November 18, 1983

Docket No. 50-320

Mr. B. K. Kanga, Director
Three Mile Island Unit 2
GPU Nuclear Corporation
P.O. Box 480
Middletown, PA 17057

Dear Mr. Kanga:

Subject: Reactor Building Polar Crane Load Test

The TMI-2 Technical Specifications require NRC approval for procedures on significant cleanup activities. In support of our review process, GPUNC submitted a Safety Evaluation Report (SER) for the reactor building polar crane load test and requested NRC approval of the proposed activity. We are responding to the GPUNC request and enclosing our detailed safety evaluation of the proposed polar crane load test. In our safety evaluation we considered the following: (1) the refurbishment of the polar crane, including the inspection and maintenance program and modifications to the as-built design, (2) the functional and operability testing of the refurbished polar crane, (3) the load testing of the refurbished polar crane, (4) the inspection, maintenance, and testing of the crane wire rope, (5) the inspection and evaluation of the reactor vessel head and internals handling fixture (tripod), (6) the design and inspection of the load test frame and the testing of the associated rigging and load cell, (7) the quality assurance/quality control considerations as they relate to the refurbishment and requalification of the polar crane, (8) the potential for accidents and the corresponding consequences, (9) occupational exposure related to the requalification of the polar crane, (10) potential for releases of radioactive materials to the environment, (11) whether the polar crane load test constitutes an Unreviewed Safety Question, per the criteria in 10 CFR Part 50.59, (12) the findings of the Office of Investigations (OI) report dated September 1, 1983, and (13) the suggestions of the polar crane technical report prepared for OI, dated August 23, 1983.

Based on our detailed review as described in the Enclosure, we conclude the following:

1) The polar crane has been satisfactorily refurbished for the proposed load test. A successful load test will demonstrate the functional performance of the crane for required recovery

8312070352 831118
PDR ADOCK 05000320
P PDR

NhO
11/7/83

OFFICE	TMIPO:NRR	TMIPO:NRR	PD:TMIPO:NRR	ELD	DD:NRR	D:NRR	
SURNAME	TCPoindexter:bg	RAW RAWeller	BJSnyder		EGCase	HRDenton	
DATE	11/ 7/83	11/2/83	11/ 4/83	11/ /83	11/8/83	11/10/83	

activities, including moving missile shields, lifting the reactor vessel head and service structure, removing the plenum assembly, and supporting defueling activities.

2) The crane has been adequately refurbished to the extent practicable with like, equivalent, or improved parts sized to correspond to the original 500 ton rating.

3) The inspection and maintenance related to the polar crane refurbishment was comprehensive and adequate to ensure polar crane safety.

4) The functional and operability testing of the refurbished crane has verified the quality of the refurbishment program and demonstrated that the crane can be operated in a safe manner.

5) The planned load test sequence, involving the assembly of the test load, the actual load test, and the disassembly of the test load, is adequate for demonstrating the operability of the crane hoist, trolley and bridge under load conditions sufficient for cleanup activities.

6) The inspection, maintenance and testing of the crane wire rope is adequate to assure that the rope integrity will be maintained for all planned lifts.

7) The stress analyses on the tripod undersized welds by GPU/Babcock and Wilcox indicate that the as-built welds can accommodate the induced stresses from the load test. However, we will require nondestructive examination (NDE) on 3 of the higher stressed welds to verify weld integrity. The use of the tripod for the requalification test is prohibited pending completion of the NDE. We have determined that the tripod is safe to be used to move the 6 ton internals indexing fixture and other miscellaneous loads up to 10 tons before the NDE is performed.

8) The design and inspection of the load test frame and the testing of the associated rigging and the load cell demonstrate that the load will be evenly distributed over the test frame, and the entire assembly is capable of handling the estimated maximum load.

9) Quality assurance/quality control and procedural controls for the crane refurbishment and requalification program are sufficient to ensure the safe use of the crane and the safety of the planned load test.

OFFICE ▶							
SURNAME ▶							
DATE ▶							

10) The probability of a load drop is extremely small, and, even in the event of a drop, the consequences of such an event would be well within the limits of 10 CFR Part 100 given the relatively benign condition of the facility (i.e., very low decay heat and no significant gaseous activity in the form of noble gases or iodines), the installed plant systems for accident mitigation (e.g., the installed ventilation filtration systems) and the procedural controls over load pathways to avoid critical areas such as the incore instrument service area and reactor pressure vessel.

11) The estimated occupational exposure for the load test is well within the scope of impacts previously assessed in our PEIS. The releases of radioactive material to the environment during the conduct of the test are expected to be negligible and, thus well within the limits of the Technical Specifications.

12) Based on the criteria of 10 CFR Part 50.59, the polar crane load test does not constitute an Unreviewed Safety Question.

13) The Functional Description, Revision 3, dated June 30, 1983, is also approved per the enclosed discussion.

Thus, we conclude that there is reasonable assurance the polar crane load test will not endanger the occupational work force or the health and safety of the public and, accordingly, pending completion of the NDE on the tripod assembly to verify weld integrity, we approve your conduct of the polar crane load test. The test can be initiated, including the moving of the missile shields to assemble the test load, following formal approval of the polar crane operating and load test procedures. Our detailed safety evaluation is enclosed.

Sincerely,

Original signed by
B. J. Snyder

Bernard J. Snyder, Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc: J. Barton
J. Byrne
J. Larson
Service Distribution List
(see attached)

OFFICE ▶							
SURNAME ▶							
DATE ▶							

SAFETY EVALUATION BY THE
OFFICE OF NUCLEAR REACTOR REGULATION
THREE MILE ISLAND PROGRAM OFFICE
FACILITY OPERATING LICENSE NO. DPR-73
GPU NUCLEAR CORPORATION, ET AL.
THREE MILE ISLAND NUCLEAR STATION, UNIT 2, (TMI-2)
DOCKET NO. 50-320
REFURBISHMENT OF THE REACTOR BUILDING POLAR CRANE, LOAD TEST, AND RECERTIFICATION FOR USE

November 18, 1983

TABLE OF CONTENTS

FIGURES

Page

TABLES

APPENDICES

THREE MILE ISLAND PROGRAM OFFICE
SAFETY REVIEW OF THE
REACTOR BUILDING POLAR CRANE LOAD TEST

1. Introduction

As a result of the March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2 (TMI-2) the reactor building polar crane was damaged to the extent that it was inoperable. The damage resulted from the severe environmental conditions in the building during and following the accident and was primarily to those crane elements that were sensitive to the elevated temperatures in the early portion of the transient or to subsequent corrosion in the years thereafter.

Inasmuch as the polar crane is an absolute prerequisite for the major activities (i.e., reactor pressure vessel head lift and plenum removal) leading to the defueling of the damaged core, the refurbishment and requalification of the damaged crane was recognized as being essential to further progress in the cleanup. Accordingly, in the spring of 1982, we developed criteria for the refurbishment of the crane and forwarded the criteria to GPU by letter dated April 1, 1982 (Reference 1). GPU initiated an intensive inspection and maintenance program on the crane in the late summer of 1982. By letter dated October 12, 1982 (Reference 2), GPU submitted the functional description for the polar crane, describing the minimum crane components and movements which are necessary to move the missile shields and reactor vessel head. This document also included the GPU program for crane QA/QC, maintenance and modifications, and operability and load testing. An updated issue (Revision 2) to the polar crane functional description was forwarded to us by letter dated February 17, 1983 (Reference 3). By letter to GPU dated March 7, 1983

(Reference 4), we concurred with GPU's functional description of the polar crane as it related to the conduct of the polar crane load test. GPU made additional changes in Revision 3 (Reference 5) to the Functional Description dated June 30, 1983. We concur with these changes.

On February 18, 1983, GPU submitted the safety evaluation report (SER) for the polar crane load test (Reference 6), and we initiated our safety review of the proposed activity. Our review included the detailed load test and operating procedures for the polar crane as well as an addendum, dated March 15, 1983 (Reference 7), to the GPU load test SER which was submitted in response to our initial review of the SER submittal. Our safety review of the load test was in progress when, on March 22, 1983, a GPU contractor employee assigned to TMI-2 made allegations about the safety of the polar crane and other cleanup related issues. On March 25, 1983, Chairman Palladino directed the NRC Office of Investigations (OI) to evaluate the allegations. We then deferred the safety review of those polar crane load test issues associated with the allegations and limited the use of the polar crane by GPU to lifts of 5 tons or less, utilizing another hoist. However, we continued our review of the detailed load test and operating procedures for the crane and, in relation to this review, GPU submitted addendums, dated June 17, 1983 and June 30, 1983 (References 3 and 9), to the load test SER to update the information for the planned test. Also, in June 1983, GPU discovered undersized welds on the reactor vessel head and internals handling fixture (tripod) during an inspection of the component. Inasmuch as this component is an integral part of the planned load test and will be used to lift the reactor vessel head, we requested by letter, dated July 8, 1983 (Reference 10), that GPU inform us of their plans to insure the tripod can perform its function safely. GPU responded to our request in a letter, dated August 1, 1983 (Reference 11), with an evalution of the performance capability of the tripod. We have met with GPU on several occasions to discuss the results of their analyses and have also requested additional information related to the as-built design of the tripod (Reference 12). GPU responded on August 11, 1983 (Reference 13) and October 4, 1983 (Reference 24).

Our load test safety review was reinitiated in mid-July 1983 and, by letter dated July 18, 1983 (Reference 14), we forwarded a request to GPU for additional information related to the conduct of the test. GPU responded to this request in letters dated August 16, 1983 and August 24, 1983 (References 15 and 16). On August 23, 1983, the Director of the NRC Office of Investigations, B. B. Hayes, forwarded a technical report on the reactor building polar crane to W. J. Dircks, the Executive Director for Operations, USNRC (Reference 28). In the transmittal memorandum, Mr. Hayes stated that the report was being submitted for review and appropriate action. Shortly after issuance of the report a series of internal NRC meetings were held with engineers, management, the author of the report and the TMIPO to discuss the recommendations of the report. That technical report and the discussions that followed were considered in the staff's requirements for refurbishment and in the preparation of this safety evaluation. Finally, a report from OI (Reference 17) regarding the evaluation of the allegations was issued on

September 1, 1983. The report findings indicated that there were administrative and procedural deficiencies in the crane refurbishment program. In light of the report findings, we met with GPU in a public meeting in Middletown, Pennsylvania, on September 27, 1983 to discuss the overall crane refurbishment program. At the meeting, we informed GPU that we would need additional information to provide assurance that the refurbishment and testing of the crane has proper management controls to ensure quality workmanship. A formal information request (Reference 25) was forwarded to GPU on September 28, 1983 and GPU responded by letters (References 26 and 27) dated October 11, 1983 and October 24, 1983.

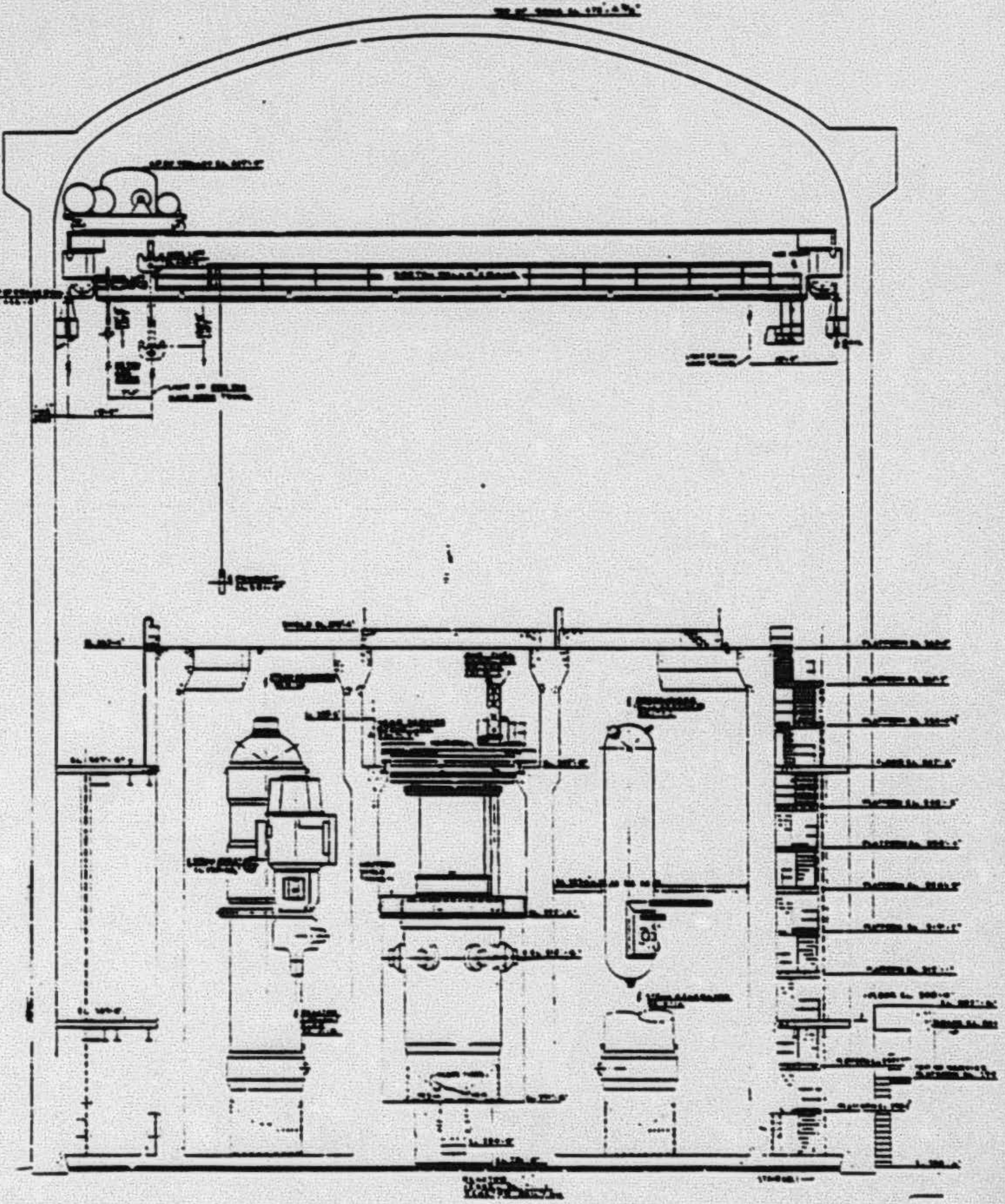
Based on information in the aforementioned submittals from GPU related to the refurbishment and re-qualification of the polar crane, information exchanged in numerous discussions with GPU and GPU contractors, information provided in related correspondence (References 18 and 19), and the results of the OI investigation of crane related allegations, we completed our safety review of the planned polar crane load test. Our review was performed by the staff of the Three Mile Island Program Office and by a contractor (See Appendix A for a description of professional qualifications) who is an expert on hoisting, rigging, and cranes for nuclear facilities (See Appendix B, Safety Review of TMI-2 Polar Crane, T. Stickley). The review was also supported by technical assistance from the Structural and Geotechnical Engineering Branch, Materials Engineering Branch, and a metallurgist, from the NRC Region 1 office, who specializes in welding processes. Our review included a direct inspection of the polar crane and associated components. This report documents our detailed safety evaluation.

2. Description of the Polar Crane

The major components of the polar crane include the following: (1) bridge and associated drive train and braking systems, structure, wheels, and runway rail, (2) trolley and associated drive train and braking systems, structure and wheels, (3) main hoist and associated drive train and braking systems, wire rope, and hook, (4) auxiliary hoist and associated drive train and braking systems, wire rope and hook, (5) power supply to the major polar crane components, and (6) crane cab and pendant operating controllers. The crane configruation is shown in Figure 2.1. The crane is located at the 426 feet elevation and is approximately 79 feet above the operating floor (elevation 347 feet) in the reactor building. The main hoist of the crane was designed for a rating of 500 tons, and the auxiliary hoist was designed for a rating of 25 tons. This safety review covers only the planned load test of the main hoist. The safety review of the refurbishment and requalification of the auxiliary hoist will be performed in a separate action if GPU decides to refurbish and requalify the hoist for future use in the cleanup.

FIGURE 2.1

POLAR CRANE SIDE VIEW



3. Refurbishment of the Damaged Polar Crane

The TMI-2 accident exposed the polar crane to temperature and environmental conditions that resulted in damage to its electrical and mechanical components. Structural components were not damaged as was confirmed by GPU's inspection reports (Appendix C) and the inspection by our crane consultant. As previously stated, the refurbishment process was only intended to restore the crane components that were considered necessary for head lift and subsequent cleanup activities. The components were to be restored to pre-accident conditions and capabilities. In their letter dated January 4, 1982 (Reference 20), GPU requested guidance on the requirements for crane refurbishment. We responded on April 1, 1982, with the following guidance:

1) Resistance measurements should be taken to verify that no unacceptably low or high resistances exist between the various circuits and circuits to ground;
2) The quantity and quality of lubricants should be checked and found acceptable or a suitable replacement of the lubricant should be made;
3) Due to the past potentially corrosive environment, a thorough inspection should be performed on the wire rope system of the 500 ton main hoist using the Wire Rope Users Manual which is published by the American Iron and Steel Institute as a guide; and
4) The checklist provided (See Table 3.1) should be used as a guide for a recommended inspection plan.

Other regulatory and industry guidelines, many of which were not specifically discussed in our April 1, 1983 letter but are applicable to refurbishment and testing activities for the polar crane, are as follows:

NUREG-0612 - Control of Heavy Loads at Nuclear Power Plants

This standard was published by the NRC in July 1980 to provide guidance to licensees for the safe handling of heavy loads. Chapter 5, "Guidelines for Control of Heavy Loads," is applicable to the refurbishment activities and references ANSI B30.2 - 1976, ANSI B30.9 - 1971, and ANSI N14.6. Discussions of these standards follow later in this section. GPU committed in their letter to us, dated January 4, 1982, that the NUREG-0612 acceptance criteria will be met.

American National Standards Institute N14.6 (ANSI N14.6) - 1978

This standard is applicable to special lifting devices weighing 10,000 pounds or more. This standard requires that the structure be load tested at 150% of the maximum load to which the device is to be subjected. The standard also requires that load bearing members be capable of lifting three times its maximum load without generating a combined shear stress or maximum tensile stress at any point in the device in excess of the yield strength of the material (factor of safety of 3 for yield). The device should also be capable of lifting five times that weight without exceeding the ultimate strength of the materials (factor of safety of 5 for ultimate). Parts of this standard are applicable to the load test frame and the missile shields.

American Institute of Steel Construction (AISC)

This standard sets forth standards for steel structures. Section 5 of this standard provides guidance for the design, fabrication, and erection of structural steel for buildings. This standard provides single and combined stress limits, welding electrode requirements and "pass-fail" equation checks for stress loading. The equations used incorporate varying safety factors that depend on the type and magnitude of stresses present. This standard is applicable to the load test frame.

American National Standards Institute B30.9 (ANSI B30.9)

This standard provides guidance for the selection of slings in industrial use. For wire rope slings of the type to be used in the load test, a factor of safety of five is required. For example, if a wire rope is rated at one ton, its actual breaking strength is at least five tons, thereby giving a factor of safety of five. However, one ton is the maximum weight that the individual slings could be subjected to in normal use. All slings used for the load test must meet the requirements of this standard.

American National Standards Institute B30.2 (ANSI B30.2)

This standard provides guidance for the construction, use, testing and maintenance of overhead cranes. This document is applicable to all crane specific refurbishment; however, as discussed later in this document, some exceptions to this standard have been taken by GPU and concurred with by the NRC.

The refurbishment process was sufficient to allow for bridge rotation about most of the entire circumference of the containment, end stop to end stop trolley travel, and full main hoist movement. The auxiliary hoist is not required for head removal and therefore has not been refurbished. Required crane components include the two bridge drive trains with a minimum of one electric brake at each end, the main trolley drive train with brake, components of the main hoist drive train, including the hoist unit and all brakes, a load sensing device, a power supply, crane controls, and structure.

Additional mechanical work that GPU is anticipating is the realignment of the runway rails. We have reviewed the rail report from Whiting Corporation to Bechtel dated August 8, 1983, a report from R. L. Rider to R. L. Freemerman dated August 2 and 10, 1983, and a report from D. M. Lake to R. L. Rider dated April 5, 1983. All of these reports discuss the misalignment of rails and rail-to-rail gaps (see Appendix C).

After consulting with our expert consultant from EG&G, we conclude that the rail misalignment could lead to accelerated bearing or wheel wear, but this is an economic issue and not a safety concern. We do not consider the repair of rail misalignments to be a necessity before the load test. Accordingly, it is GPU's option whether this item is repaired prior to the load test or sometime in the future. GPU has indicated that they intend to repair the rail misalignments prior to the load test.

The most significant mechanical refurbishment was brake replacement and adjustment. Many of the motor clutches also needed cleaning and adjusting. These tasks have been completed and the motors successfully tested.

During the electrical inspection of the crane, the most extensive damage was found on the conductor/collector system which supplied power to the bridge and trolley, the runway conductor/collector system and the cab and pendant controls that supported bridge, trolley, and main hoist functions. The conductor/collector system which supplied power and control for the main and auxiliary hoists and the trolley drive motor was replaced by a cabling system consisting of 33 conductors (sized to match the original design). The cabling was strung from the center of the crane bridge end girder to the center of the trolley. The replacement cable meets all necessary criteria for its intended use including ampacity, insulation level, flexibility, and installation.

The polar crane runway conductor/collector system (not the same as the hoist and trolley drive conductor/collector system) originally spanned the entire circumference of the containment dome and supplied power to the crane system. Radiation exposure would have been significant for a replacement in kind, therefore GPU designed an alternate crane power supply (feeder) system. The main power wiring from the motor control center for the crane is 3 phase with two #4/o wires per phase (total of 6 wires). Before entering the penetration, each phase wire splits into an additional two #4/o wires (thereby providing twelve #4/o wires (4 wires/phase) through the penetration. The wiring then changes back to two #4/o wires per phase up to the main power disconnect. All wiring up to this point is in accordance with the original design of the crane. From the main power disconnect to the 225 ampere disconnect switch/circuit breaker and on to the crane, a single 3 conductor (one wire per phase) #2/o cable is used.

The 225 ampere circuit breaker that was installed for the protection of the feeder was sized according to the actual load requirements that are anticipated during the recovery. The crane is limited to one movement at a time with the movement of the main hoist drawing the highest current. The heaviest main hoist lift anticipated for the recovery is the 200-220 ton load test assembly. Based on this assumption, the main hoist motor will not be loaded to more than 50% of its capability of 150 hp and will draw approximately 95 amperes. The control circuit transformer rating of 2KvA adds 4 amperes if near fully loaded, bringing the total loading to less than 100 amperes. Therefore the 225 ampere breaker is adequately sized for the requirements of the test.

The 3 conductor (one conductor/phase) #2/o cable, based on a short time rating of 60 minutes and a temperature of 75 °C, can withstand 222 amperes. Since the maximum current required for worst-case loading is less than 100 amperes, the cable is also adequate for its anticipated electrical use. The cab and pendant controls were replaced by a single pendant which has all original control functions except that it does not have a warning bell push button nor a key operated on/off switch (see Appendix C inspection reports).

Although it was not a refurbishment related task, GPU also replaced, at the recommendation of the crane manufacturer, existing 300 ampere fuses in the polar crane main disconnect switch with nonfuseable links (dummy fuses).

This manufacturer recommended modification was made to preclude the possibility of single phasing the power supply due to a single phase fault on the crane which could cause only one fuse to blow. Single phasing under load conditions has the potential for uncontrolled load handling due to a loss of motor torque thereby resulting in an unintentional load descent. We consider this to be a necessary design modification.

The above modifications and design provide adequate electrical protection for the crane and the associated electrical penetration.

Table 3.1 is a checklist forwarded to the licensee as guidance.
Table 3.2 is a list of replacement-in-kind electrical components.
Table 3.3 is a list of replacement with unlike kind electrical components.
Table 3.4 is a list of polar crane components that are required during recovery and those that are not.

Our evaluation of the refurbishment of the polar crane also included the review of test methodology and results. The tests reviewed are listed in Table 4.1.

Based on our review, we conclude that the refurbishment of the crane has been adequately carried out by GPU for its intended use in the cleanup, and adequate measures have been incorporated in the refurbishment to ensure a safe crane.

TABLE 3.1

* POLAR CRANE CHECKLIST

ITEM NO.	INSPECTION FREQUENCY		ITEMS TO BE INSPECTED	CRANE MAINTENANCE INSPECTION SPECIFICATION
	A	B		
1	▨		BRIDGE AND TRUCKS	Inspect for bent, or damaged members, evidence of loose bolts, rivets, guards and broken welds.
2	▨		TROLLEY AND RAILS	Inspect for bent, or damaged members, evidence of loose bolts, rivets, guards, trolley rail clamps, end stops and broken welds.
3	▨		RUNWAY RAILS AND CLAMPS	Inspect for loose, broken or missing rail clamps, bolts, wedges, connectors, runway rail end stops and rail switches.
4			HANDRAILS, WALKWAYS AND LADDERS	Inspect for loose, missing, bent, deteriorated or misaligned members, loose bolts, rivets, broken welds and hangers.
5	▨		BUMPERS	Inspect for loose, broken, or bent bumper members.
6	▨		GUARDS	Inspect for loose, missing, broken or bent members.
7	▨		CRANE ALIGNMENT	Inspect for unusual wear on rails. Check by running crane bridge or trolley assembly against end rail stop to check alignment.
8	▨		JIB BOOM	Inspect for bent members, misalignment, worn pins; column fasteners, trolley stops and boom markings for rated capacity.
9	▨		BRIDGE WHEELS AND BEARINGS WHEEL BEARINGS	(a) Inspect wheels for wear, flat spots, chips, flange wear, cracks, looseness of axle-pins or securing devices. (b) Inspect clearance, chatter, loose bearing caps and lubrication.
10	▨		TROLLEY WHEELS AND BEARINGS WHEEL BEARINGS	(a) Inspect wheels for wear, flat spots, chips, flange wear, cracks, looseness of axle-pins or securing devices. (b) Inspect clearance, chatter, loose bearing caps, and lubrication.
11	▨		SHAFTS, COUPLINGS AND BEARINGS	Inspect shafts for vibration, cuts and nicks, loose or worn keyways, and misalignment. Inspect bearings for clearance, chatter, loose bearing caps and proper lubrication.
12	▨		GEARS AND CASES	Inspect gears for worn teeth, loose set screws and keys. Inspect guards and covers. Check gear cases for excessive noise and vibration and proper lubrication.
13			BRIDGE BRAKES	Inspect for wear in linkage, pins, and cams, weakness of springs, wear and condition of linings, smoothness of drum, and clearance between drum or disks. Inspect for improper solenoid air gap, evidence of overheating, damaged brass, air gap material, and loose core lamination, delay or restriction in opening of brakes. On hydraulic brakes inspect fluid level.
14			TROLLEY BRAKES	Inspect for wear in linkage, pins, and cams, weakness of springs, wear and condition of linings, smoothness of drum, and clearance between drum or disks. Inspect for improper solenoid air gap, evidence of overheating, damaged brass air gap material, and loose core lamination, delay or restriction in opening of brakes. On hydraulic brakes inspect fluid level

*Excerpted from Reference 1.

TABLE 3.1 (CONT)

ITEM NO.	INSPECTION FREQUENCY		ITEMS TO BE INSPECTED	CRANE MAINTENANCE INSPECTION SPECIFICATION
	A	B		
15			MAIN HOIST MAGNETIC	Inspect for wear in linkage, pins, and cams, weakness of springs, wear and condition of linings, smoothness of drum, and clearance between drum or disks. Inspect for improper solenoid air gap; evidence of overheating, damaged brass air gap material, and loose core lamination, delay or restriction in opening of brakes. On hydraulic brakes inspect fluid level.
16			MAIN HOIST LOAD BRAKE	Inspect for lubrication, leaks, and smooth operation. Inspect condition of screw threads, cams, and friction plates; worn, peened, or chipped ratchets and pawls, and proper clearance between friction plates.
17			AUXILIARY HOIST MAGNETIC BRAKE	Inspect for wear in linkage, pins, and cams, weakness of springs, wear and condition of linings, smoothness of drum and clearance between drum or disks. Inspect for improper solenoid air gap; evidence of overheating; damaged brass air gap material, and loose core lamination; delay or restriction in opening of brakes. On hydraulic brakes inspect fluid level.
18			AUXILIARY HOIST LOAD BRAKE	Inspect for wear in linkage, pins, and cams, weakness of springs, wear and condition of linings, smoothness of drum, and clearance between drum or disks. Inspect for improper solenoid air gap; evidence of overheating, damaged brass air gap material, and loose core lamination; delay or restriction in opening of brakes. On hydraulic brakes inspect fluid level.
19			SHEAVES	Inspect for wear, damage, worn bushings, pins, pin locking bars and bolts, and lubricating lines and fittings.
20			LOAD HOOKS AND BLOCKS	Inspect for damage wear to hook mounting device and hook swivel. Inspect blocks for loose pins, bolts, and guards. Inspect drip pans for securing bolts, gaskets, damage, and clearance.
21			WIRE ROPE, FASTENINGS.	Inspect cable, sockets, and connections for damage, broken wire strands, and lubrication. See footnote for wire rope inspection details and wire rope rejection criteria.
22			CAPACITY SIGNS	Inspect for mounting bolts, brackets, damage. Check markings on load signs for proper rating.
23	▨		MAIN DISCONNECT SWITCH	Operate switch, inspect for broken or missing support or operating members, overheating, and loose connections.
24	▨		MAIN CONDUCTORS, COLLECTORS	Inspect insulators and clamps for loose connectors, bent, pitted or damaged wires or collectors, loose or damaged staff or staff insulation, shoes, and loose, damaged or misaligned wheels.
25	▨		TROLLEY CONDUCTORS COLLECTORS	Inspect insulators and clamps, loose connectors, bent, pitted or damaged staff or staff insulation, shoes, and loose, damaged or misaligned wheels.
26	▨		WIRING AND FUSES	Inspect for damaged insulation, evidence of overheating, and loose connections.
27	▨		CONTROL PANEL RELAYS AND COILS	Inspect all contacts for proper alignment, signs of excess heating, or unusual arcing. Inspect all coils, contact leads, shunts and wires, fuses or overload devices for loose connections and signs of overheating. Inspect panel boards and arc shields for cracks, loose bolts, dirt, and moisture. Check panel markings for legibility. Inspect speed control resistors for damaged insulation, cracked or broken grids, loose connections and bolts, and brackets. Test overload relays for proper operation and settings. (See specification).
28	▨		BRIDGE CONTROLLER (ELECTRIC)	Inspect for loose tension springs, broken, cracked or loose handles, rough or burned contact segments, broken segment dividers and insulators, and proper contact pressure, unusual arcing, worn or loose cams, rollers or pins, and loose connections.

TABLE 3.1 (CONT)

ITEM NO.	INSPECTION FREQUENCY		ITEMS TO BE INSPECTED	CRANE MAINTENANCE INSPECTION SPECIFICATION
	A	B		
29	▨		TROLLEY CONTROLLER	Inspect for loose tension springs, broken, cracked or loose handles, rough or burned contact segments, broken segment dividers and insulators, and proper contact pressure, unusual arcing, worn or loose cams, rollers or pins, and loose connections.
30	▨		MAIN HOIST CONTROLLER	Inspect for loose tension springs, broken, cracked or loose handles, rough or burned contact segments, broken segment dividers and insulators, and proper contact pressure, unusual arcing, worn or loose cams, rollers or pins, and loose connections.
31	▨		AUXILIARY HOIST CONTROLLERS	Inspect for loose tension springs, broken, cracked or loose handles, rough or burned contact segments, broken segment dividers and insulators, and proper contact pressure, unusual arcing, worn or loose cams, rollers or pins, and loose connections.
32	▨		BRIDGE MOTOR	Inspect for damage, bearing noise, vibration, and lubrication, sparking, and clean lines of commutator and brush wear, loose hold down bolts and motor brackets. Inspect commutator or slip rings for evidence of overheating and brush sparking. Inspect motor leads and insulators for damaged or deteriorated insulation and loose connections.
33	▨		TROLLEY MOTOR	Inspect for damage, bearing noise, vibration, and lubrication, sparking, and clean lines of commutator and brush wear, loose hold down bolts and motor brackets. Inspect commutator or slip rings for evidence of overheating and brush sparking. Inspect motor leads and insulators for damaged or deteriorated insulation and loose connections.
34	▨		MAIN HOIST MOTOR	Inspect for damage, bearing noise, vibration, and lubrication, sparking, and clean lines of commutator and brush wear, loose hold down bolts and motor brackets. Inspect commutator or slip rings for evidence of overheating and brush sparking. Inspect motor leads and insulators for damaged or deteriorated insulation and loose connections.
35	▨		AUXILIARY HOIST MOTOR	Inspect for damage, bearing noise, vibration, and lubrication, sparking, and clean lines of commutator and brush wear, loose hold down bolts and motor brackets. Inspect commutator or slip rings for evidence of overheating and brush sparking. Inspect motor leads and insulators for damaged or deteriorated insulation and loose connections.
36	▨		HOISTS, LIMIT SWITCHES	Remove covers and inspect all electrical and mechanical components for malfunction including contacts, springs, ratchets, pins, arms and insulators, rollers, cams, and dogs. Inspect cover gaskets, counterweights, and guides. Inspect all securing bolts and guards.
37	▨		LIGHTING SYSTEM	Inspect lighting fixture for adequate support, proper location, damage, evidence of overheating, and damaged or broken socket and lenses. Inspect switches for proper operation, broken or missing parts, and covers. Inspect conductors for loose or damaged, wires, supports, and conduit junction boxes and raceways.
38	▨		HEATERS AND SWITCHES (PERSONNEL HEATERS)	Inspect for damaged wiring, proper electrical connections, guard/covers and switch operation.
39			WARNING DEVICES	Inspect for proper operation of sirens, horns, bells, and lights. Check switches and inspect wiring and connections.
40			CONTROL PANELS AND ASSOCIATED CIRCUITS	Measure and record insulation resistance and ambient temperature of power and control circuits (Minimum Allowed

TABLE 3.1 (CONT)

FOOTNOTE: (Item No. 21 - Wire Rope) Remove wire rope dressing from those running lengths exposed to maximum wear, exposure and abuse. Examine in particular sections in contact with equalizer sheaves and saddles or where corrosion may develop because of poor drainage. Replace all rope exceeding the following:

(1) DAMAGED STRAND - One completely broken or torn strand.

(2) KINKS OR CRUSHED SECTIONS - Severe kinks or crushed rope in straight runs where core is forced through outer strands or wires are damaged. (This does not apply to runs around eyes, thimbles, shackles.)

(3) FLATTENED SECTIONS - Flattened sections where the diameter across the flat is less than 5/6 of original diameter. (This does not apply to runs around eyes, thimbles, shackles.)

(4) WEAR - LOSS - (wear or otherwise) of diameter of outer wires exceeding 10% of nominal diameter of the wire rope.

(5) BROKEN - WIRES - The number of broken or torn wires exceeds six randomly distributed broken or torn wires in one lay or three broken wires in one strand in one lay.

TABLE 3.2

Replacement In-Kind Electrical Components

1. Main contactor "M"
2. "B" relay
3. "1SCR" relay
4. "2SCR" relay
5. time delay relays - 1AT, 2AT, 3AT bridge
6. time delay relays - 1AT, 2AT, 3AT trolley
7. time delay relays - 1BR, 1AT, 2AT, 3AT main hoist
8. overload relays and heaters
9. 24 relays, 24 heaters - bridge
10. 4 relays, 6 heaters - trolley
11. 6 relays, 6 heaters - main hoist
12. (4) - bridge clutch fuses
13. (2) - main hoist eddy current brake fuses
14. (4) - main hoist shunt brake fuses

TABLE 3.3

Design Modifications and Unlike Kind Electrical Component Replacements

Originally	Functionally Equivalent Replacement*
1. 300 Ampere Fuses	Non-Fuseable Links
2. Bridge Conductors (33) Collector System	33 Conductor Cable
3. Runway Conductors (33) Collector System	Feeder Cable/225 Ampere Breaker
4. Pendant/Festoon System	Pendant System Without Lock Key
5. Main Hoist Load Cell Jumpered Out (Pressure Switches and Selector Switch)	Rigged with Dillon Load Cell

*Functionally Equivalent indicates that the original component was replaced with another that is not identical but performs the same function without a loss of safety margin.

*TABLE 3.4

REQUIRED BRIDGE DRIVE COMPONENTS

COMPONENT	REQUIRED?	REMARKS
Main Bridge Drives		Two of four main bridge drives on opposite ends are required. Indicated number of required components are those associated with the two required main bridge drives.
Main Bridge Drive Motors (2 of 4)	Yes	Required for operational bridge drives.
SKSA Electric Brakes (2)	Yes	Originally these brakes were for parking only. As a minimum, brakes will be recovered sufficiently to act as drag brakes.
Hydraulic Brakes (2)	No	Crane can be positioned without these brakes.
Zero Speed Switch-Bridge Drive #1	No	Zero speed switch prevents engaging inching drive when bridge speed would cause inching drive to overspeed. Not required since inching drives are not required. Even if inching drives are recovered, switch is not required since operator control can be used to replace function.
Coupling, Zero Speed Switch to #1 Main Bridge Motor	No	Since zero speed switch is not required.
Whiting 8" Flexible Couplings (2 of 4)	Yes	Operational main bridge drives only.
10 VHSM Gear Drives (2 of 4)	Yes	Operational main bridge drives only.
Flexible Coupling (4 of 8) – Amerigear F8-103	Yes	Operational main bridge drives only.
Pillow Block Bearings (8)	Yes	All required unless bridge wheel drive assembly is dismantled.
6 P.D. Gear and 24 P.D. Gear (4)	Yes	All required unless bridge wheel drive assembly is dismantled.
Bridge Drive 4:1 Gear Reducers (2 of 4)	Yes	Operational main bridge drives only.
Bridge Wheels (16)	Yes	
Bridge Wheel Bearings (32)	Yes	
Resistors related to main drive motors (2 of 4)	Yes	Operational main bridge drives only.
All control components related to the main bridge drives such as starters, resistor contactors (1A-4A) and overload units on bridge panel.	Yes	Operational main bridge drives only. All five speeds will be recovered.

*Excerpted from Reference 3.

TABLE 3.4 (CONT)

REQUIRED BRIDGE DRIVE COMPONENTS

COMPONENT	REQUIRED?	REMARKS
Inching Bridge Drives		Inching bridge drives are not required since bridge can be final positioned by jogging with main bridge drives.
Inching Motors (4)	No	
Magnetic Clutch (4)	No	
Resistors related to inching drive motors (2 of 4)	No	
Slow speed motor rectifier sets	No	
Miscellaneous		
Control transformer (2 KVA) mounted in cab	Yes	
Warning horn, light and associated controls	No	Not essential to crane operation.
Master and selector switches in cab	No	
Start-stop pushbutton, bell foot switch, crane fast-slow switch in cab	No	It is assumed a pendant type control will be used.
Runway and bridge conductor collector system	No	System will be replaced with a temporary system powered from the existing polar crane feeder disconnect at elevation 347'-6".
Motor heater and other space heaters	No	Not essential to crane operation.
Crane lights	No	Not essential to crane operation.
Pendant controls	Yes	It is assumed the pendant control will be restored to support the main hoist bridge and trolley function.

TABLE 3.4 (CONT)

REQUIRED TROLLEY DRIVE COMPONENTS

COMPONENT	REQUIRED?	REMARKS
Main Trolley Drives		
Trolley Main Drive Motor (1)	Yes	
Trolley Brake - 8" BRBA (1)	Yes	As a minimum, brake will be recovered sufficiently to act as a drag brake.
Trolley Motor Zero Switch Speed Switch	No	Zero speed switch prevents engaging inching drive when trolley speed would cause inching drive to overspeed. Not required since inching drives are not required. Even if inching drives are recovered, switch is not required since operator control can be used to replace function.
Coupling for Zero Speed Switch	No	Since zero speed switch is not required.
Amerigear C-101½ Flexible Coupling (2)	Yes	
Amerigear FS 104 Flexible Coupling (4)	Yes	
Flexible Coupling (2)	Yes	
ABART Gear Reducer (1)	Yes	
40 V Rack Unit (1)	Yes	
17 BT Rack Unit (2)	Yes	
Trolley Truck Bearing Assemblies	Yes	
Trolley Wheels (8)	Yes	
Trolley Main Drive Motor Resistors	Yes	
All control components such as starter, resistor contactors (1A-4A) and overload units associated with high speed drive	Yes	
Forward and reverse limit switches next to end stops	Yes	
Alarm limit switches 9" from end stops	No	Operator control will be adequate.

TABLE 3.4 (CONT)

REQUIRED TROLLEY DRIVE COMPONENTS

COMPONENT	REQUIRED?	REMARKS
Inching Trolley Drives		Inching drives are not required since trolley can be final positioned by jogging the trolley main drive motors.
Inching Drive Motor (1)	No	
Magnetic Clutch (1)	No	
Resistors related to inching drive motors	No	
Slow speed rectifier sets	No	

TABLE 3.4 (CONT)

REQUIRED MAIN HOIST COMPONENTS

COMPONENT	REQUIRED?	REMARKS
Main Hoist Main Drive Train		
Main Hoist Motor	Yes	
Main Hoist Drive Motor Resistors	Yes	
Main Hoist Motor Zero Speed Switch	Yes	
Coupling, Main Hoist Motor to Zero Speed Switch	Yes	
Flexible Couplings (2) – Amerigear F-103	Yes	
Crosshead Drive Gear Unit	Yes	
Main Hoist Driveshaft Support Bearing	Yes	
All control components such as breakers, starters, switches & relays in Main Hoist Control Panel & Main Hoist Slow Speed Control Panel	Yes	
All contactors (1A-4A) overload devices & fuses related to Main Hoist System	Yes	
Main Hoisting Unit		
Main Hoist Solenoid Brakes (2)	Yes	Redundant brakes required based on a licensing (FSAR) commitment.
Main Hoist Solenoid Brakes Rectifiers & Transformers	Yes	
No. 500-C Main Hoist Gear Unit	Yes	
Main Hoist Drum Pinion Drive Gears (2)	Yes	
Main Hoist Drum Support Bearings (4)	Yes	
Drum Pinion Drive Gear Support Bearings (2)	Yes	
Main Hoist Drums (2)	Yes	
Main Hoist Wire Rope	Yes	
Main Hoist Weight Type Limit Switch	Yes	Required based on a licensing (FSAR) commitment.

TABLE 3.4 (CONT)

REQUIRED MAIN HOIST COMPONENTS

COMPONENT	REQUIRED?	REMARKS
Main Hoist Screw Type Limit Switch	Yes	Required based on a licensing (FSAR) commitment.
Main Hoist Load Sensing Device on trolley	No	Load indication will be provided at load.
Selector Switch for Main Hoist Load Sensing Device	No	Since load sensing device on crane is not required.
Adjustable Dial for Main Hoist Load Sensing Device	No	Since load sensing device on crane is not required.
Main Hoist Upper Sheave Nest	Yes	
Main Hoist Bottom Block Assembly	Yes	
Main Hoist Hook	Yes	
Main Hoist Inching Drive Train		
Inching Drive Gear Motor	Yes	
Inching Drive Magnetic Clutch	Yes	
Inching Drive Magnetic Clutch Rectifier & Transformer	Yes	
Inching Drive Eddy Current Brake	Yes	
Inching Drive Eddy Current Brake Rectifier, Resistors & Transformers	Yes	
Flexible Coupling - Amerigear F-102½	Yes	

4. Functional and Operability Testing of the Refurbished Polar Crane

After needed repairs were identified and made, as described in the previous section, the installations and modifications had to be functionally and operationally tested prior to use under load conditions. As components were installed, they were tested for functional verification. Reports describing the results of these tests were provided to the NRC for review (see Appendix C). The Whiting Corporation Polar Crane Operating and Maintenance Instruction Manual and ANSI B 30.2 (Overhead and Gantry Cranes) were used as sources of acceptance criteria. The tests consisted of exercising the bridge, trolley, and main hoist drives (one-at-a-time) in both slow and fast modes and in both motor directions under no load conditions. The operation of each drive train permitted the full exercising (at least several full turns of the drive wheel or rope drum) of all components in the drive train. The main hook was raised and lowered for an extended period of time to demonstrate performance capability. The trolley was operated over the full length of the bridge and the bridge was driven through varying degrees of rotation. During each operation, crane inspectors were assigned to observe the operation of the drive trains, including motors, gear trains, clutches, brakes and shafting. Checklists describing dynamic characteristics such as excessive vibration, wobble or noise, unusual bearing temperature, spillage, seepage or throw of lubricant were used to record the observations.

We, as well as our expert consultant, have reviewed the results of these tests (see Table 4.1) and conclude that GPU has performed all necessary functions to demonstrate that the crane is functionally and operationally ready for the load test.

TABLE 4.1

Polar Crane Functional Tests Reviewed by NRC and Consultant

Subject	Document Date
1. Polar Crane Limited Operation No Load Test	4/5/83
2. Work Package for No Load Test (#M048)	1/12/83
3. Static Tests on High Speed Motor Resistor Banks	3/1/83
4. High Speed Motors, Trolley Slow Speed Panels, Slow and High Speed Motors for Bridge, Trolley and Main Hoist	3/1/83
5. Non-Destructive Examination of the Main Hook	2/28/83
6. Setting of the Main Hoist Upper Limit Switches	8/12/83
7. Setting of Trolley Limit Switches (Work Package # E0085)	2/25/83

5. Load Testing of the Refurbished Polar Crane

The polar crane load test is designed to requalify the crane for the heaviest required lift of the TMI-2 recovery effort. The heaviest required lift will be the removal of the 163 ton reactor vessel head and service structure to shielded storage on the 347 feet elevation. Accordingly, it is GPU's intent to requalify the crane to a rating of 170 tons to provide a margin for the additional weight of the rigging associated with head lift. In order to demonstrate the crane's lifting capability of 170 tons, a load test will be performed with a test weight estimated to be 212 tons. Consistent with an effort to maintain occupational radiation exposures as low as reasonably achievable (ALARA), the test weight will be constructed of materials already in the reactor building and will consist of the 5 missile shields (one from over the pressurizer and four from over the reactor vessel) which must be moved during the course of cleanup. The missile shields will be assembled on the operating floor (347 feet elevation) in a newly constructed test frame and the load will include the reactor vessel head and internals handling fixture (tripod), the in-line load cell, and associated rigging. The load test assembly is shown in Figure 8.1.

The load test sequence is listed in Table 5.1 and is structured to demonstrate the functional capability of the crane in a series of progressive steps, beginning with a test lift of the 6 ton internals indexing fixture. Following the functional check of the main hoist with the internals indexing fixture, the fixture will be moved to a designated storage location. A similar functional check of the main hoist will then be performed on a 40 ton missile shield with attached rigging and in-line load cell. Following this test, the load test sequence will include the assembling of the four 40 ton reactor vessel missile shields and single 32 ton pressurizer missile shield on the test frame. The lift rigging, tripod, and load cell will be attached and the entire assembly will be lifted off the operating floor. The lift will demonstrate the lifting capability of the main hoist, load cell, and also, the tripod assembly. An operational check of the main hoist brakes will be performed. With the load elevated, the trolley and bridge movement will be checked in sequence, including the performance of the trolley and bridge brakes and gearing. Any operational deficiencies or problems will be noted for corrective action. Following completion of the load test, the test load will be disassembled and the reactor vessel missile shields will be stored over the "D" ring concrete structure which surrounds the "B" steam generator. This structure is a storage location for the missile shields by design at TMI-2. The pressurizer missile shield will be moved back to the storage location over the pressurizer.

As discussed below, the planned load test sequence is not in strict accordance with the guidance (i.e., ANSI B30.2 - 1976, Overhead and Gantry Cranes) we recommended in our April 1, 1982 letter on the refurbishment and requalification of the damaged crane, but the sequence is reasonable, given the radiation fields that the workers are exposed to in the building, and adequate to demonstrate the functional performance of the crane under load conditions. ANSI B30.2, Section 2-2 (Inspection, Testing and Maintenance) requires that the crane be tested at not more than 125% of the rated load and, if a new rated load is being determined, the rating should not be more than 80% of the maximum load sustained during the test.

In the Functional Description and the Safety Evaluation Report, GPU stated that the test load weight would be between 200 and 220 tons with the best estimate at 212 tons. The uncertainty (roughly 5%) in the exact weight of the test load is due to the uncertainties in the exact weights of the missile shields and load test frame. When evaluating the anticipated test weight against B30.2, Chapter 2-2 requirements, the 125% maximum load criteria is met, based on the best estimate of 212 tons. However, if the test load is as low as 200 tons, the requested load rating of 170 tons could be as much as 85% of the test load weight, based on the worst case assumption for the test load. We do not consider this to be a significant deviation from the ANSI standard given the radiological conditions in the reactor building, the attendant radiation exposure which would accrue from bringing additional weight into the building for the test load, and the relatively few heavy lifts (e.g., only one planned lift in excess of 150 tons) required to complete TMI-2 recovery.

ANSI B30.2, Section 2-2 further requires that the test consist of the following as minimum requirements:

1) Hoist the test load a distance to assure that the load is supported by the crane and held by the hoist brake(s),
2) Transport the test load by means of the trolley for the full length of the bridge,

3) Transport the test load by means of the bridge for the full length of the runway in one direction with the trolley as close to the extreme right hand end of the crane as practical and in the other direction with the trolley as close to the extreme left hand end of the crane as practical, and
4) Lower the test load and stop and hold the load with the brake(s).

Items 1 and 4 will be performed, however the load test sequence is such that the required full trolley test with the load test assembly fully supported by the crane (item 2) will not be made because the test is designed to simulate the movements required for head lift. We conclude that moving the load test assembly as proposed will confirm the ability of trolley components to operate under loaded conditions and that any additional movement over other areas of the plant is unnecessary and inconsistent with the desirability of minimizing the times that loads are suspended over the operating floor. Also, the required full bridge test (item 3) will not be made as the bridge rotation will be limited by procedure to operation in the azimuthal sector required for head lift and it is unnecessary to demonstrate the capability for carrying the load over other areas of the building. Also, there are physical interferences which would not permit the full rotation of the bridge with the test load assembly attached.

TABLE 5.1

MAIN HOIST LOAD TEST SEQUENCE

1. Attach lift rigging to internals indexing fixture (IIF).

2. Lift IIF to clear floor elevation 347'6" sufficiently for brake check. Stop and hold to observe for settling of the load or other abnormal conditions. Lower and, stop and hold to observe for abnormal conditions. Lower to floor. Correct abnormal conditions if and when present.

3. Lift IIF and move it to its designated storage location.

4. Attach lift rigging, including load indicating device, to reactor pressure vessel missile shield R-4.

5. Lift R-4 to clear top of D-ring concrete sufficiently for brake check. Stop and hold to observe for settling of the load or other abnormal conditions. Lower and, stop and hold to observe for abnormal conditions. Lower to D-rings. Correct abnormal conditions if and when present.

6. Lift R-4 sufficiently to clear hold-down studs and nearby handrails, and transfer it over missile shields R-3, R-2 and R-1 to the load test assembly area on elevation 347'6". Lower R-4 onto the load test frame.

7. Repeat Steps 4 through 6 for reactor pressure vessel missile shield R-3.

8. Repeat steps 4 through 6 for reactor pressure vessel missile shields R-2 and R-1, and pressurizer missile shield P-1, respectively, except "stop" and "hold" requirements may be deleted if no abnormal conditions were encounted while moving R-3. Otherwise, repeat steps 4 through 6 completely.

9. Attach lift rigging, including load indicating device, to the load test assembly.

10. Lift load test assembly to clear floor sufficiently for brake check, stop and hold to observe for settling of the load or other abnormal conditions. Lower and, stop and hold to observe for abnormal conditions. Lower to floor.

11. Lift load test assembly to clear floor sufficiently for the trolley test. Move the trolley not less than 10 feet NORTH while remaining within the boundary designated for the trolley test. Reverse the trolley and return the load test assembly to the starting location.

12. Move the bridge not less than 15 feet EAST (distance measured at runway rail) while remaining within the boundary designated for the bridge test. Reverse the bridge and return the load test assembly to the starting location. Lower the load test assembly onto the floor.

TABLE 5.1 (CONT)

13. Observe and correct any abnormal conditions that may occur during brake check, and trolley and bridge movement while testing with the load test assembly. Correct any abnormal conditions, if and when present. If corrective actions are taken, repeat portion of test where abnormal conditions appeared until all problems are resolved.

6. Polar Crane Wire Rope

The TMI-2 polar crane utilizes two 2,310 feet, 1-3/8 inch nominal diameter wire ropes for raising and lowering loads. These ropes were used prior to the accident and were subjected to the pressure and temperature effects of the accident. Since the accident, they have been exposed to a potentially corrosive high humidity environment. Because of these conditions, the wire rope either had to be inspected per the requirements of ANSI B30.2, paragraphs 2-2.4.1 and 2-2.4.2 or replaced. GPU elected to perform an inspection over the entire accessible length of the rope (see Appendix C) for any deterioration that could result in appreciable loss of original strength due to:

1) Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion or wear of outside wires,
2) A number of broken outside wires and the degree of distribution or concentration of such broken wires,
3) Worn outside wires,
4) Corroded or broken wires at end connections,
5) Corroded, cracked, bent, worn or improperly applied end connections,
6) Kinking, crushing, cutting or unstranding,
7) Inner wire and core damage from any cause in localized areas,
8) Internal and external lubrication,
9) Heat damage from any cause,

10) Peening both externally and internally in localized areas,

11) Scrubbing,

12) Fatigue failure,

13) Abrasion,

14) Improper reeving.

GPU also forwarded to the Pittsburgh Testing Laboratory (PTL), a nationally recognized independent laboratory, samples of the wire rope for comparison with a strand of new rope, (see Appendix C). PTL concluded that both the new and old wires had equivalent properties in terms of lift capabilities based on tensile strength, microstructure, and microhardness. There was surface rust on the TMI-2 sample, however, it was determined that the amount of rust did not significantly affect the strength properties. No kinking, crushing, cutting, or unstranding was found in any areas of the rope. The rope has been fully lubricated as a result of the inspection and maintenance program for crane refurbishment.

In accordance with industry standards, the polar crane load test will not result in the full length of the wire rope being load tested. Because of the material tests and inspection results, it is reasonable to assume that the remaining wraps of rope left on the hoist drum during the load test, are in good condition, and therefore, will be safe to use in future lifts requiring longer lengths of rope. ANSI B30.2, Section 2-1.11.2, only requires that two wraps of rope remain on each anchorage of the hoisting drum. GPU will adhere to this criterion through administrative controls.

The sheaves in the lower block and upper sheave nest were also inspected for deficiencies that could cause wire rope damage and/or undesirable hoisting operation. No deficiencies were found.

Based on our review of the referenced inspection and test reports, we conclude that the use of the wire rope for the polar crane load test will not endanger the health and safety of the public.

7. Reactor Vessel Head and Internals Handling Fixture (Tripod)

The polar crane load test will also verify the ability of the reactor vessel head and internals handling fixture to lift a 170 ton load. This test is required in part because the documentation on the original qualification of the tripod could not be located by GPU to verify testing and materials used in fabrication. Additionally, during the inspection of the tripod on June 8, 1983, numerous undersized welds were discovered on the structure and further evaluation and testing of the tripod to demonstrate its lifting capability became all the more important. We forwarded a letter to GPU on July 8, 1983, requesting information on these welds including a stress analysis, visual inspection results, and any plans for action to be taken relative to the welds.

GPU responded in part on August 1, 1983, and concluded that the tripod with the undersized welds meets all design requirements and, therefore, is acceptable for use as is. We forwarded another letter to GPU on August 8, 1983, requesting additional information. A response was received on August 18, 1983. Additional discussions were held with GPU related to the structural design of the tripod and we requested further stress calculations on the critical welds of the assembly. GPU provided the additional stress analyses by letter dated October 4, 1983. We have reviewed the additional information and conclude that, based on the stress analysis results, the as-built welds are capable of sustaining the stresses induced from a load in excess of three times the rated load for the crane without exceeding allowable stress limits. The detailed evaluation of the structural design adequacy of the tripod by the NRC Structural and Geotechnical Engineering Branch is provided in Appendix D. However, notwithstanding the stress analysis results, actual weld integrity can only be verified by non-destructive examination (NDE). Accordingly, we will require NDE on the three higher stressed welds as added assurance that the tripod is capable of performing its intended function. The use of the tripod for loads in excess of 10 tons is prohibited pending completion of the NDE to verify weld integrity. The tripod is safe to use to move the 6 ton internals indexing fixture and other miscellaneous loads up to 10 tons before completion of the NDE.

8. Load Test Frame, Rigging and Load Cell

The load test frame, rigging, and the load cell were designed and tested in accordance with current industry standards with some exceptions. These standards and their applicability are discussed in Section 3. The following discussion summarizes how compliance was achieved or why exceptions to the standards were taken.

A. Load Test Frame

The load test frame is a structure that will be used as a "container" for the five missile shields, four weighing approximately 40 tons and one weighing approximately 32 tons. The load test assembly fully loaded has been estimated to weigh a total of 212 tons. This includes the 6 ton tripod fixture, associated lift rigging, an estimated 192 tons of missile shields and the structural steel of the load test frame. As previously discussed in Section 5, the uncertainty in the total load is approximately ±5%.

The load test assembly is comprised of a lower support structure, missile shields stacked on the lower structure, the load spreader frame which rests on top of the uppermost missile shield, and rigging that connects the lower frame and upper load spreading frame (see Figure 8.1). The load test frame will be load tested at the same time it is used. The test/use of the frame is for the combined weight of the missile shields which is approximately 192 tons. ANSI N14.6 requires a 150% test whereas the actual test/use is at 100%. We concur with the 100% since the only use of the assembly is for the test. At the rigging connecting point on the load spreader frame, there is an equalizing bracket assembly that insures that the load is balanced between each set of rigging ropes (2 per set) on each corner of the frame. Each of these rigging ropes has a minimum breaking strength of 146 tons. This results in a lifting capacity of 292 tons for each corner of the frame which results in a safety factor of greater than five for each rope. All wire ropes will be tested by GPU for certification before use or will be certified by the vendor before shipping. This is in compliance with ANSI B30.9 which addresses the criteria to use for wire rope slings. The load test frame was designed in accordance with AISC standards. Region I inspectors have reviewed the documentation for fabrication of the frame, including the records for the nondestructive examination (visual and magnetic particle) of the frame, and concluded that fabrication was in accordance with the engineering requirements of applicable standards and procedures.

Based on the above discussion, we therefore conclude that the load test frame is adequately designed and constructed for use in the load test.

B. Missile Shield Rigging

Four wire rope slings are required for each missile shield, each being attached at the lifting lugs of the shield at one end and attached to and a single plate at the other (see Figure 8.1). Because the missile shield structure is a rigid body and the possibility does exist that the slings will not be exactly the same length, the missile shield lift is categorized as indeterminant from the standpoint of stress analysis. Therefore, in our evaluation of the potential load on each sling, only two of the four slings were assumed to support the load of 40 tons, each sling having a minimum breaking strength of 153 tons. With this assumption, we calculated a factor of safety of greater than 6 for each sling. This safety factor complies with the requirements of ANSI B30.9.

We therefore find the missile shield rigging acceptable.

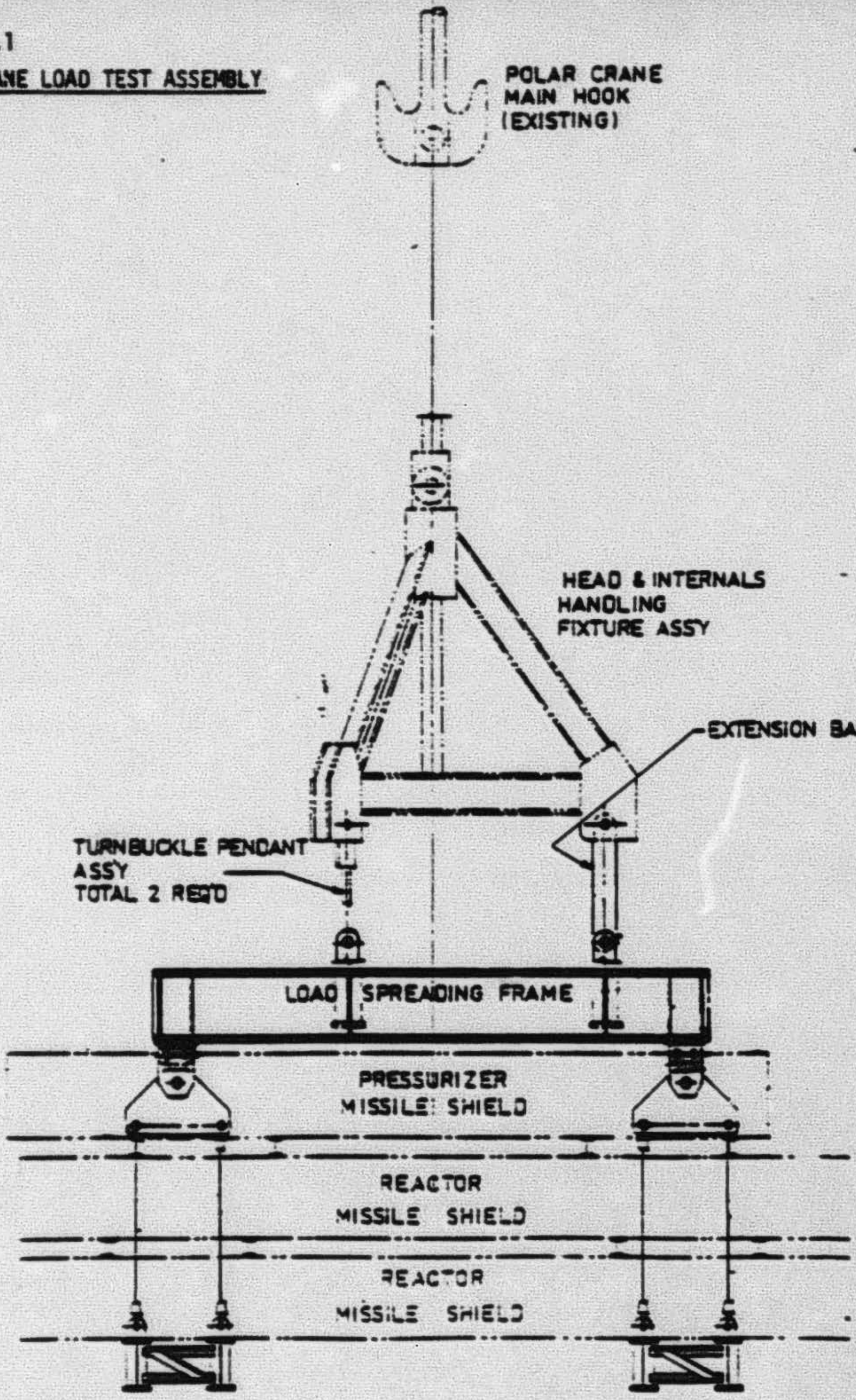
C. Load Cell

New load cell rigging was designed and fabricated to mate the load cell to the Unit 2 polar crane rigging. The rigging components comply with the design guidance of ANSI N14.6 with a few minor exceptions. ANSI N14.6 recommends a factor of safety of 3 for yield and a factor of safety of 5 for ultimate breaking strength. When evaluating the maximum potential load of 220 tons that will be sensed by the load cell cylinder, the factor of safety is 3.5 for yield and 4.6 for ultimate. Also, one of the 7" diameter pins that connects the cell to its rigging, has a factor of safety of 4.0 for yield and 4.9 for ultimate. The 4.6 and 4.9 ultimate factors of safety for the cylinder and the 7" pin respectively are close enough to the standard recommendation of 5.0 and therefore meet the intent of ANSI N14.6. All other components of the load cell rigging clearly meet the guidance of ANSI N14.6. During the load test and any subsequent use of the crane with the load cell in place, free hook rotation will be verified by personnel to assure that minimal torque will be induced at the load cell. If at any time the main hook bearing does not allow free rotation, the ongoing lift will be terminated.

The load cell was also calibrated by the manufacturer up to 220 tons, thereby giving added assurance that the stress limits of the cell will not be exceeded. In summary, we conclude that the load test frame, cell rigging and the load cell are acceptable for the polar crane load test.

FIGURE 8.1

POLAR CRANE LOAD TEST ASSEMBLY



9. Quality Assurance and Quality Control

We have reviewed the application of quality assurance (QA) and quality control (QC) requirements and practices used for the refurbishment and requalification of the polar crane. The implementation of QA and QC for TMI-2 recovery activities is controlled by the Recovery Quality Assurance Plan. The plan applies to such recovery activities as inspection, maintenance, repair, modification and testing, among others. However, based on a forthcoming NRC inspection report (No. 50-320/82-12) and findings from a recently issued report (September 1, 1983) by the NRC Office of Investigations about cleanup-related allegations by several former and current GPU and contractor employees, there were violations of the Recovery Quality Assurance Plan in the refurbishment program. As explained in the OI report, the damaged polar crane was incorrectly turned over to GPU's prime contractor (Bechtel) for refurbishment as a construction project and there were additional administrative and procedural deficiencies in the refurbishment prgram.

In light of the identified administrative and procedural deficiencies in the refurbishment program, we held a public meeting with GPU in Middletown, Pennsylvania, on September 27, 1983 to discuss the programs, including the managerial controls employed throughout the refurbishment. At the meeting, we informed GPU that additional information would be needed to provide assurance that the refurbishment has the proper management controls and quality workmanship. The information requested included the following: (1) assurance by GPU that the Quality Assurance organization has independently reviewed the polar crane refurbishment activities and that any identified deficiencies have been corrected, (2) assurance by GPU that modifications to the polar crane involving "unlike kind" components have been evaluated and reviewed in accordance with applicable administrative procedures, (3) assurance by GPU that all polar crane testing is performed in accordance with applicable administrative procedures and with the cognizance or approval (for tests performed by other groups) of the Test Working Group (TWG), and (4) assurance by GPU that all personnel including contractors, involved with polar crane activities were adequately trained in GPU administrative and procedural requirements. These requirements were formalized in a letter to GPU dated September 28, 1983. GPU responded to our request by letters dated October 11, 1983 and October 19, 1983, outlining a program for completion of our requirements. We have reviewed the GPU program for the correction of the administrative and procedural deficiencies, including the schedule for the completion of training on GPU administrative procedures and crane operating requirements, and conclude that the program is adequate.

Notwithstanding the GPU efforts to correct the administrative and procedural deficiencies identified for the polar crane refurbishment program, we focused our review on assurance of polar crane safety. Our primary focus in this safety evaluation was not whether the correct administrative controls (i.e., the GPU Recovery Quality Assurance Plan) were used in the refurbishment program but whether the process actually utilized by Bechtel in the refurbishment program portends health and safety concerns related to the crane itself. To address this issue, we evaluated the following: (1) the findings of the forthcoming NRC inspection report (No. 50-320/83-12) and the September 1, 1983 OI report, (2) the program actually utilized by Bechtel to refurbish the polar crane, including control of work performed, documentation of work performed, quality assurance checks, and degree of engineering involvement, (3) the technical expertise employed by Bechtel during the refurbishment program, and (4) the results of the functional and operability testing of the refurbished crane to determine if major defects were inherent in the refurbishment program.

In the spring of this year, allegations were made by several former and current GPU and contractor (Bechtel) employees about cleanup-related activities, including the refurbishment of the polar crane. The allegations were primarily about the procedural deficiencies in the program incorporated to refurbish the crane. However, none of the findings of the OI investigation or forthcoming NRC inspection (Report No. 50-320/83-12) indicated that there were any safety-related concerns associated with the refurbished crane.

The program utilized by Bechtel to refurbish the polar crane involved the use of "work packages" and Bechtel administrative procedures (which had not been approved by GPU) to control, perform, and document the work in the crane refurbishment. The program incorporated the Bechtel Design Engineering Organization for engineering purview and assistance. Prior to implementation, the bulk of the work packages were reviewed by our on-site staff. The refurbishment work was planned and scheduled on a daily basis and strict control was maintained over reactor building entries. Personnel were trained prior to the performance of in-containment work and equipment was staged for the planned activities.

Activities in the building were monitored by closed-circuit television and radio communication. With regard to the work actually performed, our review of the work packages indicated they were technically adequate and the quality of the work was such that no significant rework was necessary.

For various aspects of the refurbishment and requalification program, Bechtel employed technical expertise from U.S. Crane Certification Bureau, Inc., Whiting Corporation (the crane manufacturer) and United Engineers and Constructors. Additionally, Bechtel employed the services of a former Whiting employee for quality assurance support. U.S. Crane was the prime overseer for the refurbishment program while Whiting performed an evaluation of the crane runway rails. United Engineers and Constructors participated in the electrical refurbishment of the crane. Thus, Bechtel had considerable technical support from companies having special skills for the refurbishment program to ensure a safe crane for the requalification test.

In addition to the technical expertise employed on the procedures and controls utilized to refurbish the crane, actual verification of the adequacy of the work performed was demonstrated by functional and operability testing of the crane and its separate components (i.e., the brakes, motors, power supplies, etc.). As each functional part, (e.g., the main hoist brakes) was refurbished, it was functionally tested to demonstrate its performance capability. Further, at the end of the refurbishment program, the crane was operationally tested as a complete system to demonstrate the functional performance, under no-load conditions, of all operating entities of the crane, including the bridge drives (high and low speed, forward and reverse), trolley drives (high and low speed, forward and reverse), main hoist drives (high and low speed, raise and lower), main hoist upper limit switches, the brakes for the bridge, trolley and main hoist, and pendant control. The operational testing was successful and demonstrated the crane was capable of performing its required functions. Our expert crane consultant was a direct observer of portions of the limited operational testing of the crane (containment entry on January 19, 1983).

We conclude that, notwithstanding the identified procedural deficiencies in the refurbishment of the polar crane, the program utilized to refurbish, test and operationally verify a working crane is now technically sufficient and provides reasonable assurance that the crane is safe for the conduct of the requalification test.

10. Load Pathways and Accident Analyses

We have evaluated the entire load test sequence and considered the potential for accidents in relation to the required lifts and the pathways selected for lift movement. This evaluation includes a review of the heavy load drop analysis provided by GPU to address the guidance in NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants."

The guidance in NUREG-0612 was developed to address the concerns related to the dropping of heavy loads in certain locations in the plant and impacting stored spent fuel or fuel in the core, equipment required to achieve safe shutdown, or equipment to remove decay heat from the core. While these are valid concerns at normal operating plants, they are of less concern at TMI-2 for the reasons discussed below.

First, the TMI-2 facility is already in a safe shutdown condition and, thus, there are no concerns related to a potential drop impacting the capability for achieving safe shutdown. Second, the reactor has been shut down for approximately 4-1/2 years and the decay heat generation has decayed to a level of approximately 24 Kw, roughly the heat generated by 25 household toasters. The removal of decay heat is being accomplished by purely passive means (losses to ambient) and the potential loss of active means of removing decay heat from the core as a result of a drop accident is not a serious concern. Third, there is no spent fuel stored in the refueling canal and, thus, no potential for impacting, as a result of a drop accident, exposed fuel assemblies outside of the reactor vessel. However, there is the potential, even through the probability is very low, for dropping a missile shield on the reactor vessel and service structure and rearranging the physical distribution of the damaged fuel and debris in the vessel. With regard to the potential for radioactive releases from such an event, we note that virtually all of the noble gases and iodines have already been released from the damaged fuel assemblies in the core or have decayed to insignificant levels. Thus, at TMI-2, the potential for a large release of volatile gaseous radionuclides from a drop accident does not exist. Furthermore, any generation of airborne particulate activity would be contained inside the reactor building and filtered by the building ventilation system high efficiency particulate in (HEPA) filters prior to release and any potential releases would result in doses that are well within the limits of 10 CFR, Part 100.

With regard to the potential for recriticality in the core from an impact induced fuel and debris rearrangement, a number of criticality analyses have already been performed (see the NRC Safety Evaluation Report related to the axial power shaping rod insertion, Reference 23) which postulated fuel redistribution, and we consider the crane load test to be bounded by the previous analyses.

Lastly, we consider the potential for a load drop to be extremely low for a number of reasons. First, the crane was originally rated for 500 tons and has been refurbished with parts (e.g., brake pads) sized for the 500 ton rating. However, the maximum load to be handled in the vicinity of the reactor vessel is a single 40 ton missile shield. The TMI-2 cleanup only requires a crane capable of lifting the 163 ton reactor vessel head and service structure and even the requalification test load (approximately 212 tons) is less than half the rated capability of the original design. The environmental conditions during and following the accident were not severe enough to affect the structural integrity of the crane and related components (e.g., wire rope and tripod assembly). A detailed inspection of the crane components, including critical welds, has verified the condition of the exposed elements. Finally, the crane has a demonstrated history of significant lifts (see Table 10.1) including previous lifts of the reactor vessel head and service structure and 152 ton pressurizer.

Notwithstanding the potential, however low, for a severe load test related accident and the low probability for such an event, GPU has planned the load test to minimize the risks associated with the activity. The load test sequence has been structured to requalify the crane in a progressive series of steps, beginning with the 6-ton internals indexing fixture and proceeding to a 40-ton missile shield and, lastly, the 212-ton requalification test for reactor vessel head lift. Each of these loads, regardless of size, will initially be lifted only a short distance and held in place to verify functional performance prior to completing a movement. In the case of the missile shields, the shield will be lifted and held in place while still on the guide studs to further minimize the potential for a drop on the reactor vessel head. In assembling the test load, the missile shield located the furthest from the test frame will be the first moved for subsequent transport over the remaining shields which will serve to protect the reactor vessel and other equipment below, in the event of a drop. In general, the lifting time for all lifts will be minimized to the extent necessary to complete a movement or satisfy a test. All load pathways have been selected to avoid, where possible, the vicinity of the reactor vessel and with due consideration for the piping and components located on the elevations below the operating floor. The rotation of the bridge is bounded by procedure to the azimuthal sector required to conduct the tests, and markers have been placed on the reactor building walls to identify the limits for bridge travel. Placement of markers is consistent with the guidance provided in NUREG-0612. Other procedural precautions for the test include the stationing of an individual near the crane main power supply breaker located in the auxiliary/fuel handling building who will be in direct communication with the command center. If necessary, the test director can have the main breaker disconnected which automatically sets the brake on the main hoist.

Notwithstanding the planning and precautions taken by GPU for the conduct of a safe test, it is appropriate to postulate accidents and evaluate the consequences of such events.

We have considered the consequences of a missile shield drop on the reactor vessel head and service structure. The worst case credible event would be the fracturing of one of the pipes (e.g., core flood inlet) penetrating the reactor vessel, resulting in the draining of a portion of the reactor coolant. But, even in this case, the reactor coolant would drain down only to the level of the pipe inlet nozzle which is still above the core. Thus, the core would remain covered. The lost reactor coolant would collect in the reactor building basement and would not pose significant radiological risks for several reasons. The reactor coolant is at ambient temperatures and, thus, there is no driving force to evaporate the coolant and disperse the entrained radioactivity. The gross radionuclide concentration in the reactor coolant is less than 10 uCi/ml and there are no significant radioiodines or dissolved noble gases in the reactor coolant.

We do not consider the severing of the in-core instrument tubes which penetrate the lower reactor vessel head to be a credible event for a number of reasons. First, a significant amount of the kinetic energy in the missile shield would be dissipated in the deformation of the service structure (see Figure 10.1). Second, the missile shield would have to fragment into pieces which would fit within the physical constraints of the reactor vessel and surrounding concrete structure, an annulus of slightly less than 2 feet of maximum clearance (see Figure 10.2). The fragmented pieces would have to clear the four 28 inch diameter inlet pipes, two 36 inch diameter outlet pipes, and two 14 inch core flood tank pipes which penetrate the reactor vessel (see Figure 10.3). Having cleared the vessel piping, a piece of missile shield no larger than about 9 inches in maximum dimension would have to strike the concrete pad supporting the reactor vessel, bounce at a 90° angle and pass through one of the 9-1/4 inch diameter holes in the reactor vessel support skirt, and strike an in-core instrument tube with enough energy to fail 0.22 inch thick tubing (see Figure 10.4). We consider such an event to be incredible.

TABLE 10.1

Previous Polar Crane Lifts

Approximate weights of known heavy lifts made by the polar crane are stated below:

(Approximate Weights in Tons)

Pressurizer	*152
Core Floor Tanks	39
Reactor Coolant Piping (Inlet Piping)	112
(Outlet Piping)	105
Reactor Coolant Pumps	56
Reactor Coolant Pump Motors	51
P&H Electric Hydraulic Crane (75T capacity)	25
R.V. Head (w/o Service Structure)	81
R.V. Service Structure (Bare)	17
Upper R.V. Internals w/shipping canisters	55
Lower R.V. Internals w/shipping canisters	110
R.V. Head, Service Structure, CRDM assemblies	*152
Missile Shields - (Reactor Vessel)	40
(Pressurizer)	32

These lifts were made generally during initial plant construction and start-up.

*Includes the 6 ton tripod lifting assembly. Subsequent to the lifts discussed in this table, additional shielding rigging and miscellaneous equipment has been added to the service structure and head, thereby increasing the total weight to approximately 163 tons.

FIGURE 10.1

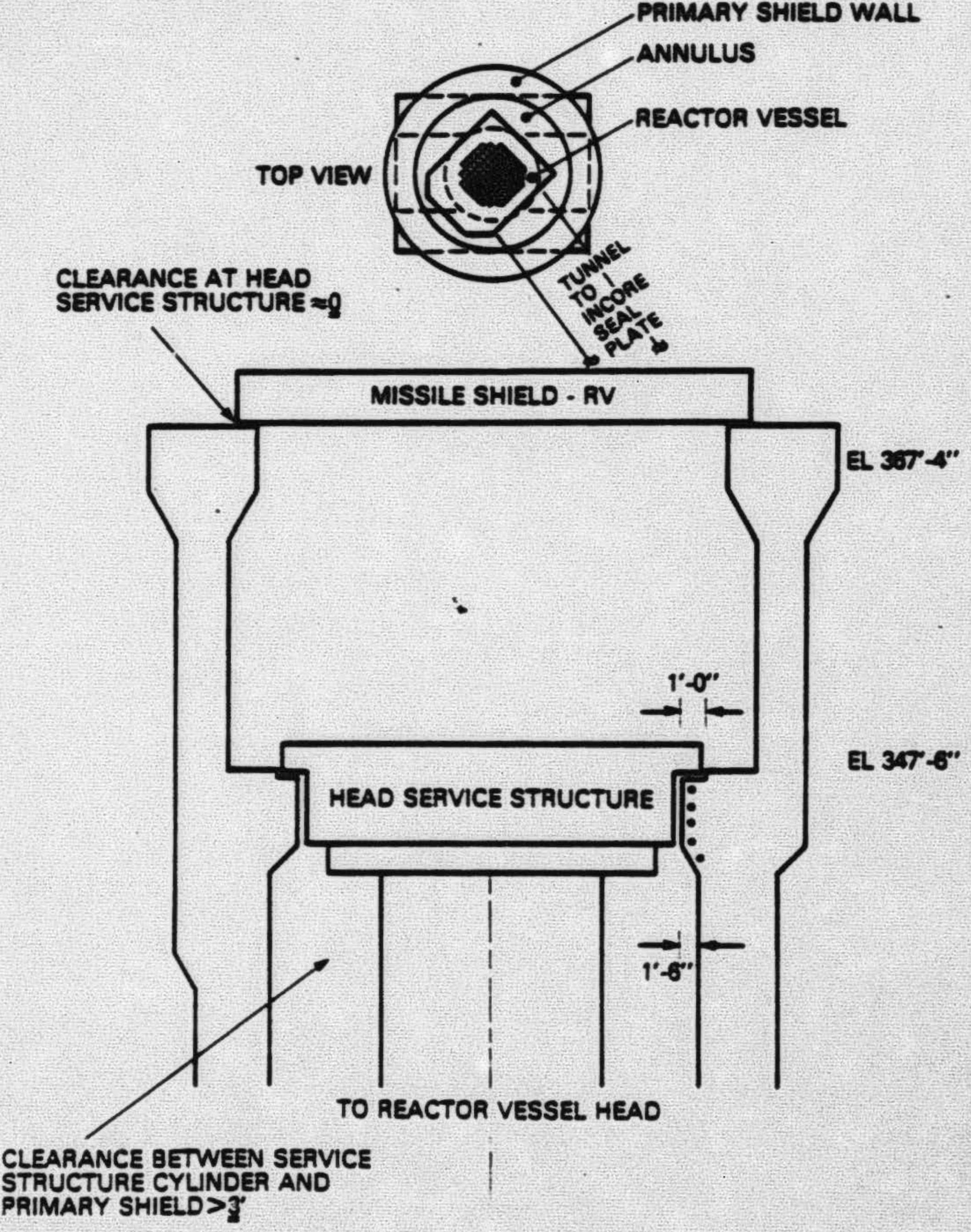

PRIMARY SHIELD WALL
ANNULUS
REACTOR VESSEL
TOP VIEW
TUNNEL TO INCORE SEAL PLATE
CLEARANCE AT HEAD SERVICE STRUCTURE ≈0
MISSILE SHIELD - RV
EL 367'-4"
1'-0"
EL 347'-6"
HEAD SERVICE STRUCTURE
1'-6"
TO REACTOR VESSEL HEAD
CLEARANCE BETWEEN SERVICE STRUCTURE CYLINDER AND PRIMARY SHIELD>3'

FIGURE 10.2

AT ELEVATION 322'-6" CLEARANCE = 138"-105"-12" =
= 21"
= 1'-9"

BELOW NOZZLE @ 291'-0" ELEVATION = 138"-100" = 38"
= 3'-2"

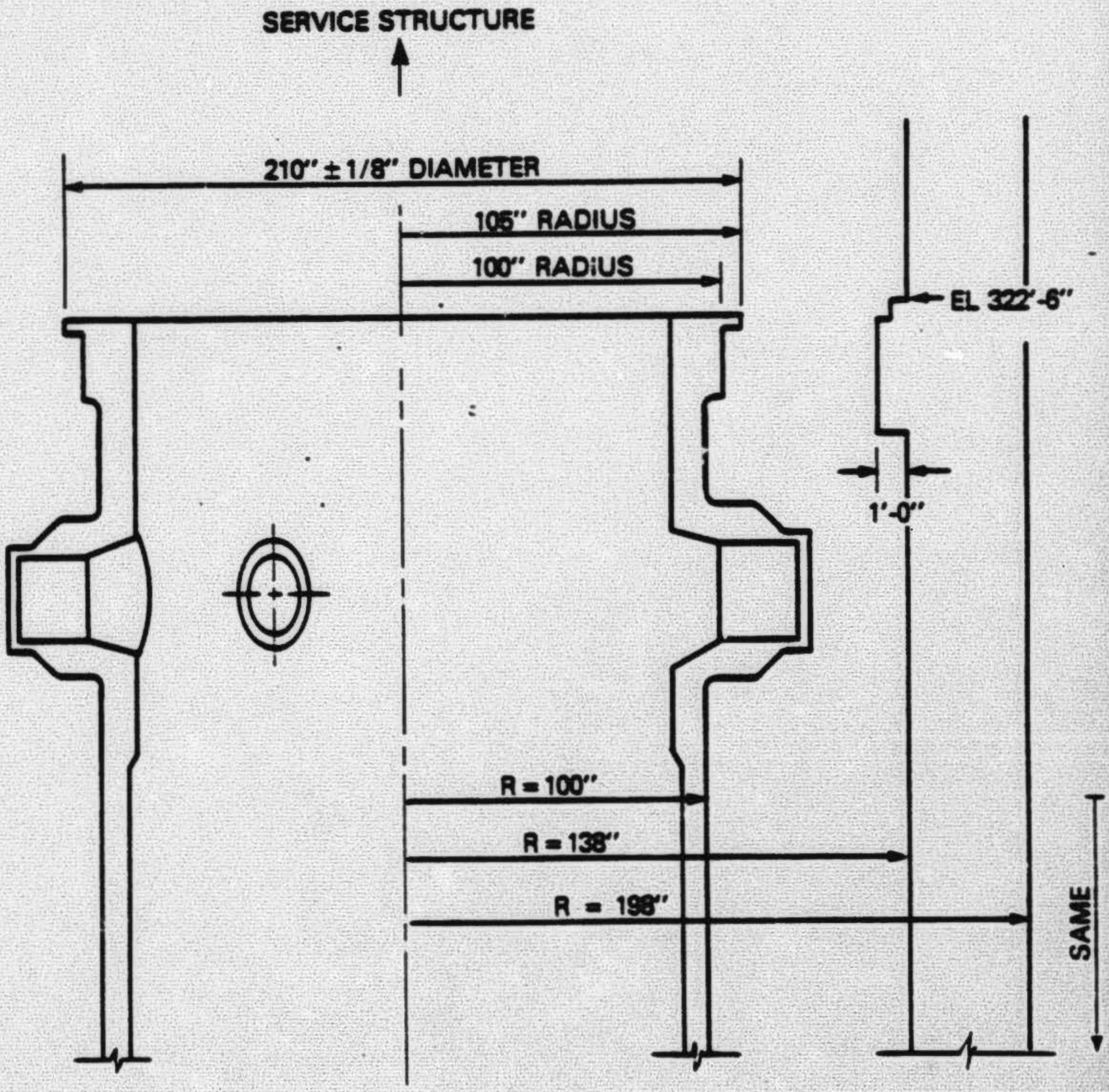
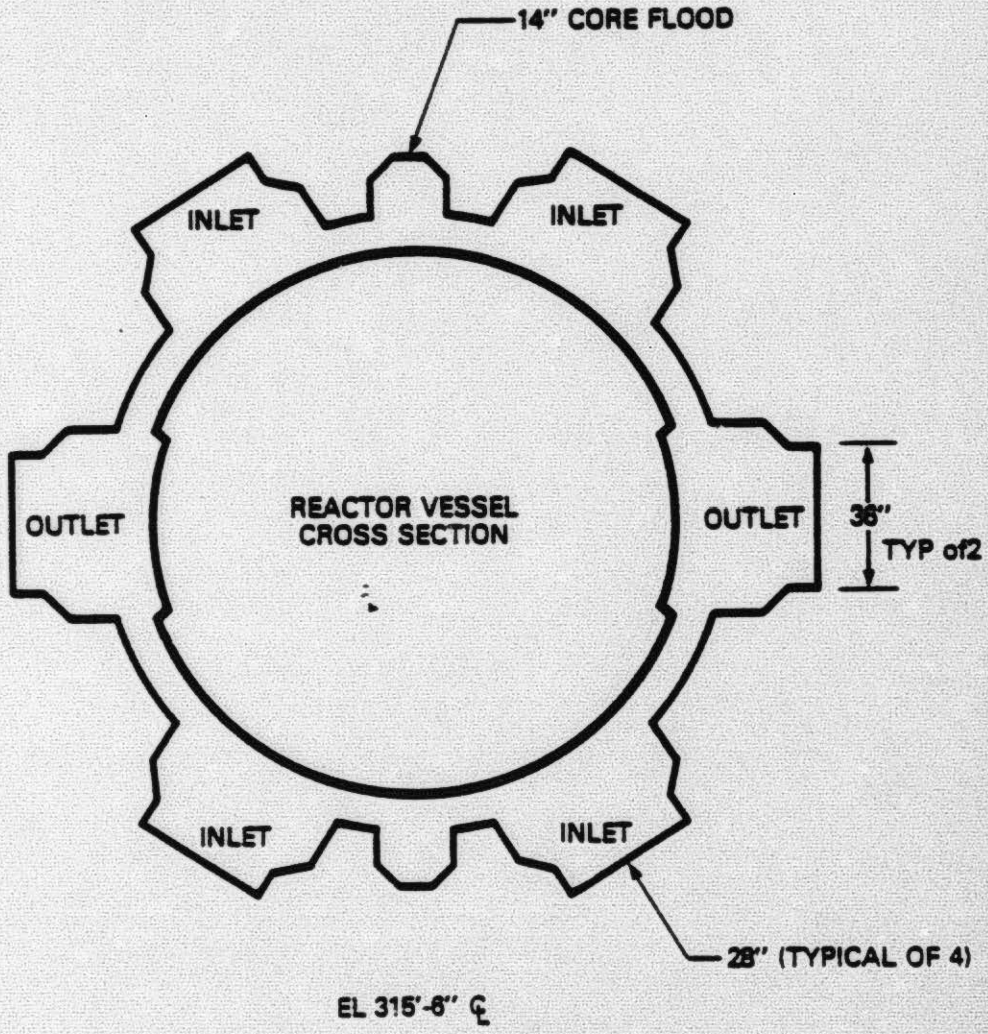


FIGURE 10.3



EL 315'-6" ℄

FIGURE 10.4

LOWER REACTOR VESSEL/SKIRT AREA

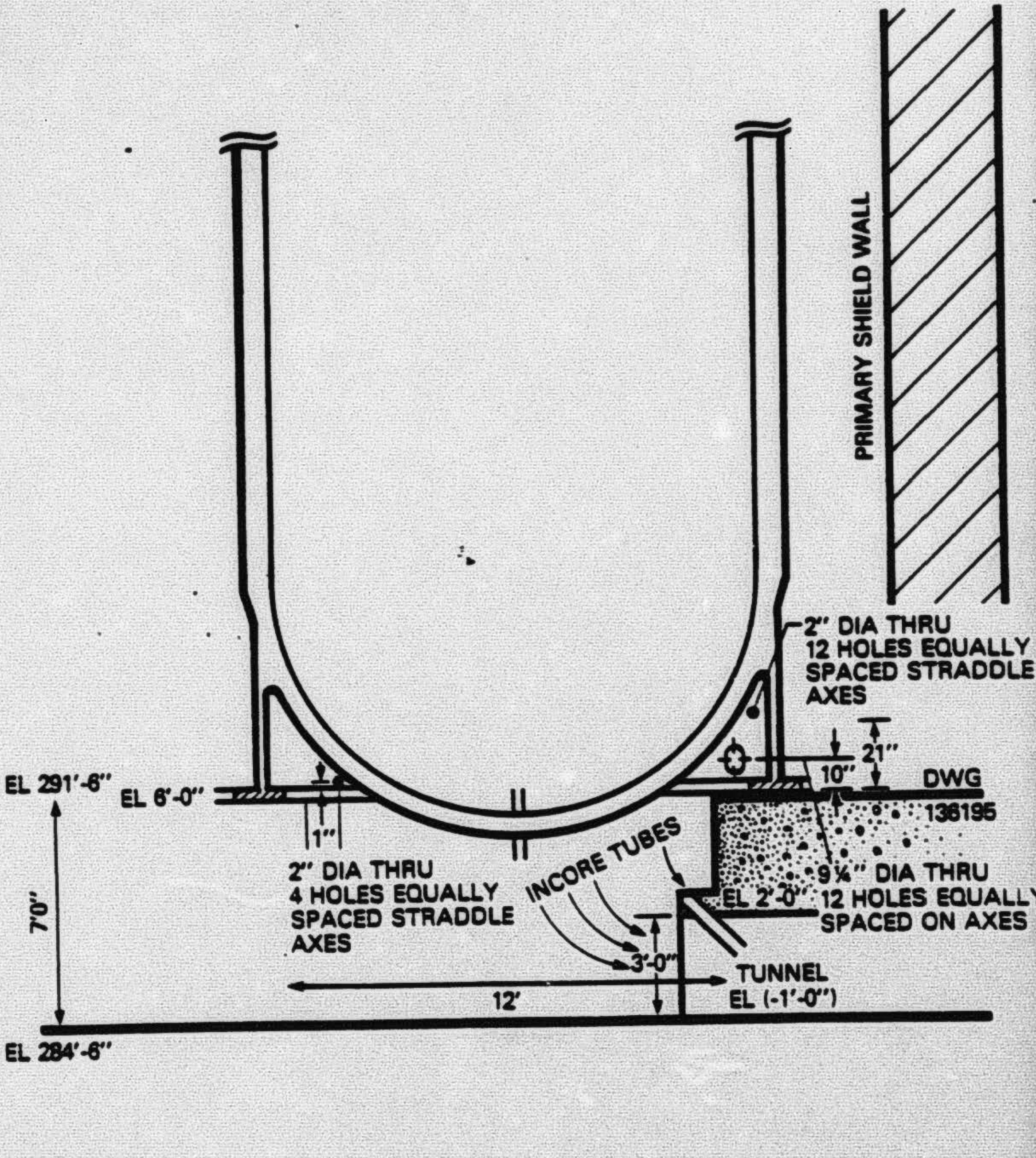
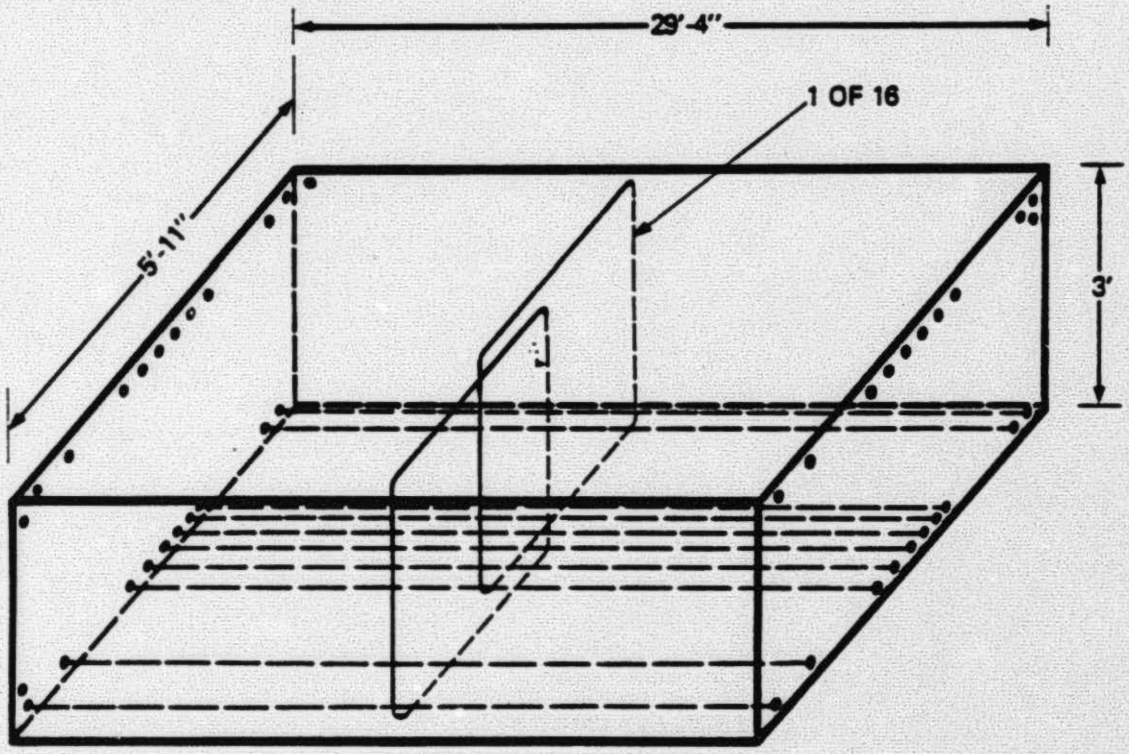


FIGURE 10.5

REACTOR VESSEL MISSILE SHIELD WITH REBAR CONFIGURATION



11. Occupational Exposure Resulting from Polar Crane Requalification

Based on the scope of work which defines the in-containment activities for the requalification of the polar crane, GPU has estimated that the conduct of the test will require approximately 270 man-hours. The bulk of the work will take place on the operating floor of the reactor building where the average exposure field is approximately 110 mrem/hr. Thus, the conduct of the load test will result in an expected occupational exposure of approximately 30 person-rem (Reference 23). We consider GPU's estimate to be reasonable and concur that the occupational exposure resulting from this effort will be somewhat less than 50 person-rem. The proposed activity and associated environmental impacts are well within the impacts previously assessed in our Programmatic Envirnmental Impact Statement (PEIS) (Reference 25).

12. Releases of Radioactive Materials to the Environment

The requalification of the polar crane does not involve the use of any fluid systems which contain radioactivity. The requalification does involve the use and movement of materials and components (e.g., the polar crane, missile shields) which are contaminated on exposed surfaces. We anticipate that the movement of the missile shields or other materials may increase somewhat the local airborne particulate radionuclide concentrations, relative to the ambient building concentrations, in the vicinity of the activity (the so-called "pig-pen effect"), similar to the local increases detected by personnel performing other cleanup activities in the building. These increases do not result in any detectable increase in radioactive material releases to the environment as the airborne radioactivity either resettles in the building or is swept into the building ventilation system and collected on the system filters. GPU recently began operating one of the reactor building ventilation filtration systems train in the recirculation mode (the other train is operating in the purge mode) to increase the removal of particulates from the building atmosphere. Accordingly, we do not expect the requalification of the polar crane to perturb the already low levels (approximately 23 uCi/year) of radioactive particulate material releases to the environment.

13. 10 CFR 50.59 Review of the Polar Crane Load Test

We have reviewed GPU's planned polar crane load test to determine if the test represents an "unreviewed safety question" when evaluated against the criteria of 10 CFR Part 50.59 (changes, tests and experiments).

The staff has reviewed each of the criteria for determing if an action is an unreviewed safety question. The criteria for making this determination and our evaluation follows:

1) Is there an increase in the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the TMI-2 Final Safety Analysis Report (FSAR)?

The staff reviewed the proposed use of the polar crane and determined that the probability of occurrence of an accident or malfunction is decreased for the following reasons. The polar crane has been refurbished with components of like (or equivalent) kind that are designed for the original 500 ton capacity. The actual load test will be performed at 50% (212 tons) of the rated design. Each major structure and load bearing component has been inspected and tested to demonstrate they meet the design specifications. In addition, improvements have been made to the original design (e.g., prevention of single phasing by removal of single phase fuses) that decrease the probability of an accident or malfunction. Therefore we have concluded that the proposed polar crane usage will not increase the probability of an accident or malfunction.

Secondly, the staff determined that the consequence of an accident associated with the use of the polar crane will be of a smaller consequence from that previously evaluated in the FSAR. The consequence of a polar crane malfunction or accident would result from the dropping of a load which could cause damage to other reactor building components or systems. This could include the reactor coolant system which would involve a loss of coolant. The consequences of a loss of coolant accident would be less than those in the FSAR because the TMI-2 core decay heat is only 24 Kw (approximately 25 home toasters), and is devoid of short lived radiodines and high energy noble gases. Additionally, the consequence of a load drop has been evaluated over all load pathways. This analysis has demonstrated that all safety equipment associated with the control and potential release of radioactive material will be fully operational in the event of a load drop. The operation of these safety systems in conjunction with the near ambient coolant conditions, the 24 Kw decay heat and the lower radionuclide source term preclude any credible accident consequence from exceeding those consequences identified in the FSAR.

2) Is there is any possibility for an accident or malfunction of a different type than any evaluated previously in the FSAR?

The staff evaluated possible accidents or malfunctions that could be created by the proposed use of the polar crane and determined that none of these accidents were of a different type than previously evaluated in the FSAR. The accidents considered were load drop events which could fail systems underneath the dropped load. This could result in a possible failure of the reactor coolant system and loss of coolant accident which is evaluated in the FSAR. For present TMI-2 conditions, with decay heat of approximately 24 Kw (25 home toasters) and absence of short lived radiodines and noble gases, the TMI-2 situation is well bounded by the FSAR large LOCA analyses.

3) Is there a reduction in the margin of safety as defined in the basis for any technical specification?

The staff has determined that the safety systems discussed in the technical specifications have sufficient redundancy of function so that the loss of any system as a result of a load drop will have minimal effects. Therefore the staff has determined that there has been no reduction in the margin of safety as discussed in the basis for each technial specification.

Based on the above, we conclude that the polar crane load test does not involve an "unreviewed safety question."

14. Conclusions

Based on the foregoing considerations, we conclude the following:

1) The polar crane has been satisfactorily refurbished for the proposed load test. A successful load test will demonstrate the functional performance of the crane for required recovery activities, including moving missile shields, lifting the reactor vessel head and service structure, removing the plenum assembly, and supporting defueling activities.
2) The crane has been adequately refurbished to the extent practicable with like parts or with parts sized to correspond to the original 500 ton rating where like parts were unavailable.
3) The inspection and maintenance related to the polar crane refurbishment was comprehensive and adequate to ensure polar crane safety.
4) The functional and operability testing of the refurbished crane has verified the quality of the refurbishment program and demonstrated that the crane can be operated in a safe manner.
5) The planned load test sequence, involving the assembly of the test load, the actual load test, and the disassembly of the test load, is adequate for demonstrating the operability of the crane hoist, trolley and bridge under load conditions sufficient for cleanup activities.
6) The inspection, maintenance and testing of the crane wire rope is adequate to assure that the rope integrity will be maintained for all planned lifts.

7) The stress analyses on the tripod undersized welds by GPU/Babcock and Wilcox indicate that the as-built welds can accommodate the induced stresses from the load test. However, we will require non-destructive examination (NDE) on 3 of the higher stressed welds to verify weld integrity. The use of the tripod for the requalification test is prohibited pending completion of the NDE. We have determined that the tripod is safe to be used to move the 6 ton internals indexing fixture and other miscellaneous loads up to 10 tons before the NDE is performed.

8) The design and inspection of the load test frame and the testing of the associated rigging and the load cell demonstrate that the load will be evenly distributed over the test frame, and the entire assembly is capable of handling the estimated maximum load.

9) Quality assurance/quality control and procedural controls for the crane refurbishment and requalification program are sufficient to ensure the safe use of the crane and the safety of the planned load test.

10) The probability of a load drop is extremely small, and, even in the event of a drop, the consequences of such an event would be well within the limits of 10 CFR Part 100 given the relatively benign condition of the facility (i.e., very low decay heat and no significant gaseous activity in the form of noble gases or iodines) and the installed plant systems for accident mitigation (e.g., the installed ventilation filtration systems) and the procedural controls over load pathways to avoid critical areas such as the incore instrument service area and reactor pressure vessel.

11) The estimated occupational exposure for the load test is well within the scope of impacts previously assessed in our PEIS. The releases of radioactive material to the environment during the conduct of the test are expected to be negligible and, thus, well within the limits of the Technical Specifications.
12) Based on the criteria of 10 CFR Part 50.59, the polar crane load test does not constitute an Unreviewed Safety Question.
13) There is reasonable assurance the polar crane load test will not endanger the occupational work force or the health and safety of the public.
14) Pending completion of the NDE on the tripod assembly and following formal approval of the polar crane operating and load test procedures, the requalification test can be initiated.

REFERENCES

1) Letter, Barrett to Barton, "TMI-2 Reactor Building Polar Crane Refurbishment,".April 1, 1982, NRC/TMI-82-017

2) Letter, Kanga to Barrett, "Polar Crane Refurbishment," October 12, 1982

3) Letter, Kanga to Barrett, "Polar Crane Functional Description," February 17, 1983, 4410-83-L-0029

4) Letter, Snyder to Kanga, "Reactor Building Polar Crane Functional Description," March 7, 1983

5) Letter, Kanga to Barrett, "Polar Crane Functional Description," June 30, 1983, 4410-83-L-0120

6) Letter, Kanga to Barrett, Polar Crane Refurbishment," February 18, 1983, 4410-83-L-0037

7) Letter, Kanga to Barrett, "Polar Crane SER - Additional Information," March 15, 1983, 4410-83-L-0052

8) Letter, Kanga to Barrett, "Polar Crane Load Test SER," June 17, 1983, 4410-83-L-0118

9) Letter, Kanga to Barrett, "Polar Crane SER," June 30, 1983, 4410-83-L-0130

10) Letter, Barrett to Kanga, "Undersized Welds on Head and Internals Handling Fixture Assembly (Tripod)," July 8, 1983, NRC/TMI-83-041

11) Letter, Kanga to Barrett, "Reactor Vessel Head and Internals Handling Fixture," August 1, 1983, 4410-L-83-0162

12) Letter, Barrett to Kanga, "Reactor Vessel Head and Internals Handling Fixture," August 8, 1983, NRC/TMI 83-050

13) Letter, Kanga to Barrett, "Reactor Vessel Head and Internals Handling Fixture (Tripod)," August 18, 1983, 4410-83-L-0183

14) Letter, Snyder to Kanga, "Additional Polar Crane Information," July 18, 1983

15) Letter, Kanga to Snyder, "Polar Crane Load Test - Additional Information," August 16, 1983, 4410-L-83-0175

16) Letter, Kanga to Snyder, "Polar Crane Load Test - Additional Information," August 24, 1983, 4410-L-83-0193

17) Memorandum, Hayes to Palladino, "Three Mile Island NGS, Unit 2 Allegations Regarding Safety Related Modifications and QA Procedures (H-83-002), September 1, 1983

18) Letter, Kanga to Barrett, "Polar Crane Head Lift Rigging," January 4, 1983, 4410-83-L-004

19) Letter, Kanga to Barrett, "Polar Crane Checklist," January 12, 1983, 4410-83-L-0007

20) Letter, Barton to Barrett, "Polar Crane Refurbishment," January 4, 1982, LL2-81-0262

21) Letter, Snyder to Barton, "Axial Power Shaping Rod SER Approval," June 18, 1982

22) Letter, Kanga to Snyder, "Polar Crane Additional Information," September 2, 1983, 4410-83-L-0205

23) NRC Final Programmatic Environmental Impact Statement, March 1981

24) Letter, Kanga to Snyder, "Polar Crane Additional Information," October 4, 1983, 4410-83-L-0232

25) Letter, Barrett to Kanga, "Request for Additional Polar Crane Refurbishment Information," September 28, 1983, NRC/TMI-83-061

26) Letter, Kanga to Barrett, "Additional Polar Crane Refurbishment Information," October 11, 1983, 4410-83-L-0244

27) Letter, Kanga to Barrett, "Additional Polar Crane Refurbishment Information," October 25, 1983, 4410-83-L-0257

28) Memorandum, Hayes to Dircks, "TMI-2 Polar Crane Issues," August 23, 1983

Dr. Thomas Murley
REGIONAL ADMINISTRATOR, REGION I
U.S. NUCLEAR REGULATORY COMMISSION
631 PARK AVE.
KING OF PRUSSIA, PA. 19406

JOHN F. WOLF, ESQ., CHAIRMAN,
ADMINISTRATIVE JUDGE
3409 SHEPHERD ST.
CHEVY CHASE, MD. 20815

DR. OSCAR H. PARIS
ADMINISTRATIVE JUDGE
ATOMIC SAFETY AND LICENSING
BOARD PANEL
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

DR. FREDERICK J. SHON
ADMINISTRATIVE JUDGE
ATOMIC SAFETY AND LICENSING
BOARD PANEL
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

KARIN W. CARTER
ASSISTANT ATTORNEY GENERAL
505 EXECUTIVE HOUSE
P.O. BOX 2357
HARRISBURG, PA 17120

DR. JUDITH H. JOHNSRUD
ENVIRONMENTAL COALITION ON
NUCLEAR POWER
433 ORLANDO AVE.
STATE COLLEGE, PA 16801

GEORGE F. TROWBRIDGE, ESQ.
SHAW, PITTMAN, POTTS AND
TROWBRIDGE
1800 M. ST., NW.
WASHINGTON, DC 20036

ATOMIC SAFETY AND LICENSING BOARD PANEL
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555

ATOMIC SAFETY AND LICENSING APPEAL PANEL
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555

SECRETARY
U.S. NUCLEAR REGULATORY COMMISSION
ATTN: CHIEF, DOCKETING & SERVICE BRANCH
WASHINGTON, DC 20555

MR. LARRY HOCHENDONER
DAUPHIN COUNTY COMMISSIONER
P.O. BOX 1295
HARRISBURG, PA 17108-1295

JOHN E. MINNICH, CHAIRPERSON,
DAUPHIN COUNTY BOARD OF COMMISSIONERS
DAUPHIN COUNTY COURTHOUSE
FRONT AND MARKET STREETS
HARRISBURG, PA 17101

DAUPHIN COUNTY OFFICE OF EMERGENCY
PREPAREDNESS
COURT HOUSE, ROOM 7
FRONT & MARKET STREETS
HARRISBURG, PA 17101

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION III OFFICE
ATTN: EIS COORDINATOR
CURTIS BUILDING (SIXTH FLOOR)
6TH & WALNUT STREETS
PHILADELPHIA, PA 19106

THOMAS M. GERUSKY DIRECTOR
BUREAU OF RADIATION PROTECTION
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P.O. BOX 2063
HARRISBURG, PA 17120

DAVID HESS
OFFICE OF ENVIRONMENTAL PLANNING
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P.O. BOX 2063
HARRISBURG, PA 17120

WILLIS BIXBY, SITE MANAGER
U.S. DEPARTMENT OF ENERGY
P.O. BOX 88
MIDDLETOWN, PA 17057-0311

DAVID J. MCGOFF
DIVISION OF THREE MILE ISLAND PROGRAMS
NE-23
U.S. DEPARTMENT OF ENERGY
WASHINGTON, DC. 20545

WILLIAM LOCHSTET
104 DAVEY LABORATORY
PENNSYLVANIA STATE UNIVERSITY
UNIVERSITY PARK, PA 16802

RANDY MYERS, EDITORIAL
THE PATRIOT
812 MARKET ST.
HARRISBURG, PA 17105

ROBERT B. BORSUM
BABCOCK & WILCOX
NUCLEAR POWER GENERATION DIVISION
SUITE 220
7910 WOODMONT AVE.
BETHESDA, MD. 20814

JUDITH A. DORSEY
1315 WALNUT STREET
SUITE 1632
PHILADELPHIA, PA 19107

LINDA W. LITTLE
5000 HERMITAGE DR.
RALEIGH, NC 27612

MARVIN I. LEWIS
6504 BRADFORD TERRACE
PHILADELPHIA, PA 19149

JANE LEE
183 VALLEY RD.
ETTERS, PA 17319

J.B. LIBERMAN, ESQUIRE
BERLACK, ISRAELS, LIBERMAN
26 BROADWAY
NEW YORK, NY 10004

WALTER W. COHEN, CONSUMER ADVOCATE
DEPARTMENT OF JUSTICE
STRAWBERRY SQUARE, 14TH FLOOR
HARRISBURG, PA 17127

EDWARD O. SWARTZ
BOARD OF SUPERVISORS
LONDONDERRY TOWNSHIP
RFD #1 GEYERS CHURCH RD.
MIDDLETOWN, PA 17057

ROBERT L. KNUPP, ESQUIRE
ASSISTANT SOLICITOR
KNUPP AND ANDREWS
P.O. BOX P
407 N. FRONT ST.
HARRISBURG, PA 17108

JOHN LEVIN, ESQUIRE
PENNSYLVANIA PUBLIC UTILITIES COMM.
P.O. BOX 3265
HARRISBURG, PA 17120

HONORABLE MARK COHEN
512 E-E MAIN CAPITOL BUILDING
HARRISBURG, PA 17120