GPU 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

September 29, 1994
C311-94-2125

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 Long Range Plan

The purpose of this letter is to submit the Control Rod Drive Long Range Plan for TMI-1. Submittal of the plan satisfies the final remaining commitment made by GPUN in connection with the NRC Confirmatory Action Letter 1-94-004, dated March 29, 1994. The plan addresses both the actions taken and those considered necessary to improve control rod drive mechanism performance and reliability.

We have concluded that the short term corrective actions taken to raise RCS pH and increase the length of control rod travel during the bi-weekly exercise coupled with the replacement of four CRDM thermal barriers with a model less susceptible to ball check valve sticking provide reasonable assurance that the Technical Specification control rod drop time limit of 1.66 seconds will not be exceeded during the remainder of Cycle 10.

In the event ball check valve sticking remains enough of a problem to cause rods to exceed 1.66 seconds, the safety analysis submitted in support of TSCR 244 shows that with all rods inserting within 3.0 seconds the safety analysis acceptance criteria would not be exceeded, provided the overpower trip set point is reduced at low power. The startup and shutdown procedures have been changed to require the overpower trip setpoint to be reduced at low power to maintain the validity of the safety analysis. Since the likelihood of any rod exceeding a 3.0 second drop time is considered very low given the corrective actions taken to date, the near term nuclear safety impact associated with the existing condition is considered to be minimal.

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The enclosed plan is considered to be a practical and timely approach to the resolution of the longer term problem. It can be executed with no adverse effect on the health and safety of the public and minimal impact on plant operation.

GPUN will be available to meet with you and discuss the content of the plan or answer questions should the need arise.

Sincerely,

T. G. Broughton

T. G. Broughton
Vice President and Director, TMI

WGH

Enclosure

cc: Administrator, Region I
TMI Senior Resident Inspector

Long Range Plan to Resolve the TMI-1 CRD Drop Time Problem

I. Introduction

TMI-1 Technical Specification (TS) 4.7.1 specifies that the maximum control rod trip insertion time from fully withdrawn to ¾ 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 TMI-1. A control rod is considered inoperable when its drop time exceeds the 1.66 second TS criterion.

Increased control rod drop times have been observed on all B&W Units with Type A Control Rod Drive Mechanisms (CRDMs). Rods exceeding the TS limit at TMI-1 were first observed during rod drop testing performed at the end of the 10R outage in October 1993. The cause for slow drop times has been confirmed to be crud deposits in the thermal barrier. This was confirmed by inspection of four TMI-1 CRDMs in June 1994 and was consistent with CRDM inspection results at other B&W plants.

The crud restricts water flow to the CRDM motor tube during trip motion principally by not allowing the ball check valves to function (either not to open at all or to open partially) and by restricting the clearance between the lead screw and the thermal barrier guide bushing (Attachment 1) thereby increasing hydraulic drag. Dynamic modeling of a dropping rod with restricted water flow conditions resulted in predicted rod drop times that are consistent with the TMI-1 rod velocity profiles.

The source of the corrosion products, the transport mechanism, and the reason it has begun to affect CRDM performance after 3600 Effective Full Power Days (EFPD) are under investigation by the B&W Owners Group (B&WOG). While the root cause has not yet been confirmed, corrective actions have been taken which provide reasonable assurance that further significant degradation of control rod drop time will not occur during the remainder of Cycle 10.

This long range plan identifies those actions which have been taken and those which will be taken to assure that the control rod drop times continue to meet the TS limit. These actions support GPUN's objectives to identify, confirm, and mitigate the root cause condition which led to control rod drop times in excess of the TS limit.

II. Recent Control Rod Drop Time Experience

Historically, prior to 10R, control rod drop times seen during outages 6R, 7R, 8R and 9R, varied from 1.23 to 1.30 seconds with an average for all rods of 1.26 seconds (Attachment 2, page 1 shows the group average drop times and the standard deviation of the drop times within each group while page 2 shows the average as-found and as-left drop times). At the end of the TMI-1 10R refueling outage, three rods failed to meet the drop time criterion. Drop

times were restored to within the TS limit by dropping the rods numerous times to free the stuck ball check valves. Step decreases in drop times confirmed that the method was successful.

During follow-up testing performed during the March 1994 10U2 outage, twelve rods failed to meet the TS drop times and several rods exceeded the calculated drop time for stuck ball check valves. The suspected root cause and corrective actions (included in sections that follow) were communicated to the NRC staff in a meeting held on March 25, 1994.

Specific corrective actions (documented in Letter C311-94-2147, Cycle 10 Drop Times, Broughton to NRC, March 26, 1994) involved raising the lithium concentration and pH of the reactor coolant system (RCS) and increasing control rod movement. GPUN also included a commitment to obtain drop times within three months of the startup from the March 1994 outage. This commitment was accepted by the NRC in Confirmatory Action Letter 1-94-004, March 29, 1994. If rod drop times did not meet the acceptance criterion, GPUN was to inspect a thermal barrier to verify that crud in the thermal barrier was the cause for the slow drop times.

On June 1, 1994 and as documented in LER 94-004 dated June 24, 1994, the unit was shut down for rod drop testing. Three rods failed to meet the acceptance criterion. Inspections were performed to confirm the cause and the thermal barrier was replaced on all three rods that exceeded the drop time testing criterion in June 1994. In addition the thermal barrier was also replaced on the mechanism at core location M-3 since this rod was above the TS limit in the 10R and 10U2 tests but passed the June 1 test. Rod drop test results for the four CRDMs with the replacement thermal barriers were satisfactory. Drop times of 1.31, 1.33, 1.32, and 1.30 seconds were obtained.

III. Root Cause Determination

GPUN began investigation into the cause of the CRDM slow drop times in October 1993, immediately following the failure of three control rods to meet the TS specified full out to ¾ insertion times during the 10R outage post refueling testing. The 10R general outage activities as well as specific CRDM maintenance activities were reviewed in an attempt to find contributing factors to the slow drop time problem. Discussions with Babcock and Wilcox Nuclear Technology (BWNT) coupled with observed symptoms led to the identification of the most probable cause: a hydraulic drag on the rod resulting from stuck closed thermal barrier ball check valves. This was also supported by research facility test data obtained during original mechanism construction and testing by the vendor. The previous experience and conclusions as to the cause of slow rod drop times at the Oconee plant in May of 1993 were also reviewed. All of this information supported the conclusion.

After the 10U2 outage in March 1994, a larger sample of rod drop data was available as 12 control rods experienced drop times above the TS Limit. Plant personnel collected CRDM stator temperatures and air temperatures in the

reactor vessel head service structure in an attempt to better understand the temperature profile of the CRDM stators and possibly the motor tubes. Rod drop velocity profiles collected during performance of the drop time testing procedure were compared with those indicative of expected cause and a BWNT fluid hydraulic model. GPUN also compared control rod patch and fuel design interfaces for the slower mechanisms. Two patterns were found: rods on the edge of the core seemed more susceptible to this problem and regulating rod group 7 seemed less prone to the slow drop time problem (i.e. group 7 rods did not exceed the TS and showed a small to no increase in drop time).

Analysis of rod drop velocity curves found results to be consistent with the increased hydraulic drag BWNT calculated on a fluid hydraulic computer model. The most probable cause of slower drop times remained the thermal barrier ball check valves sticking closed due to deposits. Contributing factors identified and under investigation at that time were:

1. primary system and CRD motor tube coolant pH: specifically the higher boron concentration/lower primary system pH as a result of longer fuel cycle designs and

2. the practice of early boration to induce crud transport at the end of the most recent fuel cycles.

Through March and April of 1994, the B&W Plants with Type A Drives began extensive discussions and sharing of plant operating and maintenance data and operating practices to better understand the problem. A mechanism from the Crystal River Plant was inspected in April 1994 and deposits were found on the thermal barrier similar to those found at Oconee and subsequently at TMI-1.

During the June 1994 TMI-1 10P3 outage, four thermal barriers were inspected and replaced with modified thermal barriers having larger mechanical clearances. The rod drop times for the newly installed mechanisms were approximately 1.3 seconds, as previously identified. These values are approximately the same as the "as new" condition test data obtained from mechanisms early in plant life.

The inspections of the TMI-1 thermal barriers removed from service confirmed that the cause of the slower rod drop times at TMI-1 is crud deposition in the ball check valves and guide bushing areas of the CRDM thermal barriers. Samples of the deposits were taken from the thermal barriers and analyzed by laboratories. The final results on the TMI-1 samples became available in August 1994 and showed that the general crud deposits were mainly an iron/nickel oxide with the appearance of magnetite. The deposit composition differs from that expected of RCS crud circulating in a pressurized water reactor. The samples have a lower nickel content, and extremely small zirconium and chromium content when compared to results of EPRI data reports on Westinghouse reactors.

During a B&WOG meeting on August 9 and 10, 1994 a working group met at the request of the B&WOG Plant Performance Committee to perform a root cause analysis on the CRDM slow drop time problem. The Kepner-Tregoe problem

analysis process was utilized by the working group to determine the root cause with the following results:

CAUSE - Corrosion products originating either within or external to the CRDM motor tubes are precipitating/depositing, over time, in the region of thermal barrier ball check valves and lead screw bushing. This is thought to be due to the thermal gradient and local pH of the primary coolant.

CONTRIBUTING FACTORS -

1. Low pH in the drive causes accelerated corrosion,
2. precipitation of CRUD in the check valve location,
3. large temperature gradient at the CRDM thermal barrier (ball check area),
4. reduced mechanical agitation (increases a drive's susceptibility to the problem),
5. construction materials used in the CRDM (ASTM 439 nodular cast iron is used for several CRDM parts including the buffer spring retainer),
6. transport of CRUD from RCS and
7. impurities in CRDM fill water.

(Items 6 and 7 are believed to make a significantly lower contribution to the problem than the other contributing factors based on the data available)

Both the GPUN and B&WOG root cause investigations continue; items being evaluated include:

1. investigation of the susceptibility of ASTM 439 material to corrode and provide deposit material,
2. investigation/determination of the temperature profile of a CRDM thermal barrier and the CRDM motor tube overall and
3. obtaining periodic general RCS primary water crud samples and possibly CRDM motor tube water crud samples for chemistry analysis.

IV. Short Term Corrective Actions

GPUN has taken the following corrective actions to minimize the crud buildup within the CRDMs:

1. The RCS lithium concentration was increased to raise circulating coolant pH and reduce the corrosion rate.

2. Surveillance procedure 1303-3.1, Control Rod Movement, was revised in April 1994 to increase the rod travel of Group 1 through 6 rods to at least 10% of full travel. Based on the drop times of Group 7 rods and the clean as-found condition of the Group 7 rod (mechanism 28, core location H-12) inspected during the 10R outage, increased rod travel is believed to improve conditions at the check valves. The increased control rod travel during the biweekly rod exercise is also intended to keep the guide bushing clear by assuring that the threaded portion of the lead screw travels sufficiently through the bushing to reduce any crud buildup in the gap between the lead screw and the bushing. Increased rod movement results in a slight increase in the primary coolant exchange and thus tends to increase the pH within the CRDM.

3. In restarting from the June 1994 shutdown, the reduction of crud levels in the RCS was emphasized. The RCS lithium concentration was significantly increased prior to CRDM venting and subsequent RCS heatup. The beginning of the fuel cycle lithium limit was also increased from 2.2 to 2.65 ppm so that the RCS "at temperature pH" is ≥ 6.9. It is expected that higher lithium concentration in the RCS will be beneficial in reducing the overall RCS corrosion rate, the corrosion rate of internal CRDM components, and thus the formation of both soluble and particulate crud available to be transferred to the CRDMs. Reduction of crud levels in the RCS bulk water prior to CRDM fill and vent may or may not have measurable impact on CRDM thermal barrier crud deposition. Both practices will continue to be applied consistent with the root cause determination, CRDM and fuel performance.

   The shutdown chemistry practice of early, hot boration/clean-up has been considered by GPUN and the B&WOG. It was concluded that the practice has a positive effect on reducing the RCS crud inventory. This action is expected to reduce crud transport from the RCS to the CRDMs during plant shutdown and later fill and vent operations. This type of shutdown has been performed at TMI-1 for the last three refueling outages and GPUN currently plans to continue the practice. Increased rod movement yields a slight increase in primary coolant exchange and a slight beneficial increase in pH within the CRDM.

These actions should have minimized the source of RCS corrosion products and should reduce the effect of crud formation in the thermal barrier guide bushing for the remainder of Cycle 10.

V. Longer Term Actions

A. Corrective Maintenance Plan

In 11R, an inspection of CRDMs is planned to determine to what extent the altered RCS chemistry and the enhanced rod exercise program have improved the condition of the CRDMs. It is believed however, that the thermal barriers will not be restored to the non-degraded condition without corrective maintenance actions. A return to a non-degraded condition will provide significantly improved rod drop times and essentially eliminate the chance of not meeting the TS requirements.

Because the problem of crud build-up on thermal barriers is common among B&W plants with Type A drives, the B&W Owners Group is sponsoring work by BWNT and BWNT contractors to address this problem. BWNT and their contractor Babcock & Wilcox have the facilities to experiment with thermal barriers removed from plants and the expertise to compare new designs with the original design basis for the CRDMs.

The attached time-line sketch (Attachment 3) shows two approaches to returning the thermal barriers to non-degraded conditions: cleaning and replacement of existing thermal barriers. Both of these approaches are being developed in parallel with the root cause investigations discussed previously.

1. Clean CRDM Thermal Barriers

The cleaning approach being pursued is in-situ while the reactor vessel closure head is on the closure head support stand. Cleaning would be the action of choice if it were convincingly demonstrated that future problems caused by crud deposition would be eliminated by a thermal barrier cleaned in combination with other operational improvements as discussed elsewhere. After the cleaning, several CRDMs would be inspected in order to ensure the effectiveness of the cleaning. An approach other than in-situ would disqualify the cleaning option since thermal barrier replacement would be more practical.

Key elements in the development of this approach would include:

a. Identification of all CRDM materials (and any other RCS and fuel materials) which will be contacted by the solvent.

b. Identification of deposit composition.

c. Selection of potentially effective solvent(s) via literature search, experience, etc. and knowledge gained in (a) and (b) above.

d. Actual deposit dissolution testing with proposed solvent(s).

e. Actual corrosion rate testing on most susceptible CRDM or RCS materials with proposed solvent(s).

f. Defined and acceptable waste handling methods.

2. Thermal Barrier Replacement

The following is the description and scope of the planned Control Rod Drive Mechanism Work for the TMI-1 11R Refueling Outage scheduled for September of 1995.

Funding and schedules have been established to replace 12 thermal barriers during 11R. The Control Rod Drive Mechanisms listed below are presently the likely candidates for replacement. The final determination will be made based on the pre-outage testing results. Those CRDMs that exceed a 1.45 second drop time during the pre-11R outage drop time testing will be considered for replacement.

CORE LOCATION	MECHANISM #	REASON
B-10	10	Remaining 8 of the 12 rods that have previously exceeded TS criterion.
F-14	9	
M-13	31	
O-11	32	
O-05	50	
K-13	4	
O-07	48	
K-03	57	
F-06	42	Evidence of previous gasket leak (old gasket)
G-11	8	Rod drop time of 1.52 sec.

H-08	30	Rod drop times of 1.43 and 1.44 respectively
E-11	13	

The 11R Refueling Outage plan will include various levels of contingency planning for replacement of up to 24 thermal barriers if the increased scope is deemed appropriate.

The replacement thermal barrier might be the improved Type A design the same as that installed in June 1994 or another design modified to limit the crud deposit effects on CRDM drop times. The improved Type A thermal barrier reduces sensitivity to crud deposition by virtue of larger clearances for the ball check valve race.

An additional option being considered is the replacement of entire CRDMs with Type C drives, however, it is not known if this is practical for 11R.

In the two refueling outages following 11R, additional thermal barriers or CRDMs would be replaced. Alternately, a cleaning approach might be utilized in these later outages. Information being obtained includes: an estimate of fabrication times, on-site requirements for thermal barrier replacement with a modified Type A thermal barrier, replacement with a revised design thermal barrier and the cleaning requirements. When this information has been received and evaluated, GPUN can determine the decision date for the choice of the approach to be taken. This plan may be altered if one of the options, e.g. cleaning, is abandoned early as a solution for implementation during 11R.

GPUN has high confidence that these 11R corrective actions will result in no rods exceeding the TS limit during Cycle 11 and all rods demonstrating a significant margin to the TS limit by Cycle 13. Given replacement of thermal barriers as outlined above, GPUN estimates an average drop time of 1.34 seconds with variability similar to that experienced in Cycles 6-8.

In addition, TMI-1 fuel design changes being implemented in current reload batches, starting with Cycle 10, will result in slightly increased (approximately .05 sec) rod drop times due to the reduced number of flow holes in the fuel assembly control rod guide tubes.

B. Reduced Beginning of Cycle Boron Concentration

The Cycle 11 preliminary designs for core loading are being developed such that the begining of cycle (BOC) boron concentration is minimized to reduce the high boron/low pH effects which may contribute to acceleration of crud formation in the CRD thermal barriers. A target

value of 1700 ppm for BOC hot full power boron was chosen to maintain pH ≥ 6.9 while maintaining reasonable lithium levels. Note that the chemistry changes were based on preliminary root cause evaluations and may change as a result of additional on-going evaluations. Fuel oxide measurements currently scheduled for post-11R may provide additional data which could influence the operating pH/Li specification and/or later cycle boron concentration requirements. Core design, fuel performance and operating recommendations related to peaking margins, vessel fluence, and other limiting considerations are all potentially impacted by changes in the root cause evaluation determination.

VI. Control Rod Drop Testing Plan

The TMI-1 TS requires control rod drop time measurement following each refueling outage prior to the return to power. The purpose of the testing is to verify that control rod drop time to 75% insertion at hot full flow conditions is no more than 1.66 seconds. The ball check valves have small clearance between the ball and the cavity wall. Experience has shown that crud buildup on the ball and cavity wall has stuck the ball in place and prevented the valves from opening. Meeting the TS drop time requires the opening of at least one ball check valve in the thermal barrier to allow coolant to flow into the CRDM housing. Therefore, if all four check valves are stuck closed, drop times will exceed the TS limit. Drop time is then dependent upon and determined by the clearance between the guide bushing and lead screw.

Control rod drop time testing was performed on June 1, 1994. The objective of the testing was to confirm that the condition had not worsened. Attachment 2 indicates the average as found and as left drop times since 9R. The times are grouped by 1) those that have never failed to meet the TS limit and 2) the eight remaining rods that exceeded the TS limit during the March test and have not had thermal barriers replaced. Although the average as found drop times for the June 1, 1994 test increased from as left conditions for both good and previously slow rods, the results indicate that the corrective actions taken in March 1994 have reduced the drop time degradation. The as found average drop times were better for the June 1 test than those found during the March test.

In addition, four thermal barriers were inspected during the 10P3 outage and confirmed that the slow drop times were due to crud deposits in the thermal barrier region. These four thermal barriers were replaced and post repair testing resulted in drop times equivalent to those for new mechanisms. These inspection results and the results of drop time testing confirmed that the condition had not worsened and that it is caused by crud deposits in the thermal barriers. Therefore, there is no need for additional testing during Cycle 10.

Drop time is not a continuous function with time or crud deposition because of the effect of check valve sticking. It is not feasible to

predict the rate of crud deposition from times for individual rods, but conclusions can be drawn from the overall performance of the rods and from the chemistry conditions in the RCS and CRDM.

A number of the remaining rods have increased drop times since 8R indicating that some of the ball check valves are stuck closed. Although continued crud deposition could result in sticking the remaining check valves on one or more rods causing rod drop time to exceed the TS limit, GPUN has concluded that the following actions provide reasonable assurance that the TS criterion will be met for the remainder of Cycle 10:

1. Replaced thermal barriers on all rods that have had slow times in two separate outages.

2. Improved chemistry conditions in the RCS for the remainder of Cycle 10 make deposits from the RCS less available

3. Improved chemistry in the CRDM housing to reduce corrosion rates of internal CRDM parts

4. Increased travel during exercise helps check valve performance possibly by improving chemistry in the thermal barrier region

Additional data will be obtained to confirm the effectiveness of corrective actions taken to date and to plan maintenance activities. Pending resolution of the drop time problem, the following supplemental testing is planned:

1. The 75% insertion limit switches have been connected to the Plant Process Computer (PPC) and in the event of an unplanned trip, the PPC will collect drop time data for rods in Groups 1 through 6. As a result of Group 7 rods being partially inserted, the insertion times would be less than the test from the fully withdrawn position. Group 7 rods would not be trip tested unless the partial trip data indicated a potential slow rod.

2. For the remainder of Cycle 10, drop time testing of all 61 trippable rods will be performed for each reactor shutdown* that occurs after 4 months of operation since the previous test; unless the data was collected via the PPC as identified above.

3. Drop time testing will be performed at the beginning as well as at the end of the 11R outage.

* If plant conditions require an immediate cooldown, drop time testing will be performed on startup after reestablishing hot RCS conditions.

If any rod is found to exceed the TS drop time:

1. The NRC will be promptly notified and, if required (more than one rod is involved), 10CFR 50.72 and 10CFR 50.73 reports will be made.

2. Drop time performance will be evaluated including overall drop times, history of the affected rod(s), and number of affected rods.

3. The out of specification CRDMs identified during pre-11R outage testing will be added to the 11R refueling list for thermal barrier replacement.

4. Any out of specification rods will be restored to meet the TS limit by exercising, obtaining approval for a revised TS limit, a combination of the previous options or by repairing the CRDM before the Unit is restarted.

5. The testing plan will be re-evaluated.

For Cycle 11, the drop time test plan will be based on pre-11R test results, BWNT Owners Group findings, and the corrective actions implemented in 11R. The objective is to regain a high level of assurance that drop times will be maintained within the TS limits the entire fuel cycle so that supplemental testing is not required.

VII. Licensing Considerations

On May 20, 1994 GPUN submitted TS Change Request 244 which requested a revised control rod trip insertion time test criterion. The proposed revised criterion would be applicable to 12 specific rods for the duration of Cycle 10. The 12 specific rods are those that were slow in the 10U2 tests. These rods would be considered operable if the maximum control rod trip insertion time from a fully withdrawn position to ¾ insertion did not exceed 2.11 seconds at hot coolant full flow conditions. The 2.11 second criterion is the calculated drop time based on dynamic hydraulic modeling of the control rod drive mechanism assuming that all four thermal barrier ball check valves are stuck closed and nominal clearances exist in the lead screw-thermal barrier bushing gap.

The High Power Reactor Trip set point was evaluated for low power operation and it was found necessary to reduce the set point when reactor power is brought below 47%. This was done to assure the validity of the safety analysis which considered all control rods as having a drop time of 3.0 seconds. This action was taken in support of TSCR 244. The NRC has the TSCR submittal under consideration but has not yet approved the request.

VIII. Conclusions

The short term corrective actions taken to raise RCS pH and increase the length of control rod travel during the bi-weekly exercise coupled with the replacement of four CRDM thermal barriers with a model less susceptible to ball check valve sticking provide reasonable assurance that the TS control rod drop time limit of 1.66 seconds will not be exceeded during the remainder of Cycle 10.

In the event ball check valve sticking remains enough of a problem to cause rods to exceed 1.66 seconds, the safety analysis submitted in support of TSCR 244 shows that with all rods inserting within 3.0 seconds the safety analysis acceptance criteria would not be exceeded, provided the overpower trip set point is reduced at low power. The startup and shutdown procedures have been changed to require the overpower trip setpoint to be reduced at low power to maintain the validity of the safety analysis. Since the likelihood of any rod exceeding a 3.0 second drop time is considered very low given the corrective actions taken to date, the near term nuclear safety impact associated with the existing condition is considered to be minimal.

This long term plan with the addressed testing plan, the corrective maintenance plan and efforts to isolate the root cause are considered to be a practical and timely approach to the resolution of the problem. It can be executed with no adverse effect on the health and safety of the public and minimal impact on plant operation.

IX. References

1. NRC to GPUN Letter, Three Mile Island Unit 1 - Control Rod Drop Time Criteria (TAC No. M89053) dated May 26, 1994.

2. GPUN to NRC, Cycle 10 Control Rod Drop Times dated March 26, 1994

3. NRC to GPUN Letter, NRC Confirmatory Action Letter 1-94-004 to GPUN dated March 29, 1994.

4. GPUN to NRC, Licensee Event Report 94-002, Control Rod Drop Times Exceed TS Section 4.7.1.1 Limits dated April 18, 1994.

5. GPUN to NRC, Control Rod Drive Testing Contingency Plan dated April 22, 1994.

6. NRC to GPUN Letter, Summary of May 3, 1994 Meeting with GPU Nuclear Corporation Regarding Control Rod Drop Time Criteria at Three Mile Island Nuclear Station, Unit 1 (TMI-1) (TAC No. M89053) dated May 12, 1994.

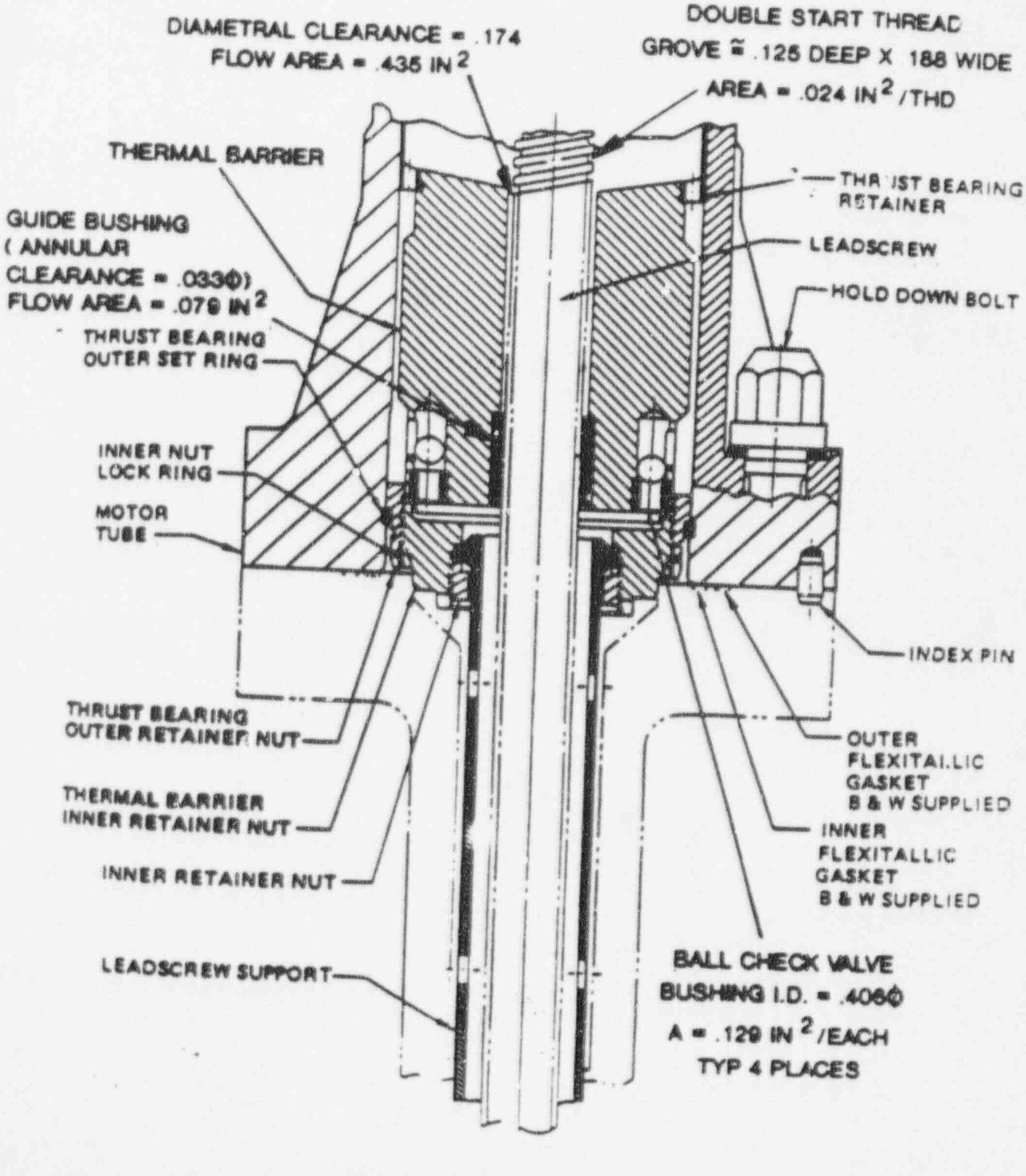
7. GPUN to NRC, Technical Specification Change Request No. 244 Cycle 10 Control Rod Trip Insertion Time Testing dated May 20, 1994.

8. GPUN to NRC, Licensee Event Report 94-004, Three Control Rod Drop Times Exceed TS Section 4.7.1.1 Limits dated June 24, 1994.

9. NRC to GPUN Letter, Summary of July 12, 1994 Meeting with GPU Nuclear Corporation Regarding Control Rod Drop Time Issues at Three Mile Island Nuclear Station, Unit 1 (TMI-1) (TAC No. M89494) dated August 3, 1994.

10. Plant Experience Report 94-002, Rev 2, Control Rod Drop Times dated September 2, 1994.

CRDM THERMAL BARRIER REGION



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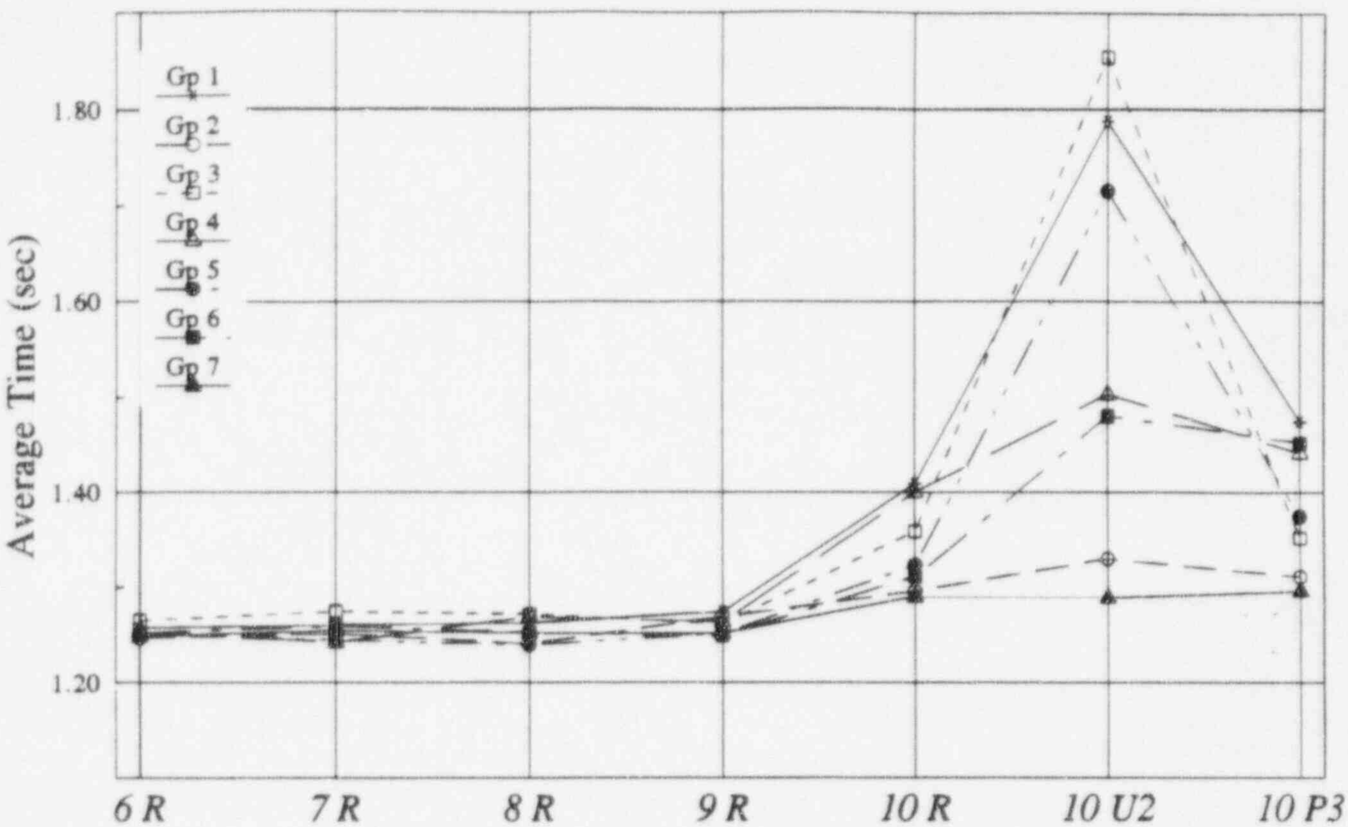

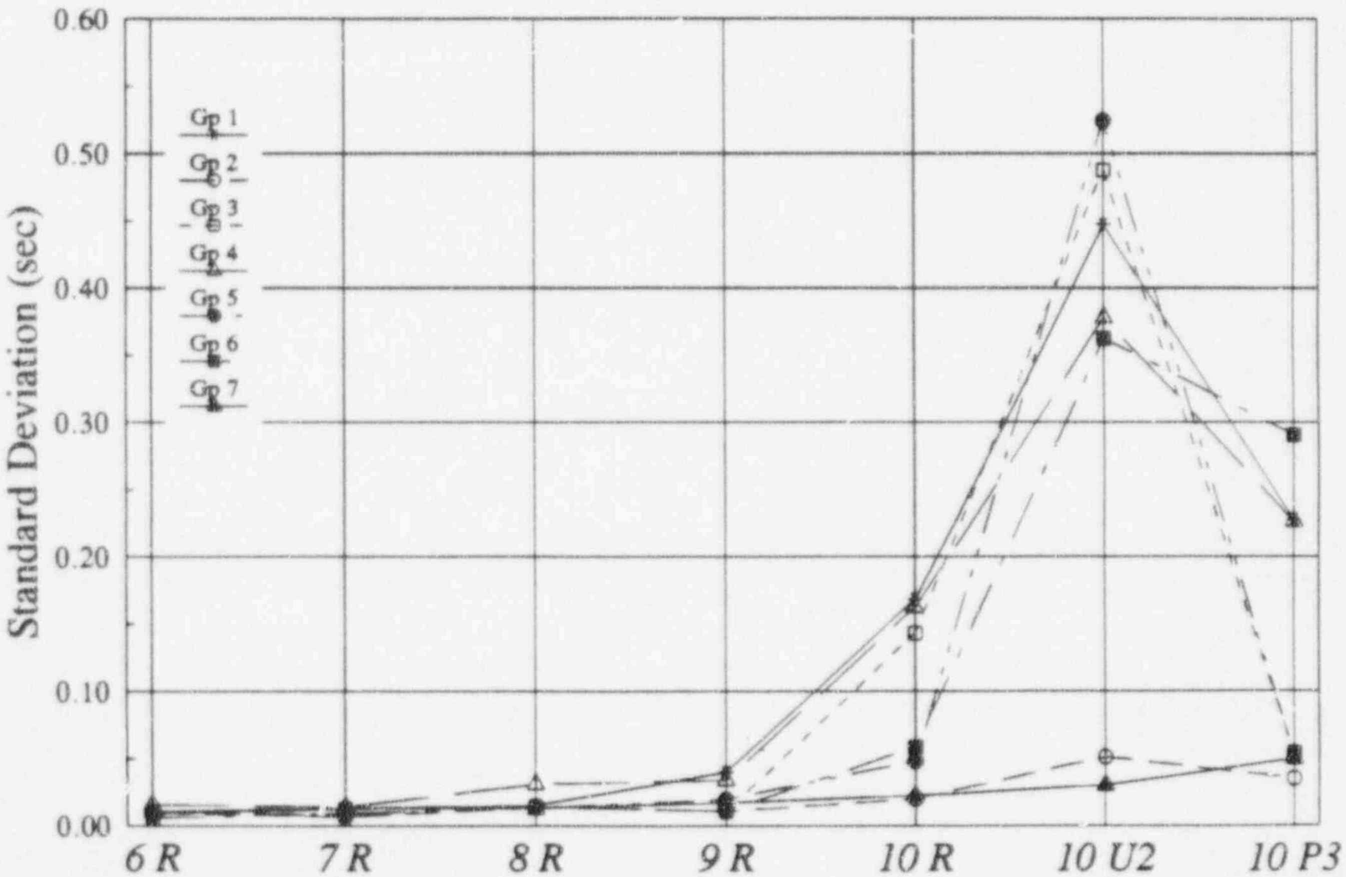

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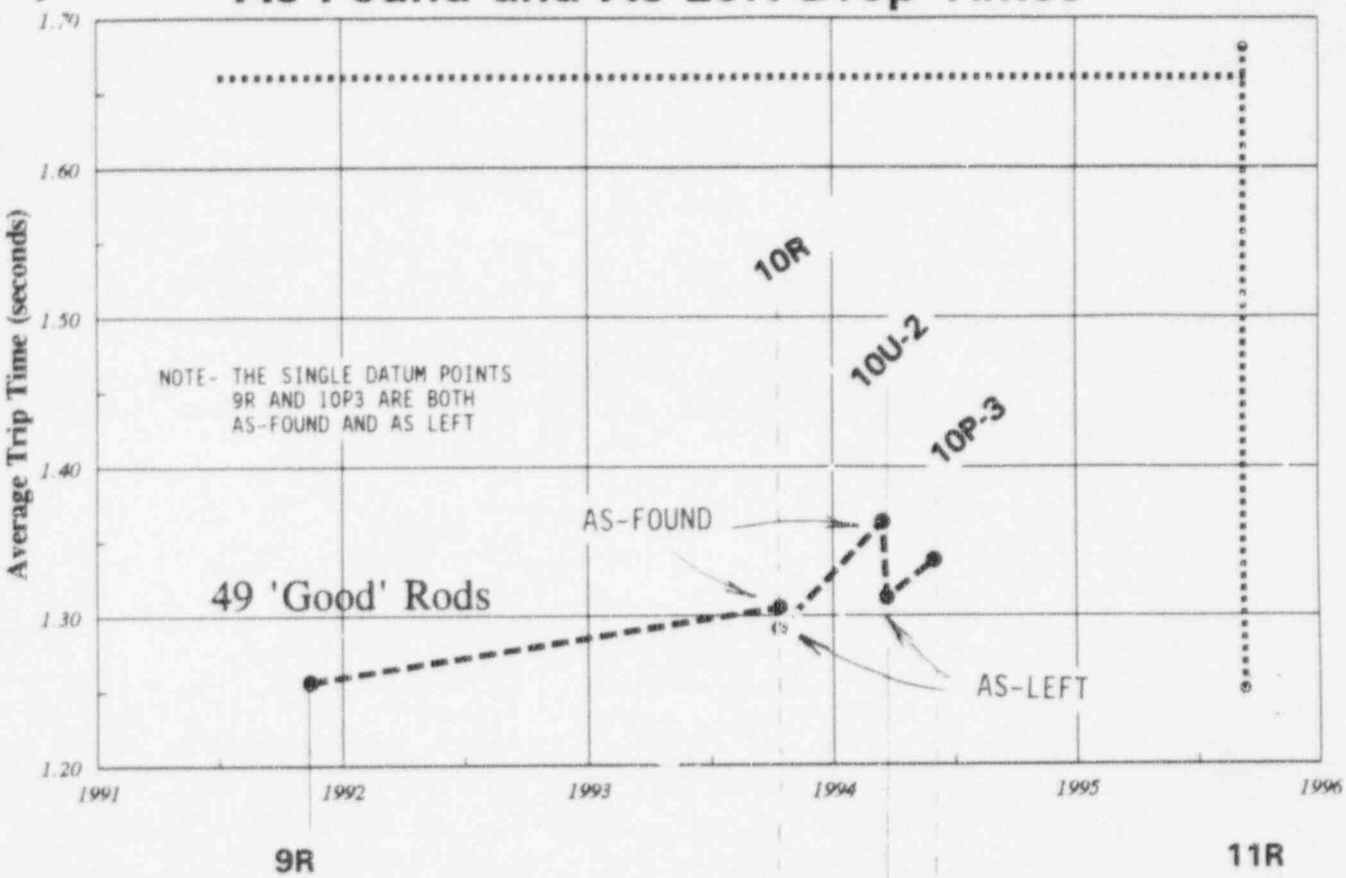
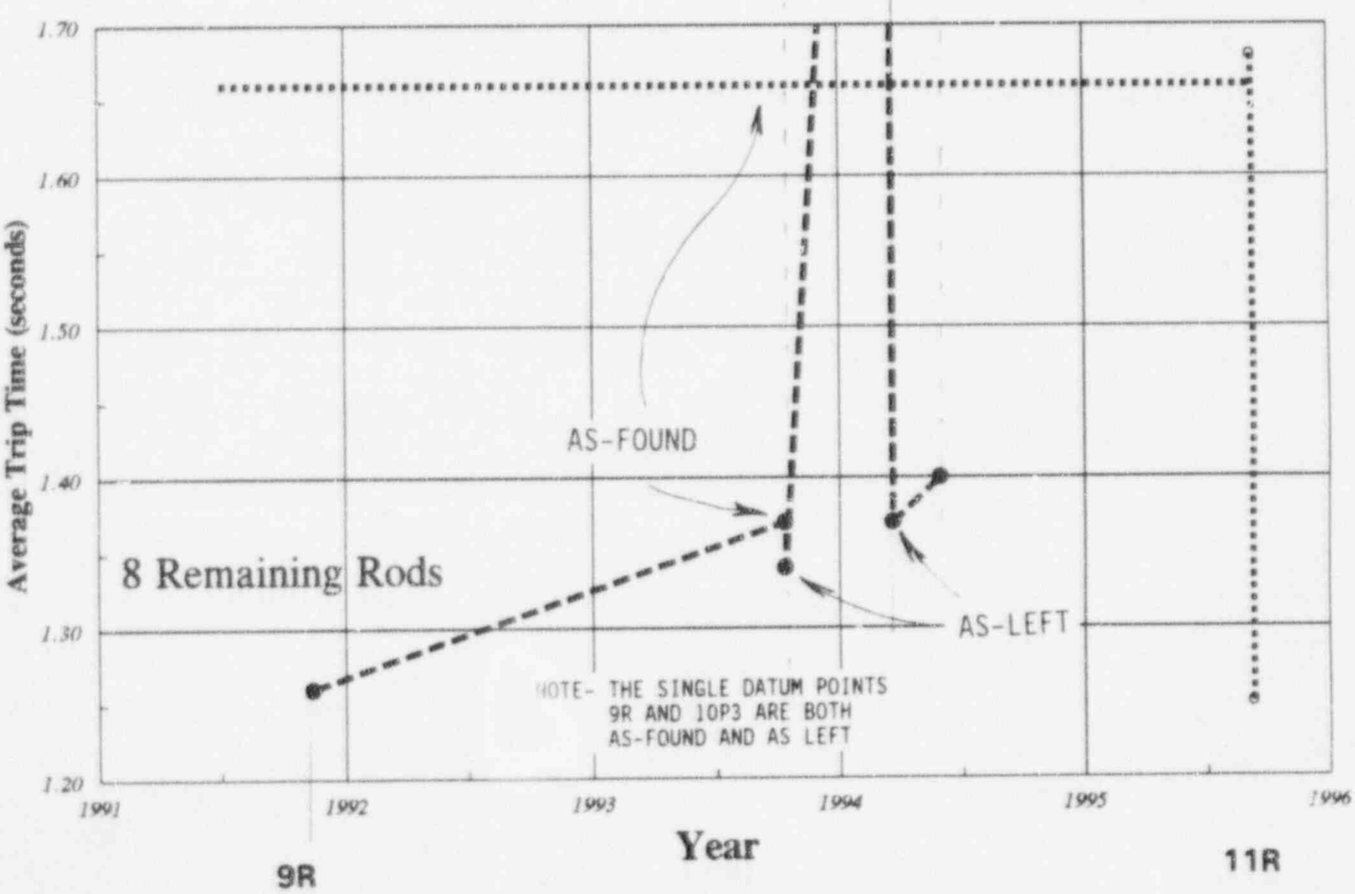
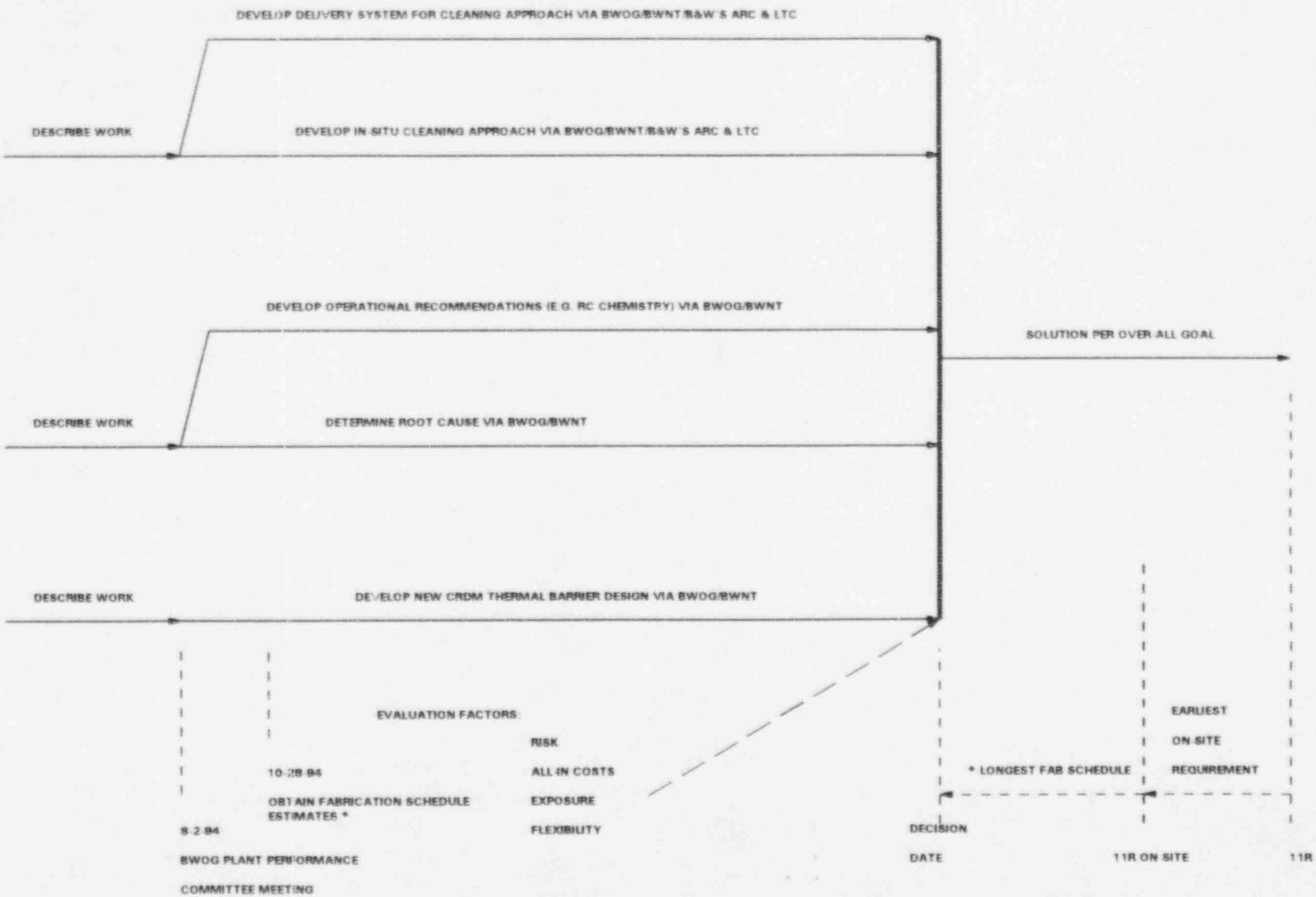




LONG RANGE SOLUTION TO CONTROL ROD DROP TIME ISSUE



Attachment 3
C311-94-2125
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