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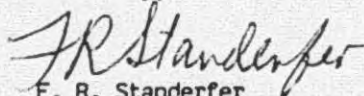
TMI Program Office
Attn: Dr. B. J. Snyder
Program Director
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Snyder:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Polar Crane Main Hoist Brakes and Hand Release Mechanism

As indicated in my letter of October 5, 1984, concerning the polar crane main hoist brakes and hand release mechanisms, a Polar Crane Review Group was established to examine problems associated with those brakes. The objectives of the Review Group were to determine the cause of the problems, if other conditions exist which could effect the safe operation of the polar crane, and to make recommendations to ensure its continued safe and reliable operation. The Review Group has completed its examination and has provided me a report of its findings and recommendations. A copy of that report is forwarded herein as a supporting document to my October 5, 1984, letter.

Sincerely,



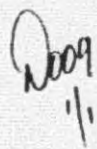
F. R. Standerfer
Vice President/Director, TMI-2

FRS/RER/jep

Attachment

cc: Deputy Program Director - TMI Program Office, Dr. W. D. Travers

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Subject: Polar Crane Review Group Report

Date: October 8, 1984
4400-84-0258

From: Co-Chairman, Polar Crane Review Group
R. E. Rogan

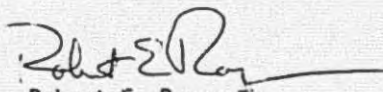
Location: Admin. Bldg.,
Room 103

To: Director, TMI-2
F. R. Standerfer

On September 6, 1984, the Polar Crane Review Group was established to examine problems associated with the main hoist brakes and hand release mechanisms of the Polar Crane. The Review Group has completed its inquiry into the matter. The attached report is an independent evaluation of the conditions which existed on the polar crane and the probable causes. This report represents the consensus of the Review Group and includes our findings and recommendations.

Supporting documentation has been assembled by A. R. Green, who served as the Recording Secretary for the Review Group, and is available for your review.

We are available at your convenience to discuss this report and matters related thereto.


Robert E. Rogan
Extension 8048

RER/mkk

Attachments

POLAR CRANE MAIN HOIST BRAKES AND HAND RELEASE ASSEMBLY

INTRODUCTION

On September 6, 1984, GPU Nuclear advised the TMI Program Office of recently discovered circumstances involving the TMI-2 polar crane main hoist brakes and hand release mechanisms. Additional information regarding this subject is detailed below.

On August 16, 1984, during an inspection of the polar crane, it was observed that the outboard brake on the main hoist was inoperable. Apparently the adjusting nut on the hand release mechanism attached to the outboard brake was out of position. The adjusting nut was repositioned on August 17, 1984 and the brake was returned to service.

An Incident Event Report (IER) was initiated on August 17, 1984 to document the "as found" condition of the outboard main hoist brake and to initiate appropriate followup evaluation. The IER evaluation identified that the hand release mechanism was an addition to the brake assembly received from the manufacturer, was not a component of the brake assemblies initially installed during plant construction, and was not identical to the hand release mechanism described in the manufacturer's technical literature supplied with the main hoist brake assemblies.

A re-inspection of the main hoist brakes was conducted on September 6, 1984. This inspection identified that (1) both main hoist brakes were in need of adjustment due to normal wear, (2) the outer jam nut on the main tie rod of both brakes was loose and not serving the intended function and (3) the main spring on the outboard brake required adjustment.

In view of the above findings, a Polar Crane Review Group (Review Group) was established by the Office of Director, TMI-2. The charter of the Review Group was to examine the problems identified with the hand release mechanisms and the main hoist brakes in an effort to determine the cause and assess the impact upon the safe operation of the crane.

This report provides an review of the Review Group activities, as well as their findings and recommendations. The report also describes actions GPU Nuclear has taken or will take to ensure the continued safe operation of the Polar Crane.

BACKGROUND

The initial plan for the refurbishment of the TMI-2 Polar Crane was generated by the Design Engineering organization of the TMI-2 Recovery Project located at the Bechtel offices in Gaithersburg, Maryland. A Polar Crane Refurbishment Task Group (Task Group), consisting of personnel from Bechtel and GPU Nuclear, as well as outside consulting crane specialists, was established to direct the actual crane refurbishment.

The refurbishment plan called for replacement of the Polar Crane main hoist brakes in-kind. The main hoist brakes are direct-current, clapper-type, twin magnet devices which are designed so that the brakes will release when the magnets are energized (i.e., the shoes will clear the wheel) and will be activated when the magnets are de-energized (i.e., the shoes are pressed against the wheel by means of a compression spring). The brake assemblies are redundant and automatically activated whenever the crane is not in the process of lifting or lowering a load. Each brake assembly is rated at one hundred fifty percent (150%) of the original rated capacity of the crane.

The manufacturer's literature identifies an optional device -- a hand release mechanism -- which, when attached to the main hoist brake frame, can be used to release the brakes manually. This device is intended for use in installation and testing or in case of a loss of power to the crane and there is a need to lower a suspended load. The hand release mechanism allows controlled release of brake torque and minimum shoe clearance to permit the wheel to turn and lower the load.

Initially, the plan for refurbishment of the crane, as reflected in the original purchase requisition, included procurement of replacement in-kind main hoist brake assemblies and the optional hand release mechanisms. A request for proposal, including the purchase requisition, was forwarded to the Whiting Corporation, the crane manufacturer. A proposal for brake replacement was developed and returned to Design Engineering. However, this proposal did not include installation of the hand release mechanism. A purchase order was issued by Bechtel based on that proposal. Thus, the requirement for the optional hand release mechanisms was omitted.

Two main hoist brake assemblies were received by GPU Nuclear from the manufacturer. A Quality Control receipt inspection verified that the brake assemblies received were as specified in the purchase order. Since the hand release mechanisms were not specified on the purchase order, the receipt inspection did not identify the hand release mechanisms as "not delivered" nor did the Quality Control inspector have cause to be aware of a plan to add such mechanisms to the brake assemblies.

After examining the main hoist brake assemblies and noting the absence of the hand release mechanisms, the Task Group consulted with the brake manufacturer concerning the placement of an order for hand release mechanisms. The manufacturer advised that the lead time to delivery was estimated to be 9 - 10 weeks. Since the delay in delivery would impact adversely on the then current schedule for the installation of the new brake assemblies, the Task Group decided to fabricate hand release mechanisms on-site.

A basic design for fabrication of the mechanisms was developed based on technical literature supplied by the vendor with the main hoist brake assemblies. This design was provided on Job Ticket CA 364, dated August 6, 1982, to the TMI-2 Maintenance Department for fabrication. The hand release mechanisms were fabricated, the job ticket was closed out on August 27, 1982, and the mechanisms were delivered to the Task Group. The mechanisms were installed on the replacement main hoist brake assemblies prior to staging in

the Reactor Building. Subsequently, in accordance with Bechtel Work Package M0020, dated September 16, 1982, the main hoist brake assemblies, with the hand release mechanisms attached, were staged in the Reactor Building and installed on the Polar Crane. Installation was completed during early December, 1982. This work was accomplished by TMI-2 Maintenance Department Mechanical Maintenance Technicians under the supervision of Mr. J. Graber, a member of the Polar Crane Refurbishment Task Group.

The main hoist brakes were adjusted in accordance with the manufacturer's technical literature during installation. Readjustment of each brake was accomplished during the no-load functional test of the Polar Crane on February 16, 1983. This readjustment was performed by TMI-2 Mechanical Maintenance Technicians and was supervised by a member of the Task Group. The adjustment during initial installation and subsequent readjustment during no load testing included specific adjustment of the magnet air gap; compression of the main spring was not adjusted on either occasion. According to the manufacturer's technical literature, "Spring compression is adjusted for nameplate torque rating at factory."

Main Hoist Brake operability was confirmed during the heavy load test of the Polar Crane during February 1984. TMI-2 Maintenance personnel and representatives of the Quality Control Group observed crane performance from the bridge and trolley platform of the crane and confirmed that no brake slippage occurred during the load test. No discrepancies in brake operability were noted at that time.

Upon completion of the heavy load test, refurbishment was considered complete and the Polar Crane was turned over to Site Operations for routine operation and maintenance. A preventative maintenance program was implemented. Inspection and maintenance of the main hoist brakes were included in this program.

A preventative maintenance inspection of the Polar Crane main hoist brakes was conducted prior to head lift on May 30 - 31, 1984. No discrepancies were noted during this inspection related to the operability of the brakes. However, the following discrepancies were noted:

1. The hand release mechanism handle on the inboard main hoist brake was found rotated 180° out of position.
2. Significant quantities of excess oil and grease were found on the deck of the trolley.
3. The tape used to retain the inboard brake hand release mechanism in the stowed position was missing.

These deficiencies were noted and appropriate corrective action was initiated.

On August 16, 1984, during an inspection of the auxiliary hoist of the Polar Crane, the task engineers observed that the brake shoes on the outboard brake of the main hoist did not appear to be in contact with the wheel. This condition was confirmed by inserting a laminated card between the brake shoes and the wheel. The task engineers notified the TMI-2 Maintenance Department of their observations. An Incident Event Report (IER) was initiated on

August 17, 1984, to document the "as found" condition of the brakes and to initiate appropriate followup evaluation to determine the cause. Also on August 17, 1984, the task engineers returned to the Polar Crane to complete their inspection. At this time, the Maintenance Department directed the Mechanical Maintenance Technician assigned to accompany the engineers on this entry to reposition the nut on the hand release mechanism. This task was accomplished, the brake shoes engaged the drum, and the brake assembly was determined to be operable by visual inspection.

In response to the Incident Event Report evaluation, which was unable to determine a root cause, a subsequent inspection of both main hoist brakes and the attached hand release mechanism was conducted on September 6, 1984. This inspection revealed that both main hoist brakes were in need of adjustment to compensate for normal brake shoe wear. In addition, the inspectors determined that (1) the main spring on the outboard main hoist brake was not at the optimal compression indicated in the technical literature and required adjustment and (2) the Main Tie Rod outer jam nut on both brakes was loose.

On September 7, 1984, Maintenance personnel returned to the Polar Crane and readjusted both brakes, readjusted the main spring on the outboard brake, and secured the outer jam nut on the main tie rod of each brake. A jam nut also was added to the hand release mechanism tie rod on each brake to secure the tie rods in place. In addition, all nuts were marked with reference points as a means of detecting future movement.

POLAR CRANE REVIEW GROUP

On September 6, 1984 the Office of Director, TMI-2, reviewed the basic information provided in the Incident Event Report concerning the outboard main hoist brake. Based upon questions surfaced but unanswered by the IER, the Director, TMI-2, established a special review group, the Polar Crane Review Group (Review Group), to inquire into the matter. The group was co-chaired by Mr. J. J. Barton, Office of the Director and Mr. R. E. Rogan, Director, Licensing and Nuclear Safety and was composed of the following additional members:

R. E. Sieglitz	Manager, Maintenance
D. Lake	Manager, Recovery Operations
R. Fenti	Operations Quality Assurance Manager
J. Schork	Safety Review Group Engineer
J. Graber	Technical Consultant, U.S. Crane Certification Bureau
A. R. Green	TMI-2 Plant Administration Manager

The Review Group convened on September 10, 1984 for the purposes of defining the scope of the review, outlining an appropriate strategy, and developing list of specific questions to be answered by the inquiry.

J. J. Barton reviewed the events leading up to the formation of review group and the purpose of its formation. R. E. Sieglitz presented a discussion of the characteristics and operation of the main hoist brakes and reviewed the process by which the hand release mechanisms were fabricated and installed. D. Lake reviewed pre-refurbishment photographs of the main hoist brakes, noting that the hand release mechanisms were not a component of the brake assemblies as originally installed. D. Lake also discussed the initial on-site design, fabrication, and installation of the hand release mechanisms on the crane. Variations in design between the manufacturers technical information and the job ticket directing fabrication were noted. D. Lake concluded his discussion by noting that the main hoist brakes were a Not Important to Safety (NITS) component.

Based on initial information available to the Polar Crane Review Group, the following facts were established:

1. The mispositioning of the hex nut on the tie rod of the hand release mechanism of the outboard main hoist brake restricted the expansion of the main spring, reducing the compression force being applied to the brake shoes by the main spring. As a result, the shoes did not make contact with the wheel and the brake was rendered inoperable.
2. The hand release mechanisms installed on the main hoist brakes were fabricated on site at TMI by the TMI-2 Maintenance Department in accordance with Job Ticket CA364, dated August 6, 1982.
3. The hand release mechanisms were installed on the Polar Crane as an integral part of the main hoist brake assemblies in accordance with Bechtel Work Package M0020, dated September 16, 1982. The actual installation on the Polar Crane was completed in early December 1982.

4. The hand release mechanisms installed on main hoist brakes of the Polar Crane matched the design drawing provided with Job Ticket CA364 with one exception. The locknut specified on the design sketch to secure the tie rod of the hand release mechanism in position was not installed on either mechanism. A regular hex nut was substituted on both brake assemblies.
5. The design sketches for the hand release mechanism which were attached to Job Ticket CA364 differed from the illustration in the manufacturer's technical literature in two cases. The manufacturer's illustration shows the tie rod threaded thru a tapped support block. The Job Ticket design shows a 5/8" threaded tie rod passing thru a 11/16" smooth bore in the support block. In addition, the manufacturer's illustration calls for a spring clip to be mounted on the support block to secure the hand release mechanism handle in the stowed position. The design accompanying the Job Ticket omitted this clip.
6. The main tie rod on both brake assemblies had been received and installed, as assembled by the manufacturer, with two jam nuts instead a standard hex nut and a jam nut, as specified in the manufacturer's technical literature.
7. The outer jam nut on both main tie rods was loose and, therefore, not performing the intended function. (Note: The inner adjusting nut had not moved.).
8. The compression on the main spring of the outboard brake assembly was reduced from its optimal setting, thus reducing the torque applied to the brake shoes.

The following questions were identified by the review group as requiring resolution:

NOTE: In the interest of clarity, for each question which has been answered as of the date of this report, the answer is provided following the question.

1. Job Ticket CA364 contained a later revision (dated December, 1978) of the manufacturer's technical literature on the main hoist brakes than was available to the TMI-2 Maintenance Department in its Crane manual (dated November, 1963). What was the source of the later revision?

ANSWER: H. Kirshbaum, a member of the original Polar Crane Refurbishment Task Force, confirmed that the technical information attached to Job Ticket CA364 was provided by the manufacturer in the replacement brake assembly package received at TMI during the summer of 1982.

2. Was there engineering review and design verification for the hand release mechanism?

ANSWER: No. The hand release mechanism design drawings attached to Job Ticket CA364 were generated by the Polar Crane Refurbishment Task Group based on an illustration in the technical literature provided with the replacement brake assemblies. There was no engineering review or design verification for the design except as provided by the Task Group. This fact was initially noted in telephone conversations with principal members of the Task Group and confirmed during on-site interviews with J. Graber, M. Radbill and H. Kirshbaum.

3. Why were the hand release mechanisms fabricated on-site as opposed to being purchased from the manufacturer?

ANSWER: Review of the procurement documents revealed that the initial purchase requisition for the replacement main hoist brakes, which was sent to the Whiting Corporation for review as part of a Request for Proposal package, called for procurement of the optional hand release mechanisms. That specification was omitted in the proposal package developed by the Whiting Corporation and returned to Design Engineering. The proposal package formed the basis for the purchase order. Therefore, the purchase order issued to procure the replacement main hoist brake assemblies did not specify procurement of the optional hand release mechanisms.

A Quality Control receipt inspection was performed on the brake assemblies which verified that the material received was as specified on the purchase order. Since the hand release mechanisms were not specified in the purchase order, they were not identified as "not delivered" nor did the inspector have cause to be aware of a plan to add such mechanisms to the brake assemblies.

When the Task Group became aware that the brake assemblies, as received, did not include the optional hand release mechanisms, the brake manufacturer was contacted regarding placement of an order for the mechanisms. A delivery time of 9 to 10 weeks was quoted. This delivery schedule was not compatible with the then current Polar Crane refurbishment schedule. Therefore, a decision was made by the Task Group to fabricate the mechanisms onsite. The decision also was influenced, in part, by the fact that the initial refurbishment plan called for the installation and adjustment of the replacement brake assemblies without electrical power available to the crane. The availability of the hand release mechanisms would facilitate brake wheel cleaning and installation of the replacement brake assemblies.

4. Were there any design reviews of the final purchase order for the complete brake assemblies prior to placement?

ANSWER: Yes. Design Engineering did review the final purchase order, which was based on the Whiting proposal, prior to placement by Bechtel. However, the primary emphasis of the review appears to have been on contractual conditions. Thus, omission of the hand release mechanism was not noted.

5. Did Messrs. Graber or Kirshbaum initiate any written or verbal communication with the manufacturer regarding design of the hand release mechanism?

ANSWER: No. Delivery times were discussed, but no design details were discussed.

6. Did the original Burns and Roe design specifications for the Polar Crane main hoist brakes include a hand release mechanism?

ANSWER: No. A review of the original documentation by R. Sieglitz revealed that the original installation specification called for a manual load lowering capability to be supplied with the main hoist brakes. The manufacturer's technical literature states that a manual release bushing, integral to the brake assembly, or the optional hand release mechanism can be utilized to manually release the brake. Therefore, either capability would have satisfied the specification. Hand release mechanisms were not installed on the original main hoist brakes.

7. Were any other "home-made" devices installed on the main hoist brakes or elsewhere on the crane during refurbishment?

ANSWER: A detailed inspection of the Polar Crane, including extensive photography of all accessible components, was conducted during the week of September 17-21, 1984. The results of that inspection are currently under review.

8. The compression of the main spring on the outboard brake of the main hoist was found to be at other than the optimal setting during the September 6, 1984 inspection. Was this condition directly related to the problem associated with the hand release mechanism which rendered the outboard main hoist brake inoperable?

ANSWER: No. The cause of reduced compression of the main spring on the outboard main hoist brake has not been determined. Spring compression is adjusted for nameplate torque rating at the factory during assembly of the main hoist brakes and readjustment of the brake shoes "will automatically bring spring compression back to the initial setting" according to the manufacturer's technical literature. However, there appears to be no relationship between the operation of the hand release mechanism and main spring compression setting. When the hand release mechanism was adjusted properly, the main spring remained at less than optimal compression.

9. When was the last inspection of the main hoist brakes of the Polar Crane prior to August 16, 1984? Were the brake shoes on the outboard brake inspected at that time? What were the findings of that inspection?

ANSWER: A scheduled preventative maintenance inspection was conducted on May 30 - 31, 1984. Documentation of that inspection, as provided by R. Sieglitz, specifically noted no scoring of the main hoist drums or excessive wear of the brake shoes. Subsequently, the personnel who conducted the inspection were interviewed and confirmed that visual inspection of the shoes and drums of both main hoist brakes was included. No brake operability problems were identified. The inspectors stated emphatically that if the brake shoes not been in contact with the wheel, it would have been noted as an abnormal condition and reported as such. Both inspectors demonstrated adequate knowledge of the crane during the interview to assure the Review Group that they were aware, at the time of the inspection, that the brake shoes should be in contact with the drum when the Polar Crane was de-energized, i.e., as was the case during the inspection.

Based upon the questions identified and the information available, the Review Group decided to interview all persons who performed in-containment work activities on the Polar Crane during the period May 30 - August 16, 1984. The objective of the interviews was to determine if anyone inadvertently or intentionally performed any activities which would have caused the maladjustment of the hex nut on the hand release mechanism and if other conditions exist which might impact the continued safe operation of the Polar Crane.

A list of all persons who worked on the Polar Crane during the period of May 30 - August 16, 1984, was generated. Based on that list, over 30 site personnel were interviewed by the review group during the period September 10 - 14, 1984.

A specific interview technique was used by the Review Group. First, the interviewees were informed of the problems which were found on the outboard main hoist brake. Then the objectives of the Review Group were defined. In particular, it was noted that the Review Group sought to determine by what means the hex nut on the hand release mechanism moved, or was moved, to the position in which it was found on August 16, 1984 and how to prevent a reoccurrence of this condition. The interviewees also were advised that the Review Group was attempting to determine if other abnormal or unsafe conditions exist on the Polar Crane and what additional actions are necessary to improve its reliability. It was emphasized that the Review Group's purpose was not to "hang anyone" but rather to try to objectively determine the cause of the problems and develop appropriate solutions. Interviewees were then asked to describe their activities while working on the Polar Crane, including such information as their location on the Polar Crane, specific job tasks or activities, general observations and any abnormal conditions observed. Personnel who worked on the trolley were asked to describe specific pathways used when moving about the crane and the locations where safety lanyards were attached. Finally, the interviewees were asked if they had questions, comments or suggestions concerning the condition of the crane and how the operational reliability of the Polar Crane might be improved. These interviews provided no substantive information concerning the probable cause of the several mechanical problems encountered.

In addition to interviewing site personnel, a manufacturer's representative and members of the original Polar Crane Refurbishment Task Group were contacted. A design engineer, representing the brake manufacturer, was interviewed by telephone on September 13, 1984. Principal members of the Polar Crane Refurbishment Task Group were interviewed by telephone during the week of September 10 - 14, 1984, and, subsequently, were recalled to the site for additional consultation.

At the end of the first week of interviews, the Review Group determined that a detailed inspection of the Polar Crane, including extensive photography, was appropriate to document the current "as-is" condition of all accessible components for comparison with the pre-refurbishment photographs and records. The purpose of this effort was to identify any additional undocumented condition(s) currently existing on the Polar Crane and to determine if any existing conditions impact the continued safe operation of the crane. A methodology for conducting this inspection was proposed by D. Lake and accepted by the Review Group.

Because preliminary information from the Maintenance Department and principal members of the Polar Crane Refurbishment Task Group indicated the possibility of additional, undocumented changes to the Polar Crane, the decision was made on September 14, 1984, to remove the Polar Crane from service until a detailed inspection of the crane could be completed and the continued safe operation of the crane could be assured. A material non-conformance report (MNCR) was generated on that date to document an apparent unapproved modification, i.e., the hand release mechanisms, on the Polar Crane. The Polar Crane was tagged out of service until the MNCR could be resolved.

A detailed inspection of Polar Crane components was performed during the week of September 17-21, 1984. Teams of inspectors observed and/or photographed all accessible components. Each team of inspectors was composed of a member of the original Polar Crane Refurbishment Task Group and at least one independent observer, e.g., the Electrical Maintenance Foreman; a Recovery Operations Mechanical Engineer. The inspection was completed on September 20, 1984. Results of the detailed inspection were presented to the Polar Crane Review Group on September 21, 1984. Those results are currently under review.

Concurrent with the detailed crane inspection effort, the Polar Crane Review Group continued personnel interviews. The Review Group interviewed principal members of the Task Group and the lead member of the site Quality Assurance Department who directed the after-the-fact QA audit of the Polar Crane Work Packages. Members of the Review Group also reviewed documentation related to crane refurbishment.

The interview process was essentially completed by September 21, 1984, (i.e., one person, a Mechanical Maintenance Technician, was interviewed the following week because he was previously unavailable). The Polar Crane Review Group began a compilation and evaluation of the information obtained during the inquiry and formulation of its findings and recommendations.

The Review Group considered several possible scenarios during which personnel action may have caused the mispositioning of the nut on the hand release mechanism of the outboard main hoist brake, rendering the brake inoperable. These included:

1. Personnel climbing over and around the outboard brake to gain access to the main hoist area. Traffic patterns in this area were examined to determine if workers routinely came in contact with the hand release mechanism (e.g., as an aid to walking or climbing, as a safety lanyard tie off point).
2. A worker observed that the nut on the hand release mechanism appeared to be loose, interpreted it as being improperly adjusted, and tightened it.
3. An operational test or other activity involving the hand release mechanisms was conducted during which the outboard brake was disenabled and inadvertently left in that condition.
4. A person or persons performed an unauthorized deliberate act to disenable the brake.

The Review Group found no evidence that any of the above occurred.

The Review Group also considered other potential causes, not related to personnel actions, which might have resulted in rendering the brake inoperable. The Review Group has not been able to determine when after May 31, 1984 or by what means the nut moved, or was moved, on the tie rod sufficiently to render the brake inoperable. However, based on interviews and analysis of all available information, it appeared that the most probable cause of movement of the nut was normal crane operation (i.e., motor vibration).

It also was noted by the Review Group that the Polar Crane Refurbishment Task Group did not classify the hand release mechanism as a modification in associated documentation. In retrospect, based on current procedures and definitions, it is the judgement of the Review Group that addition of the hand release mechanism constituted a modification. The official record, as it pertains to modification of the Polar Crane, should be reviewed to determine if there is a need to correct the record on this point.

FINDINGS

Finding No. 1

The position of the regular hex nut on the tie rod of the hand release mechanism, as found on August 16, 1984, restricted expansion of the main spring of the brake assembly thus reducing the compression force applied to the brake shoes. As a result, the brake shoes did not reseal on the wheel and the brake was rendered inoperable.

Finding No. 2

The addition of hand release mechanisms to the replacement main hoist brake assemblies during the Polar Crane Refurbishment Program did constitute a modification of the Polar Crane in that hand release mechanisms were not a component of the brake assemblies originally installed during plant construction. In addition, the hand release mechanisms installed on the replacement brake assemblies differed in design from those available from the brake manufacturer.

Finding No. 3

The QA review of Polar Crane refurbishment work packages could not have identified the presence of the hand release mechanisms on the replacement main hoist brake assemblies since there was no specific reference to the mechanisms in the purchase order which procured the replacement brake assemblies or the Bechtel work package which directed installation of the brake assemblies.

Finding No. 4

The mispositioning of the hex nut on the hand release mechanism of the outboard brake assembly occurred between May 30, 1984 and August 16, 1984.

Finding No. 5

There is no evidence to suggest that the hex nut on the hand release mechanism was mispositioned as a result of a deliberate act by any person(s) during the time period in question. Extensive interviews with personnel involved in Polar Crane activities identified no activity which would have resulted in repositioning the hex nut such that the brake would have been rendered inoperable.

Finding No. 6

There is sufficient information available to reasonably conclude that motor vibration during normal crane operation was the most probable cause of movement of the hex nut to a position such that the brake shoes could not reseal against the wheel because main spring expansion was inhibited by the position of the hex nut on the hand release mechanism tie rod. This condition is speculated to have occurred as follows.

The nut on the tie rod of the hand release mechanism is a regular nut, not a control device, and is capable of free movement along the tie rod. When hoisting or lowering occurs, the brake shoes on the main hoist are withdrawn from contact with the wheel as twin magnets compress the main spring. During this period, the main hoist motor is operating, providing a source of vibration to the brake assemblies and attached hand release mechanisms. This vibration could have caused the nut to travel inward along the threads of the tie rod of the hand release mechanism since the support block was free to move unimpeded along the tie rod the full distance allowable based on magnet travel. Theoretically, the nut also could advance to that maximum distance. When lifting or lowering motion is stopped, the magnets are de-energized and no longer compress the main spring. The main spring expands and applies a compression force on the shoes against the wheel. This motion also exerts an outward force on the support block, jamming it against the hex nut. If the nut on the tie rod of the hand release mechanism traveled the maximum inward distance allowable during crane operation, it would secure the support block in a position such that full expansion of the spring would be prevented when the magnets are deenergized. Thus, the main spring compression force on the brake shoes would not reseat the shoes on the wheel and the condition found on the outboard main hoist brake on August 16, 1984, would result.

Finding No. 7

There was no intent on the part of the Polar Crane Refurbishment Task Force to obscure the installation of the hand release mechanisms. Rather, their fabrication and installation was identified in several Task Force documents. However, the Task Force members repeatedly expressed the view that the hand release mechanism was a catalog component of the manufacturer's design, was more a tool than a component of the brake assemblies, and was never considered as a modification of the brake assembly. Indeed, the Task Group considered the main hoist brake assembly to be a "replacement in kind."

Finding No. 8

No additional changes to the Polar Crane were identified during the detailed inspection that would impact its continued safe operation.

Finding No. 9

The administrative procedures currently in place at TMI-2 provide a high degree of assurance that the addition of a device, like the hand release mechanism or other modifications, as occurred in this case, will not recur.

Finding No. 10

The inoperable condition of the outboard main hoist brake, identified on August 16, 1984, did not place TMI-2 in an unanalyzed condition. The inboard brake, which is designed to hold a load of up to 750 tons (i.e., 150% of the original rated crane load of 500 tons) is sufficient to hold the maximum load of the TMI-2 Polar Crane, currently rated at 170 tons. There was no evidence of brake slippage at any time during the head lift program. On the contrary, the head was lifted less than an inch five (5) times during the initial phase

of the lift operation to permit load leveling and to verify the operability of the brakes. While the head was over the vessel, the lift height was limited to a height which was demonstrated, through analysis, to be safe. Calculations showed that no significant damage to the reactor vessel would have resulted if a full gravity drop of the head had occurred from that height. In actual operations, the resultant impact force would have been less than the worst case value calculated for the Safety Evaluation Report.

Recommendation No. 1

The hand release mechanisms on main hoist brake assemblies of the Polar Crane should be removed. (Status: Completed September 25, 1984.)

Recommendation No. 2

The hand release mechanism installed on the outboard main hoist brake should be sent to an independent laboratory for analysis to determine if crane vibration could have been the cause. (Status: Shipment to laboratory for testing pending finalization of test specifications.)

Recommendation No. 3

All documents related to the Polar Crane refurbishment work should be audited, including all work packages, job tickets, work authorization notices, procurement documents and miscellaneous memorandum to determine if any other devices were fabricated, procured and added to/replaced components of the Polar Crane which have not been previously identified. (Status: Ongoing.)

Recommendation No. 4

The double jam nuts on the main tie rod of both brake assemblies, supplied with the replacement brake assemblies by the manufacturer, should be replaced with a jam nut and one standard hex nut in accordance with the original manufacturer's design. (Status: Completed September 25, 1984.)

Recommendation No. 5

Both main hoist brake assemblies should be readjusted after completion of Recommendation No. 4 above. (Status: Completed September 25, 1984.)

Recommendation No. 6

The preventative maintenance program for the Polar Crane should be reviewed and upgraded to incorporate the manufacturer's recommendations and other improvements, such as verification of the operability of both brake assemblies. In addition, increased attention should be directed to periodic inspection and adjustment of the main hoist brakes. The apparent excessive lubrication of certain Polar Crane components should be corrected. (Status: Ongoing.)

Recommendation No. 7

The results of the audit of the Polar Crane Refurbishment Program documentation and results of the laboratory analysis of the response of the outboard hand release mechanism to vibration tests should be forwarded to the Office of the Director, TMI-2, for evaluation and appropriate action. (Status: Pending completion of associated tasks.)

Recommendation No. 8

The Polar Crane should undergo an operational test of all load bearing components and safety devices (e.g., limit switches, brakes) prior to return to service. (Status: Inspection plan has been developed. Inspection is scheduled for October 8-10, 1984.)

Recommendation No. 9

Upon completion of the detailed audit of the Polar Crane Refurbishment documentation, a detailed review of the official NRC docketed record, as it relates to Polar Crane modifications, should be conducted to determine if there is a requirement to "correct the record". (Status: To be conducted upon completion of the document audit.)

SUMMARY

GPU Nuclear has initiated action on all of the recommendations of the Polar Crane Review Group. Based upon the findings of this group and subject to implementation of those recommendations directly related to crane operation, the Polar Crane can be returned to service with assurance of its continued safe and reliable operation.