Duquesne Light
435 Sixth Avenue
Pittsburgh, Pa
15219

APR 2 1982

(412) 456-6000

2DLC 4556

UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, DC 20555

ATTENTION: Mr. Darrel G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation

SUBJECT: BEAVER VALLEY POWER STATION - UNIT NO. 2
DOCKET NO. 50-412
GENERIC LETTER 81-07
CONTROL OF HEAVY LOADS

REFERENCES: a) D. G. Eisenhut letter of December 22, 1980 to all licensees of operating plants and applicants for operating licenses and holders of construction permits.
b) 2DLC-4240 of September 21, 1981, "Control of Heavy Loads."

Gentlemen:

This letter transmits additional information on the control of heavy loads and corrects a previous submittal on the same subject.

Attachment A consists of the responses to the following sections of Reference (a):

a) 2.2 Specific Requirements for Overhead Handling Systems Operating in the Vicinity of Fuel Storage Pools.

b) 2.3 Specific Requirements for Overhead Handling Systems Operating in the Containment.

c) 2.4 Specific Requirements for Overhead Handling Systems Operating in Plant Areas Containing Equipment Required for Reactor Shutdown, Core Decay Heat Removal, or Spent Fuel Pool Cooling.

Attachment B consists of a revised copy of Table 1 of the response to Section 2.1 submitted by Reference (b). In the course of the study performed to address Sections 2.2, 2.3, and 2.4, several errors were discovered in this table. The changes to Table 1 consist of the following:

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a) Correction of the specified polar crane bridge capacity.

b) Addition of two heavy loads for the polar crane.

c) Correction of the reactor coolant pump motor weight.

d) Addition of the auxiliary hook on the spent fuel cask crane.

This completes the submittal of information requested by Reference (a). If you have any further questions on this subject, please contact our staff.

DUQUESNE LIGHT COMPANY

BY E. J. Woolever
E. J. WOOLEVER
VICE PRESIDENT

cc: Mr. R. DeYoung, Director
Office of Inspection and Enforcement

Mr. R. Haynes, Administrator
Region 1

Ms. E. Doolittle, Project Manager
Licensing and Review

Mr. G. Walton, Resident Inspector
Beaver Valley Power Station

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION - UNIT NO. 2
CONTROL OF HEAVY LOADS - NUREG-0612

2.2 Requirements for Overhead Handling Systems in the Vicinity of Fuel Storage Pools

2.2.1 Identify by name, type, capacity, and equipment designator, any cranes physically capable (i.e., ignoring interlocks, moveable mechanical stops, or operating procedures) of carrying loads, which could, if dropped, land or fall into the spent fuel pool.

RESPONSE Name: Moveable Platform with Hoists
Type: Gantry, Multiple Girder, Electric Crane
Capacity: Gantry: 20 tons
Hoist No. 1: 10 tons
Hoist No. 2: 10 tons
Equip. Designation: 2MHF-CRN-227

2.2.2 Justify the exclusion of any cranes in this area from the above category by verifying that they are incapable of carrying heavy loads or are permanently prevented from movement of the hook centerline closer than 15 ft to the pool boundary, or by providing a suitable analysis demonstrating that for any failure mode, no heavy load can fall into the fuel storage pool.

RESPONSE The Spent Fuel Cask Trolley (2MHF-CRN 215) is shown on figure 3A of the September 22, 1981 Beaver Valley Unit 2 submittal to the NRC on this subject. The travel area of this trolley extends from outside the north end of the decontamination building where spent fuel shipping casks are brought to the site through the decontamination building and into the east end of the fuel building. As shown on Figure 3A of the above-referenced report, the spent fuel cask is not transported over the spent fuel pool at any time. When the spent fuel shipping cask is brought into the fuel building, it is kept on the east side of a 2 ft thick concrete wall which separates the cask laydown area and the spent fuel pool. The centerline of the main hook on this trolley is a fixed distance away from the spent fuel pool and no lateral movement towards the spent fuel pool is possible. The cask is lowered to the bottom of the cask laydown area adjacent to a 2 ft wide slot in the wall which provides a passageway for fuel elements to be transported from the spent fuel pool to the cask laydown area. The elevation of the bottom of the slot is above the top of the fuel elements in the spent fuel pool rack, so that the fuel elements will not be uncovered if water is lost via the slot. As the cask is lifted and transported out of the fuel building, it is lifted above the level of the wall in order to clear the north rail of the moveable platform with hoists. The lifting time over this point is minimal, and the distance to the spent fuel pool is the maximum possible, assuring that a cask drop would not damage stored spent fuel elements.

2.2.3 Identify any cranes listed in 2.2.1 above, which you have evaluated as having sufficient design features to make the likelihood of a load drop extremely small for all loads to be carried and the basis for this evaluation (i.e., complete compliance with NUREG-0612, Section 5.1.6, or partial compliance supplemented by suitable alternative or additional design features). For each crane so evaluated, provide the load-handling-system (i.e.,crane-load-combination) information specified in Attachment 1.

<u>RESPONSE</u> None

2.2.4 For cranes identified in 2.2.1, above, not categorized according to 2.2.3, demonstrate that the criteria of NUREG-0612, Section 5.1 are satisfied. Compliance with Criteria IV will be demonstrated in response to Section 2.4 of this request. With respect to Criteria I through III, provide a discussion of your evaluation of crane operation in the spent fuel area and your determination of compliance. This response should include the following information for each crane:

a. Which alternatives (e.g., 2, 3, or 4) from these identified in NUREG-0612, Section 5.1.2, have been selected.

<u>RESPONSE</u> Alternative 2

b. If Alternative 2 or 3 is selected, discuss the crane motion limitation imposed by electrical interlocks or mechanical stops and indicate the circumstances, if any, under which these protective devices may be bypassed or removed. Discuss any administrative procedures invoked to ensure proper authorization of bypass or removal, and provide any related or proposed technical specification (operational and surveillance) provided to ensure the operability of such electrical interlocks or mechanical stops.

<u>RESPONSE</u> The moveable platform with hoists crane spans the spent fuel pool and carries two electric hoists (one for handling spent fuel, the other for new fuel). Fuel assemblies are moved within the spent fuel pool by means of a long handled tool suspended from the east hoist. The hoist travel, tool, and sling length are designed to limit the maximum lift of a fuel assembly to a safe shielding depth. The moveable platform with hoists crane is also used to upend the new fuel assemblies within the shipping container. The upending operation consists of a hoisting motion concurrent with a traversing motion of the platform. The shipping container is never lifted off of the fuel building floor - the strong back

inside the container holding the new fuel elements is rotated to a vertical position. Thus, the load is never truly lifted, and this operation is not performed near spent fuel. When loads are carried over the spent fuel pool, the maximum load will be limited by a technical specification. The maximum lift weight will be selected to limit the damage to spent fuel in the case of a load drop. This limit will ensure that not more than the contents of one fuel assembly will be damaged and a load drop will not result in potential offsite exposures in excess of those listed in 10CFR100.

c. Where reliance is placed on crane operational limitations with respect to the time of the storage of certain quantities of spent fuel at specific post-irradiation decay times, provide present and/or proposed technical specifications and discuss administrative or physical controls provided to ensure that these assumptions remain valid.

RESPONSE Reliance is not placed on the time of storage of spent fuel.

d. Where reliance is placed on the physical location of specified fuel modules at certain post-irradiation decay times, provide present and/or proposed technical specifications and discuss administrative or physical controls provided to ensure that these assumptions remain valid.

RESPONSE Reliance is not placed on the physical location of specific fuel elements.

e. Analyses performed to demonstrate compliance with Criteria I through III should conform to the guidelines of NUREG-0612, Appendix A. Justify any exception taken to these guidelines, and provide the specific information requested in Attachments 2, 3, or 4, as appropriate, for each analysis performed.

RESPONSE Load drop analysis is not required in this case.

2.3 Requirements for Overhead Handling Systems in Containment

2.3.1 Identify by name, type, capacity, and equipment designator, any cranes physically capable (i.e., taking no credit for any interlocks or operating procedures) of carrying heavy loads over the reactor vessel.

RESPONSE Name: Polar Crane
Type: Electric Overhead Circular Traveling
Capacity: Trolley No. 1 Main Hook 167 tons
Aux. Hook 15 tons

Trolley No. 2 Main Hook 167 tons

Equipment Designation: 2CRN-201

2.3.2 Justify the exclusion of any cranes in this area from the above category by verifying that they are incapable of carrying heavy loads or are permanently prevented from the movement of any load, either directly over the reactor vessel or to such a location where in the event of any load-handling-system failure, the load may land in or on the reactor vessel.

RESPONSE The Refueling Manipulator Crane (2FNR-CRN-205) lifts a maximum load of one fuel element and its handling tool; by the definition of NUREG-0612, this is not a heavy load.

2.3.3 Identify any cranes listed in 2.3-1, above, which you have evaluated as having sufficient design features to make the likelihood of a load drop extremely small for all loads to be carried and the basis for this evaluation (i.e., complete compliance with NUREG-0612, Section 5.1.6, or partial complaince supplemented by suitable alternative or additional design features). For each crane so evaluated, provide the load-handling-system (i.e., crane-load-combination) information specified in Attachment 1.

RESPONSE See Enclosure 1 for the load-handling-system information specified in Attachment 1 (to the December 22, 1980, NRC letter).

2.3.4 For cranes identified in 2.3-1, above, not categorized according to 2.3-3, demonstrate that the evaluation criteria of NUREG-0612, Section 5.1, are satisfied. Compliance with Criterion IV will be demonstrated in your response to Section 2.4 of this request. With respect to Criteria I through III, provide a discussion of your evaluation of crane operation in the containment and your determination of compliance.

RESPONSE There are no cranes in this category.

2.4 Requirements of Overhead Handling Systems in proximity to safe shutdown equipment.

2.4.1 Identify any cranes listed in 2.1.1 above, which you have evaluated as having sufficient design features to make the likelihood of a load drop extremely small for all loads to be carried and the basis for this evaluation (i.e., complete compliance with NUREG 0612, Section 5.1.6, or partial compliance supplemented by suitable alternative or additional design features). For each crane so evaluated, provide the load-handling-system (i.e., crane-load-combination) information specified in Attachment 1.

RESPONSE As discussed in Section 2.3.3, the BVPS-No. 2 polar crane (2CRN-201) was very conservatively designed so that the possibility of a load drop is small.

In addition to the design features, procedures will dictate the required maintenance, inspection, and testing that will be performed on the polar crane throughout its design life. This, along with operator training that follows the guidelines of ANSIB30.2-1976, will provide assurance that the handling of heavy loads will be safe.

2.4.2 For any cranes identified in 2.1.1 not designated as single-failure-proof in 2.4.1, a comprehensive hazard evaluation should be provided which includes the following information:

a. The presentation in a matrix format of all heavy loads and potential impact areas where damage might occur to safety related equipment. Heavy loads identification should include designation and weight or cross-reference to information provided in 2.1.3.C. Impact areas should be identified by construction zones and elevations or by some other method such that the impact area can be located on the plant general arrangement drawings. Figure 1 provides a typical matrix.

RESPONSE Table 2 shows the matrix of heavy loads and potential impact areas.

b. For each interaction identified, indicate which of the load and impact area combinations can be eliminated because of separation and redundance of safety related equipment, mechanical stops and/or electrical interlocks or other site-specific considerations.

RESPONSE Table 2 provides this information.

c. For interactions not eliminated by the analysis of 2.4.2.b, above, identify any handling systems for specific loads which you have evaluated as having sufficient design features to make the likelihood of a load drop extremely small and the basis for the evaluation (i.e., complete compliance with NUREG 0612, Section 5.1.6, or partial compliance supplemented by suitable alternative or additional design feature). For each crane so evaluated, provide the load-handling-system (i.e., crane-load-combination) information specified in Attachment 1.

RESPONSE This information is included in the response to 2.4.1.

d. For interactions not eliminated in 2.4.2.b or 2.4.2.c, above, demonstrate using appropriate analysis that damage would not preclude operation of sufficient equipment to allow the system to perform its safety function following a load drop (NUREG 0612, Section 5.1, Criterion IV).

RESPONSE All interactions were eliminated.

TABLE 2
LOAD/IMPACT AREA MATRIX

CRANE	LOAD	WEIGHT (TONS)	2.1.3 a FIG	SAFETY RELATED EQUIPMENT	COORDINATES	ELEVATION	HAZARD ELIMINATION CATEGORY
2MHR-CRN-207 (732'-9")*	Residual Heat Removal Pumps	3.9	2H	Residual Heat Removal Pumps and Piping	Reactor Containment 1, 4	712'	c,e
2MHF-CRN-215 (793'-0")**	Spent Fuel Shipping Cask	21.5	3B	Spent Fuel Pool Cooling Piping	Fuel Building 4, 8 1/2-9 1/2	766'	a, d
2MHF-CRN-227 (768'-5 1/2")*	New Fuel Shipping Container	3.0	3B	Spent Fuel Pool Heat Exchangers and Piping	Fuel Building 4, 11 1/2-12	735'-6"	a,b,d[2]
	Failed Fuel Assembly Storage Can	1.5 (full)	3B	Spent Fuel Pool Cooling Piping	Fuel Building 4, 9 1/2-10 1/2	742'1"	a
2MHB-CRN-250 (768'-0")*	Removable Slabs	2.3 (largest)	5	Safety Injection System Piping and MOV's Chem. and Volume Control Piping Service Water Piping	Cable Vault C, 8	720'	b[3]
	Rod Drive Motor Generators	3.8	5	Safety Injection System Piping and MOV's Chem. and Volume Control Piping Service Water Piping	Cable Vault C, 8	720'	e

TABLE 2
LOAD/IMPACT AREA MATRIX

CRANE	LOAD	WEIGHT (TONS)	2.1.3a FIG	SAFETY RELATED EQUIPMENT	COORDINATES	ELEVATION	HAZARD ELIMINATION CATEGORY
2MHP-CRN-209A,B (731'-5")*	Component Cooling Water Heat Exchangers A,B,C	17.5	4C	Component Cooling Water Piping Remaining Component Cooling Water Heat Exchangers	Auxiliary Building J-G, 11-12 1/2	716'-9"	e
2MHP-CRN-210 (765'-8 1/2)*	Removable Slabs	4.5 (largest)	4A	Chemical and Volume Control Piping	Auxiliary Building F-H, 11-12	755'	b[3]
	Nonregenerative Heat Exchanger	4.25	4A	Chemical and Volume Control Piping	Auxiliary Building F-G, 11-12	735'-6"	b[3],d
[illegible]IP-CRN-220 [illegible],C (752'-6")	Charging Pumps-Pump	3.75	4B	Chemical and Volume Control Piping Safety Injection System Piping Service Water System Piping	Auxiliary Building D-F, 11-12	735'-6"	a,b
	Charging Pumps Motor	1.95	4B	Chemical and Volume Control Piping Safety Injection System Piping Service Water System Piping	Auxiliary Building D-F, 11-12	735'-6"	a,b
2MHP-CRN-221-A,B (749'-0")*	Component Cooling Water Heat Exchangers	17.5	4B	Component Cooling Water Piping	Auxiliary Building G-H, 11-12	716'-9"	e

TABLE 2
LOAD/IMPACT AREA MATRIX

CRANE	LOAD	WEIGHT (TONS)	2.1.3a FIG	SAFETY RELATED EQUIPMENT	COORDINATES	ELEVATION	HAZARD ELIMINATION CATEGORY
2MHP-CRN-223 (752'-0")*	Removable Slabs	9.75 (largest)	4B	Boric Acid Filter Seal Water Injection Filters	Auxiliary Building D-E, 12 G, 13	718'-6"	b^3,d
	Cesium Removal Ion Exchangers	.95	4B	Boric Acid Filter Seal Water Injection Filters	Auxiliary Building D-E, 12 G, 13	718'-6"	b^3,d
	Mixed Bed Dimineralizers	.95	4B	Boric Acid Filter Seal Water Injection Filters	Auxiliary Building D-E, 12 G, 13	718'-6"	b^3,d
	Deborating Dimeralizers	1.4	4B	Boric Acid Filter Seal Water Injection Filters	Auxiliary Building D-E, 12 G, 13	718'-6"	b^3,d
2MPH-CRN-234 (751'-10")*	Component Cooling Water Pumps	1.0	4B	Component Cooling Water Piping and Remaining Pumps	Auxiliary Building H-J, 10-11 1/2	738'-3"	e
	Component Cooling Water Motor	1.7	4B	Service Water System Piping Component Cooling Water Piping and Remaining Pumps	Auxiliary Building H-J, 10-11 1/2	738'-3"	e
2MHP-CRN-235 (743'-9")	Removable Slabs	2.8	4B	Service Water System Piping Safety Injection System Piping Quench Spray System Piping Component Cooling Water Piping	Auxiliary Building G-H, 10-10 1/2	718'-6"	b^3,d

HAZARD LIMINATION CATEGORIES:

a. System redundancy and separation precludes loss of capability of system to perform its safety related function following this load drop.

b. Sufficient administrative controls will exist to prevent lifting this load to a height sufficient to penetrate the concrete floor separating the lifting device and load from the safety related equipment.

c. Sufficient time exists to allow repair of any damage caused by this drop before loss of capability of this system to perform its safety related function would adversely affect orderly plant operation.

d. Sufficient administrative procedures will exist to maintain the load within the bounds of the safe load path, and to prevent the movement of the load over safety related equipment.

e. Sufficient administrative controls will exist to maintain the load within the bounds of the safe load path and to specify when the load may be lifted over safety related equipment.

NOTES:

1. Coordinates are columns designations from plant equipment location drawings.

2. This load is never fully lifted, only upended. In addition the lift is restricted by the crane safe load path.

3. When lifting removable slabs or covers, the lift height will be restricted to a nominal valve when moving the slab away from the floor opening.

* Elevation of the top of the crane rail

** Elevation of the hook at maximum height

Enclosure 1

Load - Handling System Data

Name:	Polar Crane (2CRN-201)
Crane Manufacturer:	P&H (Harnischfeger)
Design Rated Load:	334 tons (Main Bridge)
	167 tons (Main Trolleys)
	15 tons (Aux. Hoist)
Maximum Critical Load	130 tons (Main Trolleys)

The Beaver Valley Power Station Unit No. 2 containment polar crane 2CRN-201 was purchased in 1973, prior to the publishing of NUREG-0544 (1979). The design was compared to the NUREG and the results are outlined below.

SPECIFICATION AND DESIGN CRITERIA

The Beaver Valley Unit No. 2 polar crane was designed to meet all requirements as set forth in CMAA Specification No. 70, and ANSI B30.2-1967. The design rated load of the bridge exceeds the maximum critical load by a factor of over 2.5 to 1. The polar crane bridge is rated at 396 tons and main hoists at 198 tons for the construction period.

After the construction lifts are completed, the crane bridge is rerated to a 334 capacity, and the main hoists rerated to a 167 ton capacity. The maximum allowable stresses for normal plant operating and maintenance lifts are as follows:

1. Hoisting Ropes: Are selected so that a 167 ton load on either main hook or a 15 ton load on the auxiliary hook plus the weight of the load block divided by the number of parts of rope does not exceed 20 percent of the rope breaking strength.

2. Structural Members: Are designed so the stress in the material does not exceed the allowable levels in CMAA Specification No. 70 when the maximum rated load of 334 tons is imposed between the two hoists.

3. Load carrying parts, except those listed above: Are designed so the stress in the material does not exceed 20 percent of the average ultimate strength of the material when a load of 334 tons is imposed equally between the two main hoists.

These material strength design criteria are considered to be conservative enough so that any loads lifted by the polar crane will not cause failure of any part of the crane. Complete compliance with the allowable stress levels in the CMAA specification has provided assurance that load handling with the polar crane is reliable and safe.

The BV-2 polar crane was subjected to a dead weight test load of 418 tons which is 84 tons above the maximum design rated load. A thorough examination of all critical parts and areas of the crane was performed after the lift and showed no detrimental effects. In addition, an examination of the crane was performed after the major construction lifts to ensure that no failures occurred in any parts of the crane. NUREG-0554 requires a cold-proof test of 1.25 times the maximum critical load for cranes already operating. This is not considered necessary for the BV-2 polar crane because the major construction lifts were far in excess of the maximum critical load. Thus, the BVPS-2 polar crane is adequately tested and qualified for normal operations in lifting the maximum critical load.

The polar crane design also took into account the environmental conditions it will experience during the design life of the plant. The polar crane is designed to withstand 35 mph winds while operating and 90 mph winds while not in use. The crane design temperature for operating stresses, allowable loads, coefficient of expansion, modules of elasticity, lubricators, and wiring are -20°F for minimum temperature and 105°F for maximum temperature. The polar crane is also able to withstand the maximum and minimum pressure which will occur inside the containment building. In addition, the polar crane is designed so that the chemistry of the containment spray systems will not affect any parts of the crane. To satisfy this, the use of aluminum is kept to a minimum and no mercury is used at all. Thus, as required by NUREG-0554 the design of the polar crane is sufficient to withstand postulated environmental conditions which could be present inside the containment structure due to containment depressurization system operation.

The polar crane will perform only a limited number of lifts (several hundred) throughout the design life of the plant. The maximum critical load to be lifted during plant generating life (reactor head or lower internals) is only 40 percent of the bridge design rated load of 334 tons. Thus, considering the small number of stress cycles and the conservative design rated load, the BV-2 polar crane meets the structural fatigue requirements of NUREG-0544.

SEISMIC ANALYSIS

The Beaver Valley Unit 2 Polar Crane was designed to the following basic seismic requirements:

A. The crane bridge and trolley are provided with suitable restraints so they do not leave their rails during an earthquake.

B. No part of the crane will become detached and fall during an earthquake.

The seismic analysis used by the crane manufacturer (Harnischfeger Corporation) was computational in nature and was based on the matrix displacement method (direct stiffness method). The first step in the method is to approximate the actual configuration as a structural framework which is defined by a stable system of uniform (constant cross-section), weightless beam segments, and joints at which loads are applied and weights are lumped. With this model information along with the structural loading (static loads and dynamic loading in the form of a shock spectra input), the computer performs the computation to provide the following information as output:

1. Displacements, shear and axial forces, and moments of members for static loadings.

2. Reactions and equilibrium checks at each joint for static loadings.

3. Frequencies and mode shapes.

4. Displacements, shear and axial forces, and moments of members for each of first ten forced modes of vibration.

The Dynamic Analysis for seismic events was divided into two cases:

A. For a 1/2 Safe Shutdown Earthquake (1/2 SSE), the horizontal and vertical seismic loadings are added directly considering a single horizontal direction earthquake to act concurrently with a vertical direction earthquake. The stress levels due to these combined loading conditions do not exceed 75 percent of minimum yield strength in accordance with the ASTM specification for the material or maximum stress levels permitted under all applicable codes.

B. For a Safe Shutdown Earthquake (SSE), the horizontal and vertical earthquake loads are added directly considering a single horizontal direction earthquake to act concurrently with the vertical direction earthquake. The maximum stress levels due to these combined loading conditions do not exceed the smaller of:

   1. Minimum yield strength

   2. 70 percent of the ultimate tensile strength of the material in accordance with the ASTM or equivalent specification for the material.

These design criteria for the two earthquake events are provided to assure the polar crane maintains its integrity through the worst possible design basis earthquake. There were actually five separate design cases used in analyzing stresses that would be present in the crane bridge. They are:

Case I - The seismic event analysis considered the sum of the following: (all cases using ASTM A-36 steel)

Dead Load - This is the weight of all effective parts of the bridge structure, machinery parts, and the fixed equipment supported by the structure.

Live Load - Weight of 2 trolleys and 334 ton load.

Impact Allowance - An additional load equal to 15 percent of the rated capacity.

Wind Load at 35 mph.

Case II - This case considered the following loads:

Dead Load

Live Load = 2 Trolleys

1/2 Safe Shutdown Earthquake
(Vertical and horizontal with trolleys at centerline, 1/4 point and end of span.)

Case III - Same as Case II, except with a full Safe Shutdown Earthquake.

Case IV - This case of crane analysis included the Dead Load plus a Test Load of 125 percent of the weight of the trolleys and a 334 ton weight.

Case V - The crane analysis here included the Dead Load plus a Live Load of 2 trolleys only at the end of the crane span with a wind at 90 mph.

The seismic analysis for the main hoist trolleys included the following design combinations (all cases using ASTM A-36 steel):

Case I - This design case of crane analysis included a Dead Load and a 167 ton Live Load.

Case II - This case includes the Dead Load weight plus a 1/2 Safe Shutdown Earthquake with no lifted load.

Case III - This analysis of the trolleys includes a Dead Load plus a Safe Shutdown Earthquake with no lifted load.

Case IV - This case consists of a Dead Load plus a Live Load of 125 percent of the 167 ton design load.

Motor and Motor Control Safety Features

The motors of the polar crane are ac wound rotor induction type and conform to NEMA Standards MG1-18.501 through MG1-18.518. The motor casings were designed to be totally enclosed, suitable for indoor and outdoor operation, the motors are capable of operating without exceeding their temperature ratings in such a manner as to allow the crane to perform all desired functions and duties within the design conditions of the crane. In addition, the motors are able to operate through all service requirements at 10 percent above or 20 percent below their rated voltage.

The polar crane motor control stations are of the "dead man" type with a spring return to the "off" position. The motor controls comply with all applicable safety requirements of ANSI B30.2-1967. A motor rated disconnecting means is provided in the leads from the main runway conductors. This safety feature, consisting of a combination fused safety switch and magnetic contactor, serves to quickly isolate power from all motors at the push of a button located in the main cab. Interlocks are provided to prevent closing the contactor unless all crane motor controls are in the "off" position.

The controls for the main hoists are ac full magnetic with five steps of variable speed, and controls for the bridge and trolley are ac static stepless. All motions of the crane are provided with the necessary controllers, secondary resistors, contactors, interlocks, and 3-phase overload protection.

The design of the BVPS-2 motors and motor controls is sufficient to assure reliability of these control systems for proper operation of the crane. Conservative design requirements and practices assures that load handling controls systems are adequate for safe handling of heavy loads.

WELDING PROCEDURES

As required by NUREG-0544, all welding done on the BVPS-2 polar crane is in conformance with the AWS D1.1-1972 Specification for Structural Welding. All welding procedures and welders were qualified in accordance with the AWS D2.0-69 standard. Welds on this crane were 100 percent visually inspected for conformance with the acceptance/rejection criterion contained in AWS D1.1-72. In addition, all groove welds subjected to loads that produce stresses greater than 79 percent of any CMAA allowable stresses were examined by either radiographic or ultrasonic methods in accordance with the AWS D1.1-72 standard. Thus, requirements and procedures for welding the materials in the polar crane have been provided to assure reliability of the crane structure to operate safely over the design lifetime.

HOISTING MACHINERY

The basic hoisting system used on the polar crane consists of a hoist drum driven by an electric motor through a gearcase. The hoist drum is used to take up and pay out the wire rope used to raise and lower the load. The load control for the main and auxiliary hoists is provided by eddy-current braking for hoisting and lowering motions. Each hoist is also provided with an independent shoe type brake which is automatically applied to the motor shaft when the motor is deenergized. These brakes are rated at 150 percent to the respective motor full load torque. Also provided is a redundant shoe type brake on each hoist motor located on an extension to the motor pinion shaft. This backup brake, also rated at 150 percent of the motor full load torque, is supplied with a delayed action to prevent simultaneous application of both shoe brakes.

Drums, Sheaves, Load Blocks, Hooks, and Hoisting Ropes

The following design criteria have been met with regard to the hoisting machinery:

1. Drums, sheaves, load blocks, and hoisting ropes are designed so that, when raising or lowering, no twisting of the cables will occur.

2. Drums and cables are chosen so that the cable will not jump the drum grooves at any lift point with a drum rotating against a slack cable.

3. Top sheaves are furnished with cable retainers to prevent the ropes from coming out of the sheave grooves.

4. The load blocks are of the enclosed type with cable retainers to prevent cables from leaving the sheave grooves.

All hoists are provided with limit switches to stop the hooks in their highest and lowest safe positions. A single limit switch is used to limit the downward travel of each hook. However, to prevent two-blocking of the load blocks redundant limit switches are provided to limit hook movement in the upward direction. These switches automatically will shut off power to the motor and set the brakes. Each limit switch is wired so the drive motor can be energized in the reverse direction after the limit switch has been opened.

The main hoist ropes are 12 part, 1 1/8 in Monitor AAA, rope with independent wire centers. The hoisting rope used on the auxiliary hoist is 4 part, 5/8 in IWRC rope. All hoisting ropes are provided with non-water-soluble lubrication to prevent any deterioration of the ropes due to moisture damage. The hoisting ropes are designed with a safety factor of five, and the attachment of the cable ends to the drums are such that if all but two wraps of the rope were unwound, the attachment would be strong enough to carry the rated load with a factor of safety of five.

BRIDGE AND TROLLEY DESIGN AND CONTROL

Bridge girder design is of the structural box section type. Web plates are stiffened with full length diaphragms where required. In addition, short diaphragms are provided to transmit the trolley wheel load to the web plates of the girders. The trolley rails are fastened to the girder top plates by welded clips and shear strips to prevent rail creep. The bridge end trucks are built from welded steel plates and shapes to provide a rigid section with lateral stability and are connected to the bridge girders with the ends of the trucks tied together to prevent spreading. The trolley frames are of all welded construction using rolled structural steel.

The bridge movement is provided by four electric motors, one to drive each corner of the bridge. Each motor has a hydraulically operated, self-adjusting brake mounted on the bridge motor shaft. All four brakes are actuated by a foot lever located in the cab. The brake has a torque rating of 150 percent of the rated full load torque of the bridge motor. The trolley traverse motors are equipped with an electric brake capable of sustaining 100 percent of the rated full load torque of the motor. At loss of power, the trolley brake automatically and immediately applies to the motor shaft.

OPERATING MANUAL AND INSTALLATION INSTRUCTION

The requirements of NUREG-0554 concerning the manufacturer's issuing of manual information and procedures for use in construction, checkout, testing, control, and operation of the polar crane have been fully satisfied.

TESTS AND INSPECTIONS

The BVPS-2 Polar Crane is subject to two Architect/Engineer Field Construction Procedures (FCP) which outline the testing and inspection procedures for operating the crane during the construction phase. After the plant is operating, the maintenance, inspection, and checkout manuals provided by the crane manufacturer will be used to maintain the crane in a safe, operable condition.

TABLE 1

Crane Mark No.	Capacity (Tons)	Heavy Load Identification	Load Weight (Tons)	Lifting Device
2CRN-201	Bridge-334 Trolley No. 1-167/15 Trolley No. 2-167	Reactor Vessel Head & Attachments	130*	Vessel Head Lifting Device
		Reactor Vessel Internals (Upper)	40*	Internals Lifting Rig Assembly
		Reactor Vessel Internals (Lower)	130*	Internals Lifting Rig Assembly
		Reactor Cavity Water Seal	8	
		Reactor Coolant Pump-Motor	40	
		Reactor Coolant System Loop Isolation Valve	15	
		Reactor Head Lifting Rig Spreader Assembly	3.5	
		CRDM Support Structure	8.0	
		Reactor Containment Operating Floor Plugs (Heaviest)	7.5	
		CRDM Missile Shield (3 Sections) (Total Weight)	34	
		Ventilation Fans	1.0	
		Ventilation Supply Ducting (To CRDM)	.9	

TABLE 1

Crane Mark No.	Capacity (Tons)	Heavy Load Identification	Load Weight (Tons)	Lifting Device
		Stud Carriers (Full)	3.6	
		Removable Rail & Beam	1.15	
		Removable Platform North & South	3.0	
		Internals Lifting Rig Assembly	10.5	
		Reactor Head Storage Stand Cover	2.5	
		Residual Heat Removal Heat Exchanger	9.4	
		Residual Heat Removal Pump	3.9	
		Regenerative Heat Exchanger	3.5	
		Polar Cranes - Botton Block & Hook	5.4	
2MHR-CRN-207	5	Residual Heat Removal Pump	3.9	
2MHF-CRN-215	125/30	Spent Fuel Shipping Cask	21.5	
2MHF-CRN-227	10/10	New Fuel Shipping Container (Upended only)	3.0	
		Failed Fuel Assembly Storage Can	1.5	

TABLE 1

Crane Mark No.	Capacity (Tons)	Heavy Load Identification	Load Weight (Tons)	Lifting Device
2MHK-CRN-250	5	Removable Slabs	2.3	
		Rod Drive Motor Generators	3.8	
2MHP-CRN-209A, B	10/10	Component Cooling Water Heat Exchangers (Two Monorails Together)	17.5	
2MHP-CRN-210	5	Removable Slabs	4.5	
		Nonregenerative Heat Exchanger	4.25	
2MHP-CRN-220A, B,C	5/5/5	Charging Pumps-Pump	3.75	
		Charging Pumps-Motor	1.95	
2MHP-CRN-221A, B	10/10	Component Cooling Water Heat Exchangers (Two Monorails Together)	17.5	
2MHP-CRN-223	10	Removable Slabs	9.75	
		Cesium Removal Ion Exchangers	.95	
		Mixed Bed Demineralizers	.95	
		Deborating Demineralizers	1.4	
2MHP-CRN-234	2	Component Cooling Water Pumps	1.0	
		Component Cooling Water Motor	1.7	

TABLE 1

Crane Mark No.	Capacity (Tons)	Heavy Load Identification	Load Weight (Tons)	Lifting Device
2MHP-CRN-235	3	Removable Slabs	2.8	

* Weights to which elements were designed. Based on Unit 1 data, the weights are expected to be lower.