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 AUTH. NAME: BYRAM, R.G.    AUTHOR AFFILIATION: Pennsylvania Power & Light Co.  
 RECIP. NAME: MARTIN, T.T.    RECIPIENT AFFILIATION: Region 1 (Post 820201)

SUBJECT: Suppl info to licensee ltr dtd 931104 re CAL 1-93-18 dtd 931029, informing NRC that util met conditions as specified in CAL 1-93-18 dtd 931029 & planning to resume refueling activities.

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# Pennsylvania Power & Light Company

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Robert G. Byram  
Senior Vice President-Nuclear  
215/774-7502

November 5, 1993

Mr. Thomas T. Martin  
Regional Administrator  
U.S. Nuclear Regulatory Commission  
Region I  
475 Allendale Road  
King of Prussia, PA 19406

**SUSQUEHANNA STEAM ELECTRIC STATION  
RESUMPTION OF REFUELING ACTIVITIES**  
PLA - 4046 FILE R41-2

Docket No. 50-387

Dear Mr. Martin:

This letter provides supplemental information to Pennsylvania Power & Light's letter (PLA-4045) dated November 4, 1993 concerning Confirmatory Action Letter 1-93-18 dated October 29, 1993. The purpose of this letter is to inform you that Pennsylvania Power and Light Company (PP&L) has met the conditions as specified in Confirmatory Action Letter 1-93-18 dated October 29, 1993 and is planning to resume refueling activities. As stated in the Confirmatory Action Letter PP&L has:

1. Reviewed all root cause analyses and corrective and compensatory actions with Mr. Rob Temps (AIT Leader).
2. Ensured that the AIT Leader was cognizant of all plans to conduct testing, maintenance and repair of any fuel handling equipment or associated components and obtained his agreement prior to proceeding.
3. Made available for review by the AIT, all documentation (including analysis, assessments, reports, procedures, drawings, personnel training and qualification records, and correspondence) that have pertinence to the refueling bridge problems encountered during the current refueling activities.
4. Made available for review by the AIT, all equipment, assemblies, and components that were associated with the problems encountered during the current refueling activities.
5. Made available for interview by the AIT, all personnel that were associated with, or have information or knowledge that pertains to the problems encountered during the current refueling activities.

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As a result of recent events at Susquehanna involving refueling floor activities during the Unit 1 7th Refueling Outage, PP&L designated several Event Review Teams (ERTs), totalling approximately 25 multi-discipline personnel. These ERTs were responsible for performing in-depth root cause analysis of each event, addressing corrective actions for each and for consolidating these results into a comprehensive and effective plan for resumption of core reload in the current outage and for conduct of future outages. The details of the ERT results for the four events of potential significance are included in Attachment A. In addition, PP&L's Nuclear Safety Assessment Group was tasked with providing an independent review and providing results to the event review team. All NSAG findings were reviewed and it has been confirmed that these issues had been addressed by the event reviews and by the corrective action plan.

These events were:

1. A core offloading error occurred on October 6, 1993 when an incorrect fuel bundle was grappled and removed from the core.
2. On October 26, 1993 a non-load-bearing telescoping section of the Unit 1 Refueling Bridge mast assembly became bound and subsequently dropped onto the grapple portion of the assembly.
3. On October 27, 1993 a double control rod blade guide impacted the Reactor Vessel wall while being moved to the Spent Fuel Pool.
4. On October 28, 1993, a non load-bearing section of the Unit 2 Refueling Bridge mast assembly (which was being used to conduct Unit 1 reload) became bound and subsequently dropped in a similar manner as had occurred on the Unit 1 Refueling Bridge mast assembly.

## **HISTORICAL PERSPECTIVE**

A review of historical events on the Refueling Floor shows that several events have occurred in which the Refueling Bridge Main Grapple Assembly has become bent. A review of industry information, although not easily compiled or verified, shows Susquehanna to have a higher frequency of occurrence than other similar plants. The majority of these events were caused by the Refueling Bridge Main Grapple Assembly contacting an object in the Refueling Cavity or Fuel Pool. At the time of each individual occurrence an investigation was performed and corrective actions taken. For many of the events "operator error" or "inattention to detail" were determined to be the cause. Each event by itself was judged to be of minor safety significance. This may have contributed to a failure to identify adverse trends and establish the true root cause. We failed over the years to recognize the adverse trend these events presented and to initiate more thorough root cause analysis of each individual event and the generic issues.

Our present effort has included a more detailed analysis of recent events, as noted above, along with a review of the original design of the Refueling Bridge Main Grapple Assembly. This design review has given us a new perspective on the proper operation of the Refueling Bridge. We now recognize that:

1. Management oversight and control of the Refueling Floor needs to be enhanced.
2. Limitations of the Refueling Equipment were not understood nor factored into procedures, including:

- o Operation of the Main Grapple Assembly in the vertical direction while the Refueling Bridge is moving horizontally was never considered in the structural design of the Main Grapple Assembly.
  - o A rapid stop of the Refueling Bridge with an extended and loaded Main Grapple Assembly can cause bending of the Main Grapple Assembly.
  - o Any impact of the Main Grapple Assembly, however minor in nature, is beyond the original design considerations and may cause bending of the telescoping sections.
3. PP&L's prior investigations of refueling events were less than adequate.

We now believe that this information, had it been obtained and understood during the review of historical events, would have led to more positive corrective actions and would have prevented the recent "bending" events.

#### **SUMMARY OF SIGNIFICANT ISSUES**

As a result of all the efforts put forth by PP&L in our investigation and analysis of recent events, historical events and design information, the following are considered the more significant issues.

1. Activities on the Refueling Floor lack a clear, accountable organizational structure. Most activities on the Refueling Floor are under the direction of station Maintenance. Actual fuel handling is under the control of Operations. Other core alterations are under the direction of Reactor Engineering. The ownership of major pieces of equipment, many of which are thought of as tools, is not clear. As a result, we lacked clear accountability for work activities.
2. Procedural controls for Refueling activities have not provided specific directions for reliable operation of the Refueling Bridge nor specific directions for recovery from off-normal conditions.
3. PP&L has examples of previous root cause analyses of events where human performance or design causes are identified as the root causes. These are judged to be less than thorough or complete. As noted above, we believe this to be the case with historical events on the Refueling Floor. We are concerned that this shortcoming may exist in other areas.
4. Monitoring of fuel handling activities by station management had been less than adequate. No structured nor routine monitoring of fuel handling activities had been implemented by station management to ensure the proper communication and fulfillment of management expectations.
5. Operators have not followed procedures subsequent to identifying fuel handling anomalies.

#### **CORRECTIVE ACTIONS**

The following is a compilation of corrective actions taken by PP&L as a result of our investigation and analysis of events:

1. Procedures

- o Plant Procedure OP-TY-081 is being developed to direct Refueling operations. It will incorporate specific direction on proper bundle verification, single direction bridge/grapple assembly motion, monitoring main grapple assembly performance, and restricting bridge travel between reactor and spent fuel pool to having main grapple assembly in its "normal up" position. Fuel loading operations will not be commenced until walkthrough using the procedures, training on the procedures and final review by the Plant Operations Review Committee are complete.
- o Plant Procedure ON-081-002 has been issued to direct recovery from Fuel Handling Anomalies such as selection of incorrect fuel bundle, any impact or sudden stop of the refueling bridge or Main Grapple Assembly, and mechanical or electrical failures of bridge equipment.
- o Bridge surveillance procedures have been reformatted to avoid confusion in selection of proper operability or post maintenance testing.
- o Main Grapple Assembly functional testing is required every 24 hours during refueling periods.

2. Mechanical

- o A new Main Grapple Assembly has been installed and will be fully tested prior to use on the Unit 1 Refuel Bridge.

3. Training

- o Operator training materials based on event reviews, procedure changes and current understanding of Refuel Bridge design and operational restrictions has been developed and will be presented to Refueling Floor operators-classroom and hands on OJT.
- o Reinforcement of Station Policy on Procedural Compliance.

4. Personnel

- o Maximum time for any crew on the Refueling Bridge is limited to no more than 3 consecutive hours.
- o A structured program for monitoring refueling floor activities by station management has been developed, including a period of continuous observation during the initial 24 hours of Refueling Operations and subsequent monitoring of at least 2 hours per each 12 hour shift.
- o Independent Quality Assurance observation of fuel handling has been instituted.

Future corrective actions which will be taken include:

1. Organization

A review team of station managers has been commissioned to define roles, responsibilities, and organizational structure for all refuel floor activities.

2. Procedures

Upon completion of the above study, consolidation of permanent refuel floor procedures will be completed.

3. Design

The schedule for a major project to enhance the overall design of the refueling bridge has been accelerated. Any short term actions resulting from the project will be implemented prior to Unit 2 6th Refuel Outage scheduled to commence March 1994 with longer term actions planned prior to Unit 1 8th Refuel Outage.

4. Root Cause


An integrated review team is being commissioned to assess root cause analysis of events involving Human Performance and Design. This team will research, analyze and recommend changes to Root Cause investigation and our self assessment process. It will identify issues that represent examples of management acceptance of less than adequate conclusions.

While several further enhancements are being implemented and longer term enhancements are being evaluated for future refueling outages, the above specific actions, when complete, will insure that all refueling activities are conducted in a safe manner.

Based upon the above, PP&L has met the conditions of the Confirmatory Action Letter and is preparing to resume refueling activities.

If you have any questions, please contact us.

Very truly yours,

  
for R. G. Byram

/ml

Attachment

cc: NRC Document Control Desk  
Mr. R.J. Clark, NRC Sr. Project Manager  
Mr. G.S. Barber, NRC Sr. Resident Inspector (SSES)  
Mr. R. Temps, NRC Sr. Operations Engineer - Region I  
Mr. W.P. Dornsife, PA DER/BRP

1. On October 6, 1993 at 0740 hours, a core offloading error occurred during the unloading of cell location 29-36. The bridge operator grappled the bundle at location 31-56 by mistake. Subsequently, this bundle was raised out of the core in preparation to transport to the fuel pool. The error was noted at this time and the bundle was returned to its original core location.

There were four root causes associated with this event. These were:

- o The Plant Control Operator (PCO) relied solely on the bridge encoder position indication system to determine grapple location.
- o The refueling floor Senior Reactor Operator (SRO) did not confirm the correct bundle being grappled.
- o The Procedural requirement prohibiting return of a refuel bundle to the core during offload operations was not followed.
- o Refueling operators did not follow the proper chain of command to the Shift Supervisor. Communications were to the Outage Supervisor (SRO).
- o Poor communication between the Outage Supervisor (SRO) and the Reactor Engineer allowed the bundle to be returned to the core.

Two additional causal factors were:

- o Core flow patterns caused the grapple to drift; therefore the actual position differed from the encoder indication.
- o Bundles located near periphery and core shroud limit the operator's view.

Since it was confirmed that the bundle was properly returned to core location 31-56, there were no safety consequences with respect to the core, based on the fact that Unit 1 Cycle 7 analysis was still valid. No bundles were ever in unanalyzed locations in the core. The potential existed, however, for misloading the bundle into a control cell which had its control rod withdrawn. This would have resulted in a violation of Technical Specification 3.9.10.2e.

Corrective actions that have been completed for this event are:

- o Procedural changes and operator training to ensure that the Control Room PCO and Refuel Floor SRO confirm correct grapple alignment of each bundle using a core map, with bail handles illustrated, and that they communicate this to the Bridge PCO.



- o Procedural changes and operator training to ensure that the Bridge PCO and the Refuel Floor SRO concur on correct location and mast alignment when grappling a fuel bundle in the fuel pool or core.
- o Procedural changes and operator training to ensure that all operators involved in core alterations review the FACCTAS instructions prior to assuming their shift of fuel movement and that they document that they have completed this review.
- o An off-normal procedure has been issued to direct recovery from fuel handling anomalies such as selection of an incorrect fuel bundle to include communication via the chain of command to the Shift Supervisor.

Corrective actions that are scheduled to be completed or in place prior to the Unit 2 sixth refuel and inspection outage are:

- o Pre-outage training is to be enhanced such that it includes a review of all core refuel and programmatic controls; a discussion of potential errors using the encoders; and core offload/reload strategy for the outage.
  - o Consolidation of all core refueling procedures into one procedure which controls all fuel movements.
2. On October 26, 1993 at 1008 hours during Unit 1 core reload, a fuel bundle was being lowered into the reactor vessel using the Unit 1 refueling bridge Main Grapple Assembly when a section of the telescoping mast became stuck and did not telescope as designed. Operators on the refueling bridge were not aware that the section had become stuck. As the bundle lowering was continued, the mast section became free from the stuck position and dropped to its normal telescoping position. The lower mast section and the fuel bundle did not drop during this event. All fuel movement using the Unit 1 refueling bridge was stopped in order to inspect the telescoping mast.

The root cause of this event was determined to be that the Main Grapple Assembly fixed or telescoping sections were bent, causing the telescoping sections to stick and not telescope downward as designed. The mast was bent when the unloaded Main Grapple Assembly grapple head impacted the reactor pressure vessel flange protector while traversing from the reactor vessel to the spent fuel storage pool immediately prior to lifting the fuel bundle described in the event. This impact was not observed by personnel on the bridge at the time.

There were no safety consequences associated with this event. The fuel bundle that was grappled at the time of the event did not drop when the telescoping mast section became free. The bundle did not contact any reactor vessel components. The radiological conditions of the refueling floor did not change as a result of this event. Analysis of the reactor vessel flange protector in the area of impact showed that there was no damage to the vessel.

The corrective actions that have been completed for this event are:

- o The fuel bundle that was loaded on the Unit 1 refueling bridge mast at the time that the mast section dropped has been administratively segregated to ensure an inspection and evaluation are performed prior to use of the bundle.
- o The Unit 1 refueling bridge Main Grapple Assembly was replaced with a new Main Grapple Assembly and inspected for proper operation.
- o The refueling bridge procedures were revised to provide specific guidance for mast evaluations and positions while in and between the reactor cavity and the spend fuel storage pool.
- o The refueling bridge procedures were also revised to ensure the Main Grapple Assembly telescoping sections seat on their respective stops and proper weight transfer is indicated prior to further downward motion.
- o Training with ROs/SROs on the event and the above procedural changes.
- o A design basis analysis of the bridge/mast operation was conducted.

Corrective action actions that will be completed for this event prior to commencing core reload are:

- o Perform the required maintenance checks and Operational surveillance testing of the refueling bridge.
3. On October 27, 1993, at 1538 hours, during movement of Double Blade Guide GEBB010 from the core to the fuel pool, the blade guide impacted the Reactor Pressure Vessel (RPV) wall. Although the bridge had been stopped prior to the contact, momentum carried the blade glide into the RPV wall. The mast was then raised so that the blade guide could clear the vessel flange and then the blade guide was placed into the fuel pool.

The root cause for this event was that the bridge operator failed to raise the main grapple sufficiently for the double blade guide to clear the RPV flange.

Causal factors associated with this event were:

- o Procedures did not require the mast to be full up prior to entering the transfer canal.
- o The bridge operator was focused on previous issues concerning grapple Z (vertical) coordinates and clearance for an unloaded grapple.
- o The use of the Unit 2 bridge requires bridge operators to adjust their motions due to the mirror-image orientation of the Unit 2 bridge.

There were no safety consequences associated with this event. The RPV wall at the impact area was inspected with a video camera. No obvious damage was observed. An engineering evaluation concluded that the RPV wall was not damaged and is safe for continued operation. The bail handle on the double blade guide was inspected and it was determined that the handle should be replaced.

Corrective actions that have been completed for this event are:

- o Procedural changes to upgrade controls for refueling operations.
- o Training with RO/SROs on the event and the above procedural changes.
- o Assignment of specific RO/SRO teams and reduction of RO bridge time from 4 hours to 3 hour shifts. RO/SRO teams to be swapped every 3 hours.
- o Assignment of a shift supervisor to monitor initial refueling from bridge to verify effectiveness of the procedure changes.
- o Re-confirmation of existing requirement that core periphery bundles must be moved toward the center of the core upon clearing top guide for ALARA concerns in the drywell.

Corrective actions that will be completed for this event prior to commencing core reload are:

- o Creation of a temporary procedure that consolidates refueling procedures. The procedure will incorporate visibility and reaction time cautions when using the Unit 2 bridge for Unit 1 refueling and vice versa.
- o Proceduralizing a requirement to ensure the trolley is at centerline prior to moving toward the fuel pool.
- o Incorporate information into operating procedures for control of bridge placard and required X, Y and Z coordinate information and provide training.

Corrective actions that will be completed for this event prior to the Unit 2 sixth refuel and inspection outage are:

- o Upgrade of the bridge and refueling communications systems.
- o Obtain GE recommendation and proceduralize recommendation for blade guide orientation while traversing.
- o Proceduralize the 3 hour time limit for refueling bridge stay time (RO/SRO).

4. On October 28, 1993 at 0710 hours, during core reload activities, the Unit 2 refueling bridge mast/grapple assembly was being lowered into the fuel pool to grapple a new fuel bundle (bundle S17-453). While lowering the mast/grapple assembly, sections of the mast hung up and did not telescope as designed. Subsequently, the mast sections became free and dropped. The 10 inch mast section transferred its weight to the 12 inch section, while the 7 inch section transferred its weight to the 5 inch section. All refueling moves were suspended and the mast/grapple assembly was left in its present position pending investigation and evaluation.

This event was caused by a bent mast which was attributed to a rapid stopping/reversal of the refueling bridge when horizontally moving a double blade guide from the reactor vessel to the spent fuel pool at 1538 hours on October 27, 1993.

There were no safety consequences as a result of this event. The radiological conditions on the refueling floor did not change as a result of this event.

Corrective actions that have been completed for this event are as follows:

- o An in-place inspection of the grapple using a camera was performed. The inspection showed that no part of the grapple was resting on the new fuel bundle bail handle.
- o An inspection of the fuel bundle bail handle after raising the grapple showed no unusual markings.
- o An inspection of the Main Grapple Assembly was performed and the determination was made that the mast was bowed and was unsuitable for further use.
- o Instructions for operators to ensure that the telescoping mast sections seat on their respective stops and that proper weight transfer is indicated were incorporated into the operating procedure that will be used to control core reload activities.

Corrective actions that will be completed prior to commencing core reload are:

- o A review of this event with all licensed operators assigned refueling duties.
- o Performance of refueling bridge operability surveillances.

An inspection of fuel bundle assembly S17-453 will be completed prior to its use. It has been administratively segregated until this inspection is complete.