FREE	1.43	1.39
1 BALL FREE	1.51	1.47
O BALLS FREE/ NOMINAL BUSHING CLEARANCE	2.14	2.11
O BALLS FREE/ .017 DIAM CLEARANCE	2.80	2.97

Seconds