KEWAUNEE NUCLEAR POWER PLANT

SIX-MONTH RESPONSE TO GENERIC LETTER 81-07 NUREG 0612 CONTROL OF HEAVY LOADS

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GENERIC LETTER 81-07

NUREG-0612

CONTROL OF HEAVY LOADS

Submitted by

Wisconsin Public Service Corporation
Green Bay, Wisconsin 54305

December 23, 1982

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1.0 Introduction

Mr. D. G. Eisenhut's letter of December 22, 1980, requested all licensees of operating nuclear power plants to review their controls for the handling of heavy loads using the guidelines of NUREG 0612. It was further requested that licensees identify the changes and modifications that would be required to fully satisfy these guidelines.

Wisconsin Public Service Corporation (WPSC) responded to this request by letters dated June 22, 1981; August 17, 1981 and October 9, 1981. In summary these letters pointed out the following: The Kewaunee Plant's load handling record was not indicative of a need for extensive design or procedural modifications. However, NUREG 0612 did point out specifics that could be used to improve control of heavy loads at Kewaunee. WPSC therefore agreed to develop a formalized heavy load handling training program, and procedures for handling heavy loads through critical areas, to provide electrical interlocks that would ensure that certain loads are within safe load designated areas, to develop administrative control directives, and to upgrade our maintenance procedures. The intent of these actions was to minimize heavy loads in critical areas, to handle these loads in a safe manner and to increase the awareness of the plant personnel of the need for adequate controls near spent fuel and safety-related equipment.

By letter dated May 17, 1982, Mr. S. A. Varga informed WPSC that these submittals provided insufficient evidence for the NRC to conclude that an evaluation with respect to the guidelines of NUREG 0612 was not required. He therefore requested WPSC to supply the information requested in Mr. Eisenhut's letter of December 22, 1980.

Section 2.0 discusses cranes with safety-related equipment in their immediate vicinity in response to the information requested from Section 2.1 of Enclosure 3 of Mr. D. G. Eisenhut's letter dated December 22, 1980. A discussion on functions of safeguards equipment and their redundant systems is also presented in this section in order to justify exclusion of some overhead load handling systems from further consideration.

Section 3.0 provides a brief summary of this submittal.

Section 4.0 are attachments which provide: a list of overhead handling systems used at the Kewaunee Plant, a list of equipment handled by various cranes, drawings and sketches identifying safe load paths for the movement of heavy loads and general crane location drawings for the Kewaunee Nuclear Plant, all of which should assist the NRC in its evaluation.

2.0 RESPONSE TO INFORMATION REQUESTED

NRC QUESTION 2.1.1

Report the results of your review of plant arrangements to identify all overhead handling systems from which a load drop may result in damage to any system required for plant shutdown or decay heat removal (taking no credit for any interlocks, technical specifications, operating procedures, or detailed structural analysis).

RESPONSE

A plant walkdown was performed by a survey team consisting of both corporate and plant staff engineers. This walkdown included the reactor containment, annulus, auxiliary building, turbine building, diesel generator rooms, and screenhouse. Attachment 1 identifies overhead handling systems used in the Kewaunee Nuclear Plant. Attachment 2 provides a list of overhead load handling systems from which an accidental load drop may result in damage to any system required for plant shutdown or decay heat removal.

Attachment 2 takes no credit for:

a) Electrical or mechanical interlocks which could prevent the movement of a heavy load over irradiated fuel or in the proximity of safe shutdown equipment.

b) Operating procedures which could be used to control the movement of a heavy load.

c) Redundant equipment located such that no single load drop can remove both trains of safeguards equipment from service.

d) Cranes or hoists above safeguards equipment unable to lift a heavy load.

e) Cranes or hoists used only when the plant is in a shutdown or refueling mode.

NRC QUESTION 2.1.2

Justify the exclusion of any overhead handling system from the above category by verifying that there is sufficient physical separation from any load-impact point and any safety-related component to permit a determination by inspection that no heavy load drop can result in damage to any system or component required for plant shutdown or decay heat removal.

RESPONSE

The overhead load handling systems discussed below are from Attachment 2.

5. Monorail over Diesel Generator 1A

6. Monorail over Diesel Generator 1B

See Drawing No. CHL-3 for exact location.

The Diesel Generator System provides emergency AC power for the engineered safeguards equipment in the event of loss of normal AC power or a station blackout. Two generators, each having the capability of supplying power requirements for one train of safeguards equipment provide a reliable redundant system. The units are located in separate rooms with a diesel generator, an engine control cabinet, a generator control and excitation cabinet, and a set of 4160 volt switchgear buses in each room. All cables, conduits, trays, air compressors, solenoid valves, control dampers, etc., for each unit are located such that no accident associated with either of these monorails will render both of the generators inoperable.

The diesel generator monorails handle various engine components, typically weighing 1000 lbs. or less. Prior to disassembly of either train diesel, the opposite train diesel is tested and verified operable per Technical Specifications.

These monorails are excluded from further considerations on the basis of: a) redundancy, b) physical separation, c) operational controls, d) components handled are less than a heavy load.*

8. Trolley over Residual Heat Removal Pumps

See Drawing No. CHL-3 for exact location.

The Residual Heat Removal System (RHR) is used to remove heat from the reactor coolant system during the second phase of plant cooldown. The RHR system is also used for low head safety injection, and during refueling to fill the refueling cavity with borated water.

The RHR system consists of two redundant full capacity loops. Each loop is made up of a residual heat removal pump, a residual heat exchanger, associated valves, piping and instrumentation. Each RHR pump is located in its own pump pit with a common trolley serving both pits. Prior to disassembling either RHR pump, the opposite train pump is tested and verified operable per Technical Specifications.

To ensure that no accident associated with this trolley will render both of these pumps inoperable, the following provisions will be taken:

a) A mechanical travel limit stop will be placed on the monorail to prevent hoist travel over the redundant train, if the opposite train pump pit covers are removed.

b) Training will be provided on operation of this trolley including sequence of removal or replacement of pump pit covers to reduce the chances of a load handling accident.

*Heavy load defined as anything greater than 1800 pounds.

This trolley will be excluded from further consideration on the basis of:

a) Components lifted by this trolley, other than the pump pit covers, do not constitute a heavy load.

b) The design of the pump pit walls and covers and their lifting devices precludes the possibility of either of the covers from falling through the opening into the pit. (The cover can fit through the opening only if it is in a diagonal position at a sharp vertical angle).

c) Redundancy of safeguards equipment.

d) Physical separation.

e) RHR pump hoist maintenance procedure PMP 57-9 being performed annually.

We feel based upon the above safeguards, we meet the safe load handling practices required by the general guidelines of Section 5.1.1 of NUREG 0612.

16. <u>Spent Fuel Pool Bridge and Hoist</u>

See Drawing No. CHL-1 for exact location of spent fuel pool.

The spent fuel pool bridge is a wheel-mounted walkway spanning the spent fuel pool with an electric hoist mounted on an overhead structure. It is used for handling spent fuel assemblies, burnable poison rod assemblies, and all other fuel assembly inserts. The spent fuel assemblies are moved within the pool by means of a long handled tool suspended from the overhead monorail electric hoist and manipulated by an operator standing on a movable bridge over the pool. The hoist travel and tool length are designed to limit the maximum lift of a fuel assembly to a safe shielding depth.

The fuel storage pool is housed in a steel frame/metal siding portion of the Auxiliary Building. The spent fuel pool is ventilated by a locally controlled air sweep system. Technical Specifications require that the Spent Fuel Pool Air Sweep System be in service during fuel handling operations.

Section 14.2.1 of the Kewaunee Updated FSAR discusses the consequences of a dropped fuel assembly accident. Other than possible damage to fuel, no other safety related systems will be involved in the event of a Spent Fuel Pool Bridge and Hoist failure. The fuel handling system is discussed in section 9.0 of the Updated FSAR. Based upon the above discussion, this crane is excluded from any further consideration.

17. Reactor Cavity Manipulator Crane

The manipulator crane is a rectilinear bridge and trolley crane with a vertical mast extending down into the refueling water. The bridge spans the refueling cavity and runs on rails set into the floor along the edge of the refueling cavity. The bridge and trolley motions are used to position the vertical mast over a fuel assembly in the core. A long tube with a pneumatic gripper on the end is lowered out of the mast to grip the fuel assembly. The gripper tube is long enough so the upper end is still contained in the mast when the gripper end contacts the fuel. A winch mounted on the trolley raises the gripper tube and fuel assembly up into the mast tube. The fuel is transported while inside the mast tube to its new position. The manipulator can lift only one fuel assembly at a time.

All controls for the manipulator crane are mounted on a console on the trolley. The bridge is positioned on a coordinate system laid out on one rail. The electrical readout system on the console indicates the position of the bridge.

The trolley is positioned with the aid of a scale on the bridge structure. The scale is read directly by the operator at the console. The drives for the bridge, trolley, and winch are variable speed and include a separate inching control in the winch. Electrical interlocks and limit switches on the bridge and trolley drives protect the equipment. A limit switch in the Dillon weight indicator parallels the gripper engage switch. The potential exists to lift a fuel assembly which could be held by a disengaged gripper. Before the operator sees the indication on the load cell, the fuel assembly could drop. The parallel limit switch provides one additional interlock to back up an operator's action. In an emergency, the bridge, trolley, and winch can be operated manually using a handwheel on the motor shaft.

Safety features are incorporated in the system as follows:

a) Travel limit switches on the bridge and trolley drives;

b) Bridge, trolley, and winch drives which are mutually interlocked to prevent simultaneous operation of any two drives;

c) A position safety switch, the GRIPPER TUBE UP position switch, which prevents bridge and trolley main motor drive operation except when it is actuated;

d) An interlock which prevents the opening of a solenoid valve in the air line to the gripper except when zero suspended weight is indicated by a force gage. As backup protection for this interlock, the mechanical weight-actuated lock in the gripper prevents operation of the gripper under load even if air pressure is applied to the operating cylinder;

e) The EXCESSIVE SUSPENDED WEIGHT switch, which opens the hoist drive circuit in the up direction when the loading is in excess of a present limit;

f) An interlock on the hoist drive circuit in the up direction, which permits the hoist to be operated only when either the OPEN or CLOSED indicating switch on the gripper is actuated;

g) An interlock of the bridge and trolley drives, which prevents the bridge drive from traveling beyond the edge of the core unless the trolley is aligned with the refueling cavity centerline. The trolley drive is locked out when the bridge is beyond the edge of the core.

Restraints are provided between the bridge and trolley structures and their respective rails to prevent derailing. The manipulator crane is designed to prevent disengagement of a fuel assembly from the gripper in the event of a Design Basis Earthquake.

Other than possible damage to fuel, no other safety related systems will be involved in the event of a manipulator crane failure. The manipulator crane is discussed at length in section 9.0 of the Updated FSAR. The dropped fuel assembly accident analysis associated with this crane is covered in section 14.2.1 of the Updated FSAR. In addition, Kewaunee Nuclear Plant's Technical Specifications requires containment integrity whenever there is a change in core geometry which affects reactivity. Based upon the above discussion this crane is excluded from any further discussion.

19. Turbine Building Crane

See Drawing No. CHL-1 for exact location.

The turbine building crane is generally used for the maintenance of the turbine generator and moisture separator reheaters during refueling/maintenance outages.

The turbine building operating floor (elevation 626'0") contains no safe shutdown equipment. Located directly beneath the northwest corner of the turbine operating floor are the 1A and 1B battery rooms (elevation 606'0"). These batteries supply D.C. for the control of circuit breakers and other components requiring a reliable control source. They also provide a standby source to various inverters used for emergency lighting, telephone system, computer power supply, and a source for control and instruments requiring a non-interruptible AC supply. The battery rooms are separated from each other by a 12-inch poured concrete wall and have a 10-inch thick concrete ceiling.

Beneath the battery rooms are the three (3) auxiliary feedwater pumps and the safeguards 480V switchgear buses 1-51, 1-52 (Train A) and 1-61, 1-62 (Train B). The auxiliary feedwater pumps provide feedwater to the steam generators following an interruption of the main feedwater system resulting from such causes as blackout, feedwater pump failures, or turbine/reactor trips. Only one auxiliary feedwater (AFW) pump is required to bring the plant to a safe shut-down. Each of the AFW pumps are separated by an 18-inch thick poured concrete wall.

The safeguards 480V switchgear buses 1-51, 1-61, 1-52, and 1-62, supply power to various engineered safety feature (ESF) equipment required to bring the plant to a safe shutdown. These safeguards 480 V switchgear buses are redundant to each other and separated by approximately 21' 8".

The turbine building crane is excluded from any further consideration on the basis of:

a) Redundancy of safeguards equipment.

b) Physical separation.

c) Prior to refueling or extended maintenance outages, the crane maintenance procedure, PMP 57-3 is performed.

d) A modified version of PMP 57-3 will be written and performed monthly. This procedure will include the critical sections of PMP 57-3. The monthly performance of this procedure will reduce the possibility of a load handling accident and allow infrequent heavy loads to be lifted during normal operations. This procedure will be written by November 15, 1983.

This procedure will include visual inspection of the following crane components:

a) Circuit breaker

b) Cab and cab controls for operability

c) Bridge electrical panel and resistors

d) Bridge rails and trolley rails for mechanical damage

e) Bridge brake

f) Trolley brake

g) Main and auxiliary hook brakes

h) Festoon cable system for proper operation

i) Cable drum and cable

j) Main and auxiliary hook

The final requirement of this procedure will be to operate the crane in all modes both from the cab and pendant.

20. Auxiliary Building Fuel Handling Crane

See Drawing No. CHL-1 for exact location.

The auxiliary building fuel handling crane is used to handle the heavy loads in the Auxiliary Building. (See Attachment 3)

The safeguards equipment that is located within the travel path of the crane includes:

a. Spent fuel elements inside the spent fuel pool
b. Component cooling system components including:
   - pumps, piping and valves
c. Electrical cables serving:
   - component cooling system pumps and valves
d. Residual heat removal (RHR) system components including:
   - RHR heat exchangers, piping and valves
e. Electrical cables serving:
   - RHR system pumps and valves

All other systems or components located within the travel of this crane are not needed for safe shutdown of the plant or would not be affected by an accidental load drop accident. Therefore, they have not been included in this discussion.

The following discussion provides justification for exclusion from further consideration of the above mentioned safeguards equipment located within the travel path of the crane.

a. Spent Fuel Pool

The travel of the crane in the area of the spent fuel pool is restricted by electrical interlocks. Operation of the crane inside this area is regulated by technical specifications. Access into this restricted area is required for:

- Loading of Spent Fuel Shipping Cask

  The Kewaunee Nuclear Power Plant does not have a spent fuel shipping cask. The spent fuel storage capacity of the spent fuel pool has been increased. This increased capacity provides storage space for all spent fuel until approximately 2001 - (with full core reserve). Accordingly, no spent fuel cask handling operations are planned or anticipated until that time. A detailed analysis of the consequences of an accidental drop of a spent fuel shipping cask will be made and procedures will be written prior to first use of a cask.

- Loading of Irradiated Reactor Vessel Surveillance Capsule Into Shipping Cask

  The irradiated specimen shipping cask is brought into the small pool (1A) for loading of the irradiated specimens. During loading written procedures are adhered to in the movement of the cask, and whenever the possibility exists, the small pool (1A) is kept free of all spent fuel elements.

- Relocation of Pool and Fuel Transfer Canal Divider Gates

  For relocation of the divider gates the crane is allowed to operate over the entire spent fuel pool area. Although this operation is under strict procedural control and safe load paths are defined, an accidental drop of the bottom block of the crane could cause damage to certain spent fuel elements.

The extent of the damage to spent fuel elements from an accidental drop of a pool divider gate is evaluated to be less than the damage due to a postulated turbine missile accident described in Section 14.2 of the Updated FSAR.

Component Cooling System

The component cooling system consists of heat exchangers, pumps, surge tank and associated piping, valves and instrumentation. The system provides cooling to the following safety related equipment:

Residual heat exchangers, residual heat removal pumps, safety injection pumps and containment spray pumps.

The component cooling system transfers heat from these systems to the service water system.

The following parts of the component cooling system have been critically studied to evaluate the effects of an accidental load drop from the auxiliary building crane.

- The component cooling pumps 1A and 1B on elevation 606'0" with their respective piping and valves to and from the component cooling heat exchangers.

  The component cooling pumps and their respective piping and valves to and from the component cooling heat exchangers do not require additional protection from a load drop because either:

  1) They have two or more floor barriers between them and the crane, or

2) Located on the floor directly above this area are the monitor tanks. There is no anticipated need to handle heavy loads in this area due to the presence of the monitor tanks. Therefore, this area is excluded from further consideration.

- A short length of component cooling supply pipe located at the extreme southeast corner of crane travel which serves both of the RHR pumps and safety injection pumps.

1) This short length of component cooling supply piping has a single floor barrier to protect it from a load drop. This barrier would provide adequate protection to this piping in the unlikely event of a crane block drop from the high hook position.

2) From the review made of the heavy loads handled by the auxiliary building crane (Attachment 3) and their associated specific pathway for movement, it was found that no heavy loads are carried over this area.

- Additional component cooling piping and valves associated with only RHR pump 1B on elevation 586'0".

The additional component cooling piping and valves associated with RHR pump 1B which are located between the elevation 586'0" and 606'0" does not require any additional protection from a crane load drop. This is because of the fact that:

1) They have redundant systems available which have good physical separation.

2) Two or more floors exist between the system and the crane. A single floor barrier would provide adequate protection to this piping in the unlikely event of a crane block drop from the high hook position.

c. Electrical Cables for the Component Cooling System

All applicable electrical cables for the component cooling system are located above the mezzanine floor in an area protected from an accidental load drop by concrete floors at elevation 649'6", elevation 636'6" and elevation 622'3".

d. Residual Heat Removal System (RHR)

The following parts of the RHR system have been critically studied to evaluate the effects of an accidental load drop from the auxiliary building crane:

- Piping and valves directly below the west wall of each RHR heat exchanger room between elevations 586'0" and 606'0".
- Pumps, valves and piping associated with only the RHR pump 1B at elevation 586'0".

Pumps, valves and pipes located below elevation 606'0" do not require additional protection because they are either:

1. Redundant to the RHR system and damage to any one of them would not adversely effect the system.

2. They are protected from a load drop by two or more floor barriers. A single floor barrier would provide adequate protection to these components in the unlikely event of a crane block drop from the high hook position.

- Piping and valves on the east wall of each RHR heat exchanger room between elevations 606'0" and 633'6".

  Piping and valves located between these elevations are protected by a single floor barrier and by redundant limit switches which will restrict the crane from traveling over this area. (These limit switches will be installed by November 15, 1983.) Therefore, no additional protection is required because:

  1) A single floor barrier would provide adequate protection to this area from a crane block drop from the high hook position.

  2) From the review made of the heavy loads handled by this crane (Attachment 3) and their associated specific pathway for movement, it was found that few heavy loads are carried over this area.

  3) Redundant limit switches restrict the crane from traveling over this area.

These interlocks may be bypassed when any of the following conditions have been satisfied:

1) If conditions ever warrant the crane to be in bypass for an extended period of time, the crane maintenance procedure PMP 57-1 will be performed prior to bypassing the interlocks and every three months thereafter.

2) A modified version of PMP 57-1 will be written to include the critical sections for the infrequent heavy loads that are lifted over this area. This procedure will be written by November 15, 1983.

This procedure will include visual inspection of the following crane components:

a) Circuit breaker

b) Cab and cab controls for operability

c) Bridge electrical panel and resistors

d) Bridge rails and trolley rails for mechanical damage

e) Bridge brake

f) Trolley brake

g) Main and auxiliary hook brakes

h) Festoon cable system for proper operation

i) Cable drum and cable

j) Main and auxiliary hook

The final requirement of this procedure will be to operate the crane in all modes both from the cab and by radio control.

e. <u>Electrical Cables for RHR System</u>

Electrical cables for the RHR system are located above the 606'0" elevation and are protected by the concrete slab at the 633'6" elevation. Cables servicing the RHR system are separated into two trains which are redundant to each other.

22. Reactor Building Polar Crane

See Drawing No. CHL-1 for exact location.

The reactor building polar crane is used to handle heavy loads in the containment building. Heavy loads handled by this crane are: reactor vessel and pressurizer missile shields, reactor vessel head, upper and lower internals, reactor coolant pumps (including motor and flywheel), inservice inspection tool, and reactor vessel studs (in handling box only), see Attachment 3. Except for the pressurizer missile shield, the movement of these heavy loads with the reactor building polar crane is done only when the reactor coolant system is in the cold shutdown condition. In addition, containment integrity must be maintained for activities affecting core geometry.

NRC QUESTION 2.1.3

With respect to the design and operation of heavy-load-handling systems in the containment and the spent-fuel-pool area and those load-handling systems identified in 2.1-1, above, provide your evaluation concerning compliance with the guidelines of NUREG 0612, Section 5.1.1. The following specific information should be included in your reply:

a. Drawings or sketches sufficient to clearly identify the location of safe load paths, spent fuel, and safety-related equipment.

b. A discussion of measures taken to ensure that load-handling operations remain within safe load paths, including procedures, if any, for deviation from these paths.

c. A tabulation of heavy loads to be handled by each crane which includes the load identification, load weight, its designated lifting device, and verification that the handling of such load is governed by a written procedure containing, as a minimum, the information identified in NUREG 0612, Section 5.1.1(2).

RESPONSE

Item c

Attachment 3 is a tabulation of heavy loads to be handled by the Auxiliary Building Fuel Handling Crane and the Reactor Building Polar Crane.

Items a & b

The sketches identify the specific pathways for the movement of the heavy loads identified in Attachment 3 for the Auxiliary Building Fuel Handling Crane, and the Containment Polar Crane. These safe load paths were developed with the following considerations:

a. Minimize the potential for a heavy load drop to impact irradiated fuel or to impact safe shutdown equipment.
b. Shortest distance between the component and its designated lay down area.
c. Limits imposed upon crane travel due to the design of the crane and maximum travel of the crane.
d. Conditions the reactor coolant system must be in prior to the movement of specific components.
e. Personnel safety.

Written procedures will be generated identifying the applicable requirements from NUREG 0612 Section 5.1.1(2) for the loads identified in the attached sketches. Written procedures will be generated if deviations from approved specific pathways (see sketches) are necessary.

Note: If the deviation from an approved specific pathway involves movement of the load over another portion of the unloading dock, no written procedure will be required. Semi-trailers may park anywhere along the unloading dock because no safety related equipment is located under this area.

Not all heavy loads identified in Attachment 3 for the Auxiliary Building Crane have defined safe load paths. The following loads do not require safe load paths for the following reasons:

1. Spent Fuel Shipping Cask

The Kewaunee Nuclear Plant has not acquired a spent fuel shipping cask. A load drop analysis for an estimated 30 ton cask was performed and is reported in the Updated FSAR section 9.5. It was concluded from this analysis that, if the cask is dropped in the small pool (north pool) the large pool (south pool) will not lose water.

In addition, the Kewaunee Plant has increased its capacity for storing spent fuel by installing condensed fuel racks in part of the spent fuel pool. When fully completed, the increased capacity will provide storage space for all spent fuel until the year approximately 2001 (with fuel core reserve.) Therefore, no spent fuel shipping cask handling operations or written procedures are needed at this time.

4c. Missile/Radiation Shield - Waste Evaporator

The waste evaporator package has not been in service at the Kewaunee Nuclear Plant since 1974. Therefore, it is unlikely that its shield will ever be moved. However, the auxiliary building crane can only lift this shield vertically; no lateral movement is possible. The panel lift is restricted by the new fuel shipping container deck located at floor elevation 649'6". Hence, lifting the shield does not pose a load drop risk.

4d. Missile/Radiation Shield - Demineralizer Removable Slabs

Demineralizer removable slabs are located on floor elevation 633'6" at column row 6. These shields are not over any safe shutdown equipment. When access is desired they are lifted several inches above the floor and stored immediately east of the openings. They are only expected to be handled once every 20 years.

6. Radwaste Cask Lids

The procedures covering the removal of these lids specifies that the lids be placed down on the flatbed truck.

8. Crane Load Block

Except for the exclusion areas over the spent fuel pool and over the RHR heat exchanger discharge piping the crane load block can move unrestricted over all areas. An analysis has been performed which concluded that a single floor barrier would be adequate protection for all components located beneath the floor in the unlikely event of a crane block drop from the high hook position. Therefore, no safe load paths nor written procedures are needed to cover the movement of this item.

10. Filter Shield Cask

The filter shield cask is handled by the auxiliary building crane inside the fuel handling and receiving area at floor elevation 606'0". No safety related equipment is located in this area. If this load is ever required to be moved over other areas, a safe load path will be developed. Therefore, this heavy load is being excluded from further consideration.

Item d

Verification that lifting devices identified in 2.1.3-c, above, comply with the requirements of ANSI N14.6-1978, or ANSI B30.9-1971 as appropriate. For lifting devices where these standards, as supplemented by NUREG 0612, Section 5.1.1(4) or 5.1.1(5), are not met, describe any proposed alternatives and demonstrate their equivalency in terms of load-handling reliability.

Response

The lifting devices at Kewaunee Nuclear Power Plant which can be categorized as special lifting devices that handle heavy loads in the containment or near spent fuel are:

1. Reactor vessel head lifting rig
2. Reactor vessel internals lifting rig
3. Load cell
4. Load cell linkage
5. Reactor coolant pump motor lifting sling

The reactor vessel head lifting rig, the reactor vessel internals lifting rig, load cell, load cell linkage and reactor coolant pump motor lifting sling were designed by Westinghouse and built for the Kewaunee Nuclear Power Plant during 1970-1971. Except for the reactor coolant pump motor lift sling, Westinghouse used the design criteria that the resulting stress in the load bearing members, when subjected to the total combined lifting weight should not exceed 1/5 (one-fifth) of the ultimate strength of the material. A stress report was prepared for the five (5) above mentioned lifting devices and all 5 lifting devices including the reactor coolant pump motor lift sling were found to meet the 1/5 ultimate strength criterion.

The product provided by Westinghouse was designed, fabricated, assembled and inspected in accordance with internal Westinghouse requirements. Except for a few specific detailed requirements, Westinghouse's requirements meet the intent of ANSI N14.6-1978.

Listed below are the paragraphs from ANSI N14.6-1978 in which the special lifting devices are not in strict compliance. Following each item are WPSC's associated remarks which demonstrate equivalent compliance.

Yield Strength

Paragraph 3.2.1.1 requires the design, when using materials with yield strengths above 80% of their ultimate strengths, to be based on the materials fracture toughness and not the listed design factors.

Response

High strength materials were used in the 5 devices listed above. Although the fracture toughness was not determined, the material was selected based on its excellent fracture toughness characteristics. The stress design factors of 3 and 5 listed in ANSI N14.6-1978 were used in the analysis and the resulting stresses are acceptable.

Load Bearing Members

Paragraph 3.2.6 requires material for load-bearing members to be subject to drop-weight or Charpy impact tests.

Response

As discussed above the fracture toughness requirements were not identified for the material used, however, the material selection was based on its excellent fracture toughness characteristics.

Q.A. Program

Paragraph 4.1.6 requires a formal quality assurance program for the manufacturer and Paragraph 4.1.7 requires certification and identification of materials.

Response

At the time of construction of these devices, there was no requirement for a QA program, and consequently the manufacturer did not have a formal quality assurance program for all items in the lifting devices. However, the manufacturers welding procedures and nondestructive testing procedures were reviewed by Westinghouse prior to use. Most of the critical load bearing members required letters of compliance for material requirements. Westinghouse performed certain checks and inspections during various steps of manufacturing. Final Westinghouse review included visual, dimensional, procedural, cleanliness, personnel qualification, etc., and in most cases, issuance of a quality release to ensure conformance with drawing requirements. No information that a quality release was issued for the reactor coolant pump motor lift sling has been found, although Westinghouse performed the final inspection.

Owner Responsibilities

Paragraph 5.1 lists Owner Responsibilities and 5.1.2 requires the owner to verify that the special lifting devices meet the performance criteria of the design specification by records and witness of testing.

Response

Design specifications for these rigs and load testing was not originally required or performed except for the reactor vessel head lifting rig and reactor vessel internals lifting rig. These latter two rigs were load tested at 100% design load followed by destructive testing on critical welds. The Westinghouse Quality Release is an acceptable alternate to verify that the criteria for certified material testing reports, NDE, and documentation required by Westinghouse drawings and purchasing documents were satisfied.

Special Identification

Paragraphs 5.1.5, 5.1.5.1, 5.1.5.2 require special identification and marking of these special lifting devices to prevent misuse.

Response

These rigs are specific lifting devices and can only be used for their intended purpose and parts are not interchangeable. Therefore, special identification is not necessary.

Testing Requirements

Paragraph 5.2.1 requires the rigs to be initially tested at 150% maximum load followed by non-destructive testing of critical load bearing parts and welds. Also, paragraph 5.3 requires testing to verify continuing compliance and annual 150% load tests or annual nondestructive tests and examinations to be performed.

Response

The requirement from paragraph 5.2.1 to load test to 150% of the total weight before each use would require special fixtures and is impractical to perform. We propose to visually check the structural members of the earlier mentioned lifting devices at the initial lift prior to moving to full lift and movement. Additionally, lifting and lowering of most of the loads handled by these special lifting devices are monitored with the use of the load cell.

The Kewaunee Nuclear Power Plant has been in operation since 1974 and for the past (8) eight years has had no problems with these special lifting rigs. Therefore, we feel the 150% load test requirement on all special lifting devices should be waived.

Stress Design Factors

NUREG 0612 Sec. 5.1.1(4) states special lifting devices should satisfy the guidelines of ANSI N14.6-1978. It goes on to state; "In addition, the stress design factor stated in Section 3.2.1.1 of ANSI N14.6 should be based on the combined maximum static and dynamic loads that could be imparted on the handling device based on characteristics of the crane which will be used. This is in lieu of the guideline in Section 3.2.1.1 of ANSI N14.6 which bases the stress design factor on only the weight (static load) of the load and of the intervening components of the special handling device."

Response

The intent of this paragraph is that the stress design factors specified in Section 3.2.1.1 of ANSI N14.6 (3 and 5) are not all inclusive and should be increased by an amount based on the crane dynamic characteristics. The dynamic characteristics of the crane would be based on the main hook and associated wire ropes holding the hook. The containment polar crane at Kewaunee uses 16 (sixteen) wire ropes to handle the load on the main hook. Should the crane hook suddenly stop during the lifting or lowering of a load, a shock load could be transmitted to the connecting device. Because of the elasticity of the sixteen wire ropes, the dynamic factor for the containment polar crane is not much larger than one (1). The maximum design factor that is recommended by most design texts [1,2,3] is a factor of 2 for loads that are suddenly applied. The stress design factors required in Section 3.2.1.1 of ANSI N14.6-1978 are:

$$3(\text{weight}) < \text{Yield Strength}$$

$$5(\text{weight}) < \text{Ultimate Strength}$$

The factor of 3 specified certainly includes consideration of suddenly applied loads for cases where the dynamic impact factor may be as high as 2. Thus we feel that the use of the design criteria in ANSI N14.6-1978 satisfies the NUREG 0612 requirement.

To provide flexibility on stress design factor, the analysis of the special lifting devices was performed with stress design factors of 1, 3 and 5. In all cases, using a stress design factor of 5 resulted in stress limits below the yeild strength of the material.

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(1) Lin, C. W., "Approximate Evaluation of Dynamic Load Factors for Certain Types of Loading," ASME Paper 70-WA/NE-2.

(2) Biggs, J. M., Introduction to Structural Dynamics, McGraw-Hill, New York, 1964.

(3) Gwinn, Jr., J. T., "Stop Over-Designing for Impact Loads," Machine Design, 33, pp. 105-113 (1961).

Item e

Verification that ANSI B30.2-1976, Chapter 2-2, has been invoked with respect to crane inspection, testing, and maintenance. Where any exception is taken to this standard, sufficient information should be provided to demonstrate the equivalency of proposed alternatives.

Response

This response will be addressed in the nine month submittal.

Item f

Verification that crane design complies with the guidelines of CMAA Specification 70 and Chapter 2-1 of ANSI B30.2-1976, including the demonstration of equivalency of actual design requirements for instances where specific compliance with these standards is not provided.

Response

The major cranes for the Kewaunee Nuclear Power Plant; i.e. 125 ton turbine building crane, 125 ton auxiliary building fuel handling crane and the 230 ton containment polar crane were purchased from Whiting Corporation of Illinois in the late sixties and early seventies. The specification against which these cranes were purchased predates CMAA Specification #70. However, the cranes were qualified against EOCI Specification #61 which was superceded by CMAA Specification #70. The other codes and standards invoked by the crane specification include:

American Society for Testing and Materials Standard Specification	(ASTM)
American Institute of Steel Construction Specification	(AISC)
American Welding Society Standards	(AWS)
National Electrical Manufacturer's Association	(NEMA)
National Electrical Code	(NEC)

A comparison of EOCI #61 with CMAA #70 was prepared by the Whiting Corporation. This comparison covers sections of CMAA #70 specification with the corresponding sections of EOCI #61 specification and brings out the deficiencies that may exist in the cranes designed per EOCI #61 if it were to meet CMAA #70.

CMAA #70 specifications addresses the design loads for the footwalks and the construction features of the cabs. Kewaunee Nuclear Power Plant's experience with both footwalks and cabs have been satisfactory.

With respect to material properties; although the two codes specify two different materials, a careful review indicates that the structural strength of the cranes manufactured in accordance with either of the two specifications would have the same factors of safety. Structural steel used for the cranes at Kewaunee conforms to ASTM A36 steel as required by CMAA #70 specifications which exceeds the ASTM A7 steel specified by EOCI #61.

A comparison of specifications for the cranes with CMAA specifications was made and from the review it was concluded that the specifications for these cranes are in agreement for the following:

a) Rated Motor Voltage

b) Squirrel Cage Motor Design

c) Specification for Remote Control

d) Classification of Resistors

e) Means for Disconnecting

f) Overload of AC Motors

g) Criteria for Floor Operated Pendant Pushbutton Stations

h) Runway Voltage Drop Criteria

The following sections of CMAA #70 specifications important to crane safety were evaluated in detail.

Impact Factor

Section 3.3.2.1.1.3 of CMAA #70 requires that the impact allowance shall be 0.5 percent of the load per foot per minute of hoist speed but not less than 15 percent of rated capacity. The corresponding section of EOCI #61 states minimum impact of 15 percent without regard to hoist speed. For hoist speeds less than 30 fpm, the two specifications are equivalent.

Response

The speeds of these three cranes are significantly lower than 30 fpm. The cranes designed according to EOCI #61 are, therefore, satisfactory.

Torsional Forces

CMAA #70 Section 3.3.2.1.3 requires that twisting moments due to overhanging loads and lateral loads acting eccentric to the horizontal neutral axis of the girder be calculated on the basis of the distance between center of gravity of the load, or force center line, and the girder shear center measured normal to the force vector. EOCI #61 states that such moments are to be calculated with reference to girder center of gravity.

Response

A review of the girder sections used for the three cranes reveals that unsymmetrical sections were not used. For the symmetrical sections shear center coincides with the center of gravity and the two codes are equivalent.

Longitudinal Stiffeners

Section 3.3.3.1 of CMAA #70 specifies the design requirements for the longitudinal stiffeners. EOCI #61 allows use of longitudinal stiffeners but does not provide design guidance for them.

The following tables provide the comparison between the longitudinal stiffener requirements CMAA #70 and the cranes at Kewaunee Plant.

Distance from Inner Surface of Compression Flange to the Center Line of the Stiffener

	As Built	CMAA-70
Reactor Bldg. Crane	28 inches	≤ 20.8 inches
Auxiliary Bldg. Crane	20 inches	≤ 19.4 inches
Turbine Bldg. Crane	26 inches	≤ 23.0 inches

h/t Ratios

	As Built	CMAA-70
Reactor Bldg. Crane	332.8	≤ 324
Auxiliary Bldg. Crane	310.4	≤ 324
Turbine Bldg. Crane	368.0	≤ 324

Response

At the present stage we have no reason to doubt design adequacy of the cranes in spite of difficulty in assessing that equivalent design practices were followed for the cranes. It must be remembered that the cranes have been used to lift the heaviest loads in the plant within their design limits without any structural problems.

Allowable Compressive Stress

Section 3.3.3.1.3 of CMAA #70 identifies allowable compressive stresses of approximately 50% of yield strength of the recommended structural material (A-36) for girders, where the ratio of the distance between web plates to the thickness of the top cover plate (b/c ratio is less than or equal to 38). Allowable compressive stresses decrease linearly for b/c ratios in excess of 38. EOCI #61 provides a similar method for calculating allowable compressive stresses except that the allowable stress decreases from approximately 50% of yeild only after the b/c raio exceeds 41.

Response

The b/c ratios for the cranes at Kewaunee plant do not exceed 38 and hence the two specifications are equivalent.

Fatigue Consideration

Table 3.3.3.1.3-1 of CMAA #70 provides allowable stresses for cranes subjected to fatigue loads based on the classification of the crane. EOCI #61 does not provide such a guidance in the design of the crane.

Response

The cranes at the Kewaunee plant are not governed by this consideration since the maximum cycles of significant load handling events for each crane are less than 20,000. For this purpose significant loads are defined as loads greater than 25 percent of the rated capacity of the crane. We estimate that heavy loads would be lifted by a given crane less than 800 times during the 40 year plant life. This provides for twenty lifts per year.

Hoist Rope Requirements

Section 4.2.1 of CMAA #70 requires that the weight of the bottom block plus the rated capacity load divided by number of parts of rope shall not exceed 20% of the published rope breaking strength. EOCI #61 specification ignored weight of the bottom block for this comparison.

Response

We have concluded that for the Kewaunee Plant cranes the rated capacity load plus the weight of the bottom block divided by the number of parts of rope do not exceed 20% of the published breaking strength of the rope. The breaking strengths for the ropes used for this review was obtained from the Whiting Crane Handbook, Third Edition 1967.

Drum Design

Section 4.4.1 of CMAA #70 requires that the drum be designed for combined crushing and bending loads. EOCI #61 specified the design to withstand maximum bending and crushing loads but did not specifically ask for combinations of the stresses.

Response

The cranes for the Kewaunee Plant were purchased from Whiting Corporation. The Whiting Crane Handbook (3rd edition), pg. 83, states that for the design of the drum the crushing strength is combined with bending strength to arrive at a combined stress which must be compared with the allowable stress. Hence we conclude that the cranes meet the design requirement of CMAA #70.

Drum Groove Depth and Pitch Design

Section 4.4.3 requires minimum drum groove depth to be 3/8 X rope diameter and minimum drum groove pitch to be either 1.14 X rope diameter or rope diameter +1/8 inch, whichever is smaller.

Response

The depth of the drum grooves for all Kewaunee Plant cranes, except the main hoist of the Polar Crane, meet requirements of CMAA #70.

The groove depth of the main hoist drum of the Polar Crane is 0.500 inch whereas the minimum recommended by CMAA #70 is 0.515 inch.

The pitch of drum grooves for Kewaunee Plant cranes meet rope diameter +1/8 inch criteria. All auxiliary hoist drums have rope diameters equal to 9/16 inch. The drum groove pitch, based on rope diameter + 1/8 inch, is 11/16 inch. This excceds the minimum pitch based on 1.14 X rope diameter which equals to 10 3/16 inches.

Gear Design

Section 4.5 of CMAA #70 is devoted in specifying that the gearing horse power rating shall be based on specific standards of American Gear Manufacturer Association and provides a method for determining allowable horse power.

Response

Whiting Corporation has informed us that gearings were purchased from gear manufacturers who complied with the American Gear Manufacturers Association Standards. CMAA #70, Article 4.5.2, design standards are the same as those in existence at the time of the crane purchase.

Bridge Brake Design

Section 4.7.7.2 of CMAA #70 requires that brakes for cranes with cab control, with cab on trolley arrangement shall have torque rating of at least 75% of the bridge motor instead of 50% specified by EOCI #61.

Response

Kewaunee cranes do not have cab on trolley control arrangements.

Hoist Brake Design

Section 4.7.4.2 of CMAA #70 requires that the minimum torque rating of holding brakes, in relation to the motor torque, at point of application be 125% when used with a control braking means other than mechanical. EOCI #61 requires hoist holding brakes torque rating of no less than 100% of the hoist motor torque without regard to the type of control brakes employed.

Response

The torque rating for the hoist holding brakes for the cranes at Kewaunee Nuclear Plant have a minimum 125% of the hoist motor torque.

The cranes are equipped with two 13" - SESA Electric Solenoid brakes servicing main hoist, and one 13" - SESA Electric Solenoid brake servicing auxiliary hoist. Each brake has a rated torque capacity of 550 ft-lb. The rated hoist motor torque for the reactor building main hoist motor is rated at 345 ft-lb. This is the smallest ratio among the cranes.

Bumpers and Stops

Section 4.12 of CMAA #70 provides requirements for the design and installation of the bridge and trolley bumpers and stops. Similar requirements are not specified by EOCI #61.

Response

The following verification of Kewaunee Nuclear Plant cranes was made to check that the bumpers and stops satisfy the intent of CMAA #70.

Bridge Bumpers and Stops

Auxiliary building and turbine building cranes are both equipped with four spring bumpers with safety cables. The Polar crane in the reactor building does not have bridge bumpers and stops to allow 360 degree rotation of the cranes.

Bridge stops were designed for the loads established by the crane manufacturer.

Trolley Bumpers and Stops

All cranes under review are equipped with trolley bumpers and stops. The criteria for the design of bumpers and stops matches with criteria of CMAA #70.

The bridge and trolley bumpers are mounted in such a manner that the attaching bolts are not in shear.

The bridge bumpers were designed for the criteria more stringent than the criteria specified by CMAA #70.

Static Control Systems

Section 5.4.6 of CMAA #70 provides design guidelines for the use of static control systems whereas EOCI #61 did not discuss static control systems. EOCI #61 specified design criteria for magnetic controls only.

Response

We have reviewed Kewaunee cranes and have concluded that the cranes are equipped with magnetic controls. This segment of CMAA #70 is therefore, not applicable.

Restart Protection

Section 5.6.2 of CMAA #70 states that the cranes not equipped with spring-return controllers, or momentary contact pushbuttoms, shall be provided with a device which will disconnect all motors from the line on failure of power and will not permit any motor to be restarted until the controller handle is brought to the "OFF" position, or a reset switch or button is operated. EOCI #61 does not specify any requirements for restart protection.

Response

We have confirmed from the crane manufacturer that all controllers used are of the momentary - contact push-buttom type and satisfy this requirement of CMAA #70.

Item g

Exceptions, if any, taken to ANSI B30.2-1976 with respect to operator training, qualification, and conduct.

Response

This response will be addressed in the nine month submittal.

3.0 Summary

A response to specific items of D. G. Eisenhut's December 22, 1980, letter and NUREG-0612 "Control of Heavy Loads" has been provided. The report has identified the cranes at the Kewaunee Nuclear Power Plant, their primary function, the loads handled by the cranes and the safeguards equipment in the vicinity of these cranes.

ATTACHMENT 1

ATTACHMENT 1

OVERHEAD HANDLING SYSTEMS

A. Elevation - 586'0" (Drawing No. CHL-3)

1. Outside trolley over traveling water screen gates No. 1-4
2. Inside trolley over traveling water screen gates No. 1-2
3. 1A circulating water pump gate hoist No. 1-1
4. 1B circulating water pump gate hoist No. 1-3
5. Monorail over diesel generator 1A
6. Monorail over diesel generator 1B
7. Hoist over main feedwater pumps
8. Trolley over residual heat removal pumps
9. Boric acid concentrates filter hoist
10. Radwaste handling crane

B. Elevation - 606'0" (Drawing No. CHL-2)

11. Maintenance shop crane
12. Electric shop crane
13. Filter room hoist

C. Elevation - 626'0" and 633'6" (Drawing No. CHL-1)

14. Decontamination room crane
15. Spent fuel filter trolley
16. Spent fuel pool bridge and hoist
17. Reactor cavity manipulator crane
18. Reactor building galion crane

D. Other (Drawing No. CHL-1)

19. Turbine building crane
20. Auxiliary building fuel handling crane
21. Annulus trolley
22. Reactor building polar crane

ATTACHMENT 2

ATTACHMENT 2

LIST OF OVERHEAD HEAVY LOAD HANDLING SYSTEMS
IN THE VICINITY OF SAFE SHUTDOWN EQUIPMENT

5. Monorail over Diesel Generator 1A
6. Monorail over Diesel Generator 1B
8. Trolley over residual heat removal pumps
16. Spent fuel pool bridge and hoist
17. Reactor cavity manipulator crane
19. Turbine building crane
20. Auxiliary building fuel handling crane
22. Reactor building polar crane

ATTACHMENT 3

ATTACHMENT 3

KEWAUNEE NUCLEAR POWER PLANT

SURVEY OF HEAVY LOADS

Crane	Loads Handled	Approximate Weight	Designated Lifting Device	Over (O) or Only Proximity (P) to Fuel	Procedures Yes/No	Frequency Handled
1. Auxiliary Building	1. Spent Fuel Shipping Cask	30 Tons	N.A.	(P)		---
	2. Pool Divider Gates	2 Tons	N.A.	(P)	Yes	2x's (per re-fueling)
	3. Radwaste Drums	3.5 Tons	N.A.	(P)	Yes	12x's (per year)
	4. Missile Shield a. Shield Wall Air Lock	7.5 Tons	Slings	(P)	No	2x's (per re-fueling)
	b. Drumming Station	16 Tons	Slings	(P)	No	12x's (per year)
	c. Waste Evaporator	20 Tons	Slings	(P)	No	Once per 20 years
	d. Demineralizers Removable Slabs	2 @ 6 Tons 1 @ 5 Tons 1 @ 4 Tons	Slings	(P) (P) (P)	No	Once per 15 years Once per 15 years Once per 15 years
	5. New Fuel Shipping Containers	2 - 2½ Tons	Slings	(P)	Yes	20 Containers (Per Refueling)
	6. Radwaste Cask Lid	4.2 Tons	N.A.	(P)	Yes	12x's (per year)
	7. Test Weights - Fuel Handling Bridge Crane	1.5 Tons 2 Tons	N.A.	(P) (P)	Yes Yes	2 x's (per year) 2 x's (per year)
	8. Crane Load Block	3.5 Tons	N.A.	(O)		---
	9. Irradiated Specimen Shipping Cask	7 Tons		(P)	Yes	5x's over life of plant
	10. Filter Shield Cask	7.5 Tons		(P)		Once x (per 5 years)

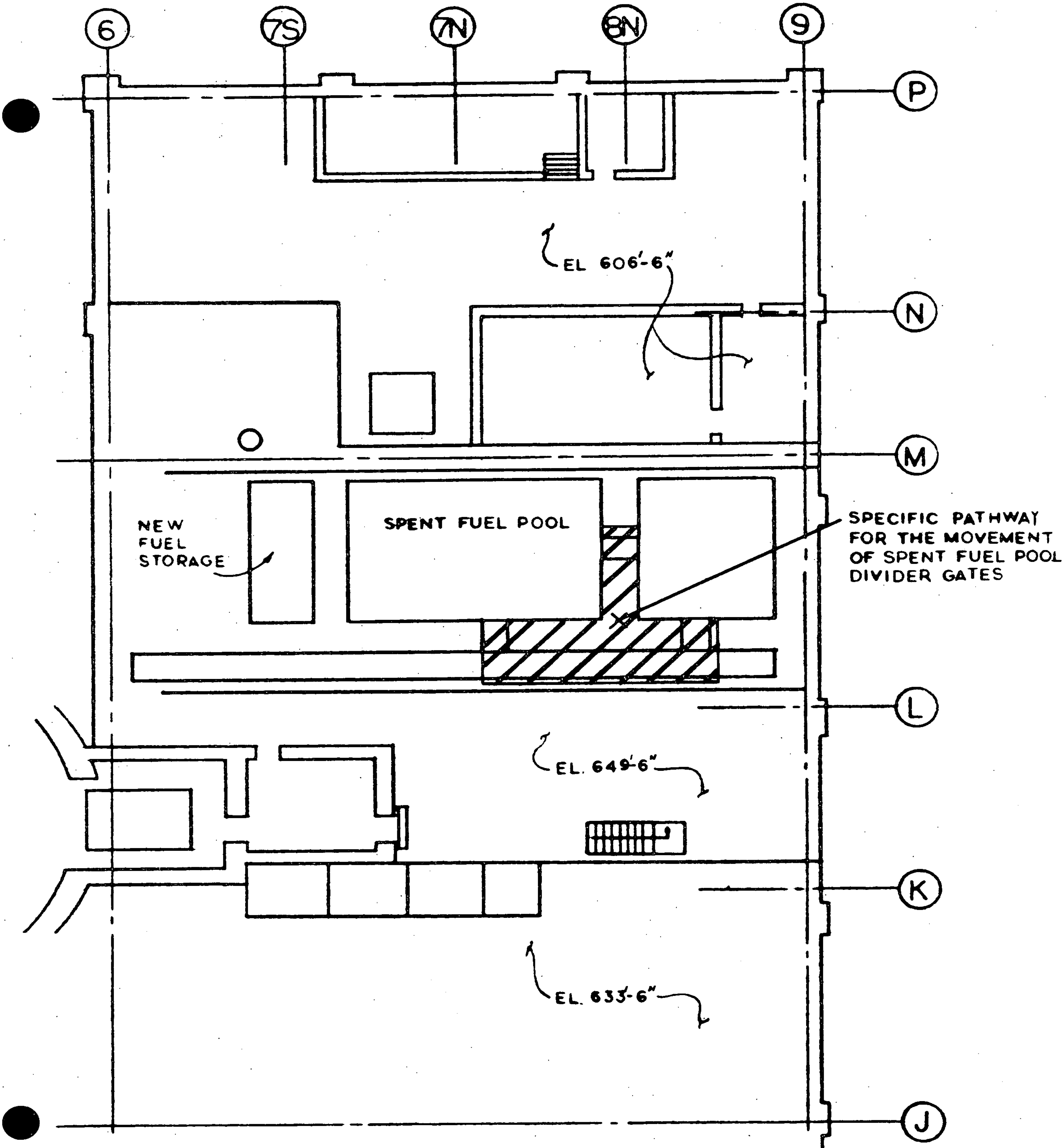
ATTACHMENT 3

KEWAUNEE NUCLEAR POWER PLANT

SURVEY OF HEAVY LOADS

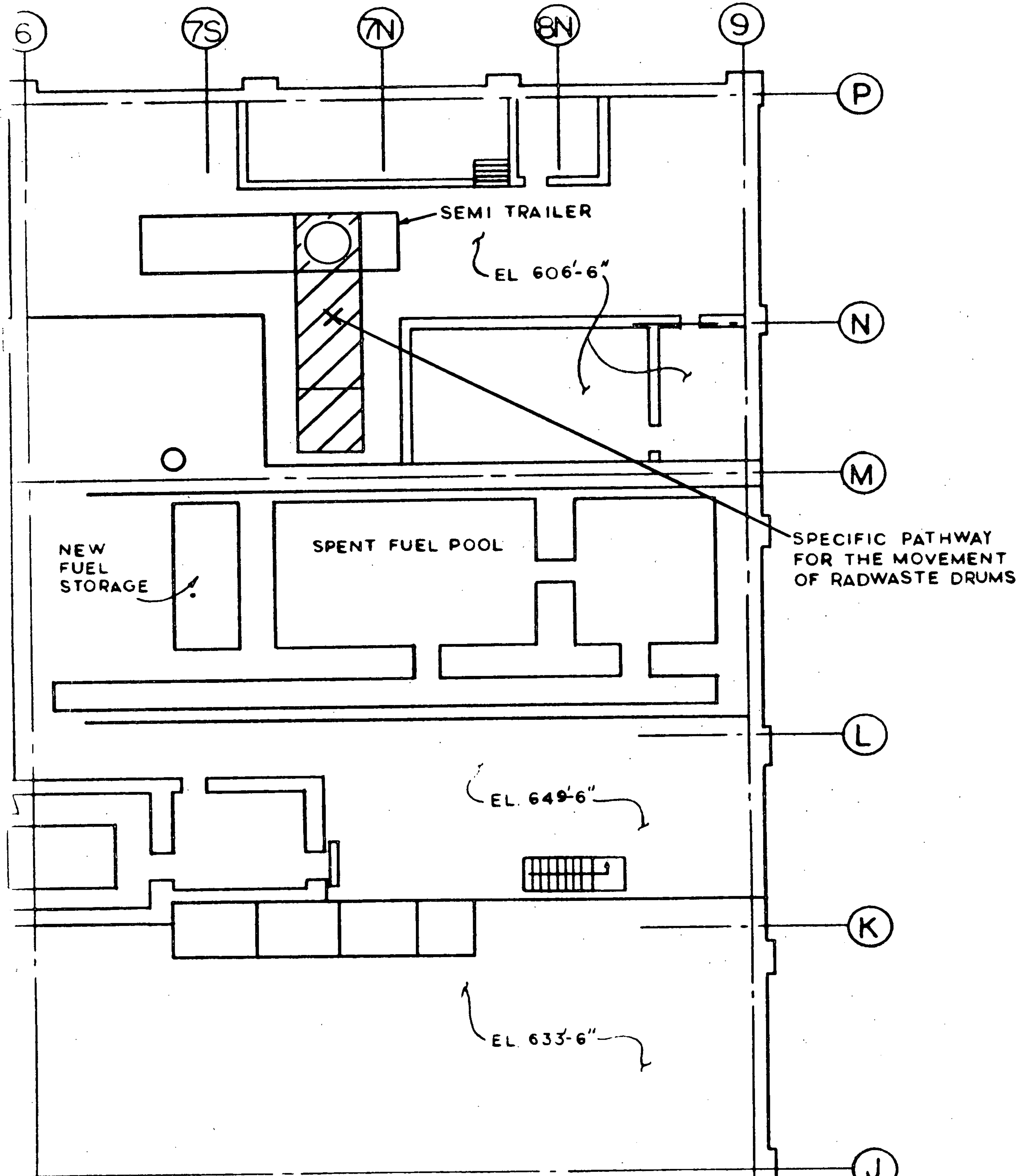
Crane	Loads Handled	Approximate Weight	Designated Lifting Device	Over (0) or Only Proximity (P) to Fuel	Procedures Yes/No	Frequency Handled
2. Containment Polar Crane	1. Reactor Vessel Head	80 Tons	Reactor Head Lifting Rig	(O)	Yes	2x's (per refueling)
	2. Rx Vessel Upper Internals	28 Tons	Reactor Internals Lifting Rig	(O)	Yes	2x's (per refueling)
	3. Rx Vessel Lower Internals		Reactor Internals Lifting Rig	(P)	Yes	4x's over life of plant
	4. Inservice Inspection Tool	4.5 Tons		(P)	Yes	4x's over life of plant
	5. Reactor Coolant Pump					
	a. Motor	32 Tons	RCP Lifting Rig	(P)	Yes	10x's per pump over life of plant
	b. Flywheel	6.6 Tons	Slings	(P)	No	As required
	c. Shaft and Impeller	4 Tons	RCP Lifting Rig	(P)	Yes	10x's per pump over life of plant
	6. Missile Shield					
	a. Reactor Vessel	20 Tons	Reactor Head Lifting Rig	(O)	No	2x's (per refueling)
	b. Pressurizer	18 Tons	Reactor Head Lifting Rig	(P)	No	2x's (per refueling)
	7. Reactor Vessel Studs (In handling box)	Tons	Slings	(P)	No	2x's (per refueling)

ATTACHMENT 4



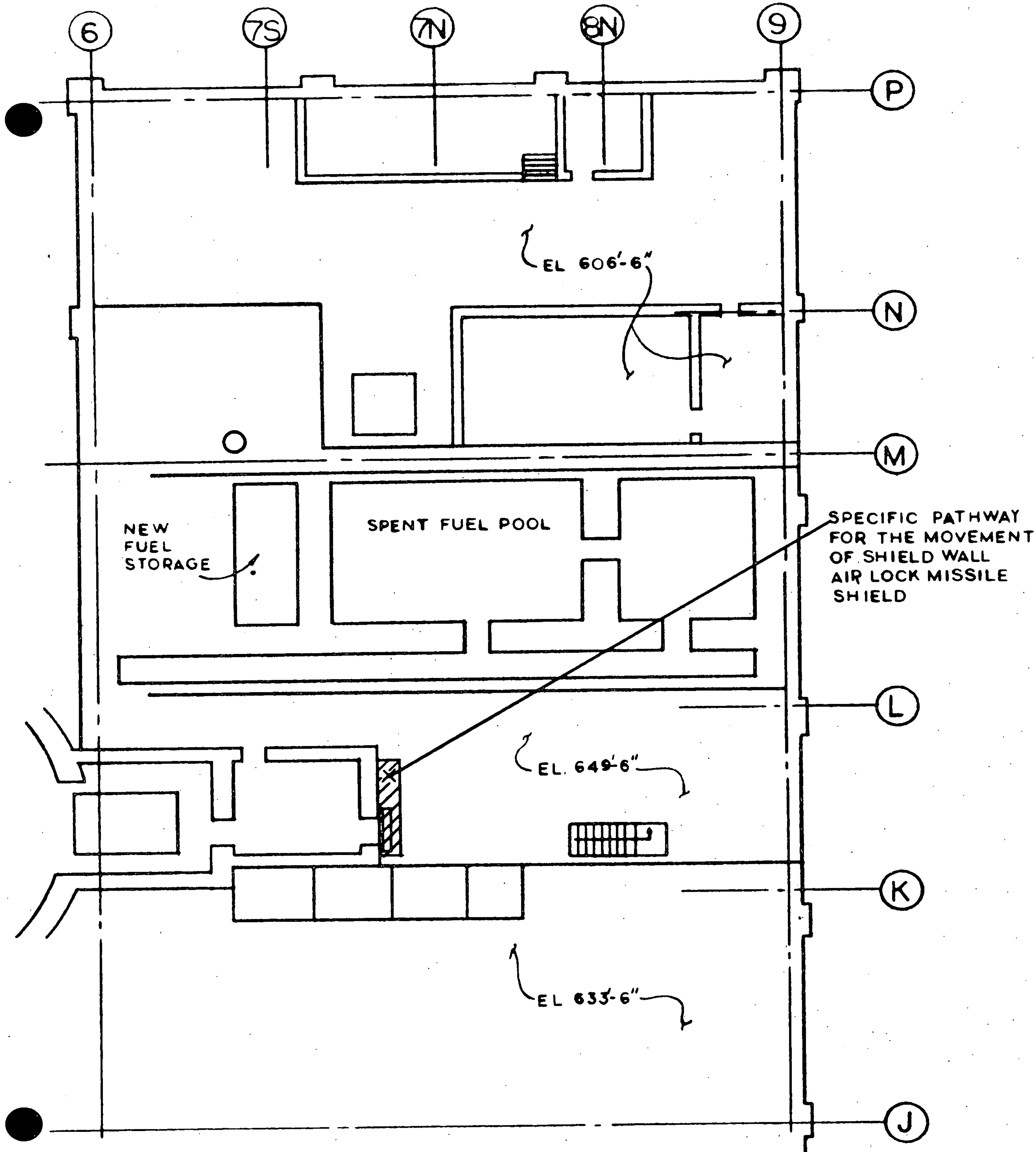
CONTROL OF HEAVY LOADS
AUXILIARY BUILDING FUEL HANDLING CRANE

SKETCH NO. ABC-1



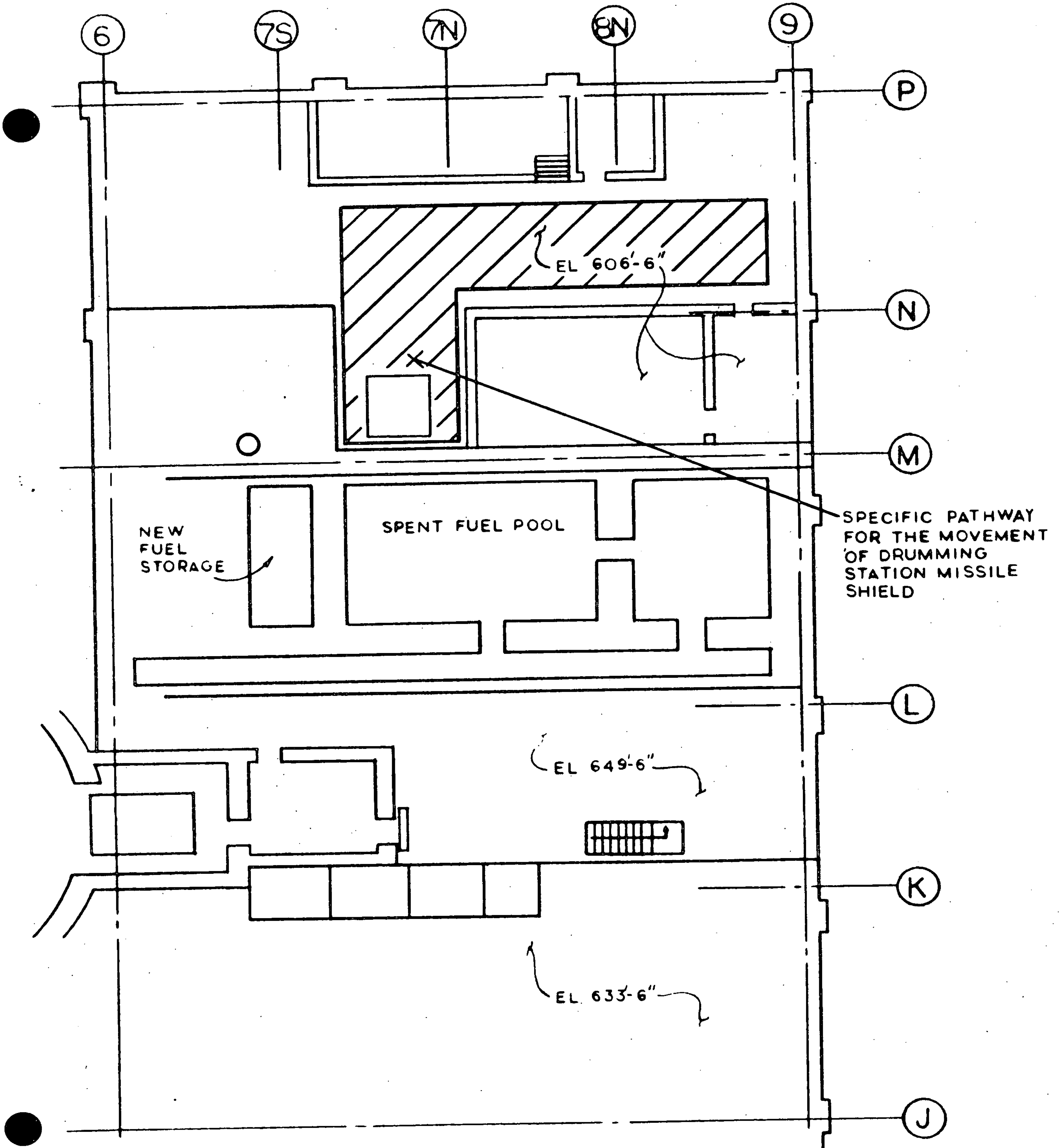
CONTROL OF HEAVY LOADS
AUXILIARY BUILDING FUEL HANDLING CRANE

SKETCH NO. ABC-2



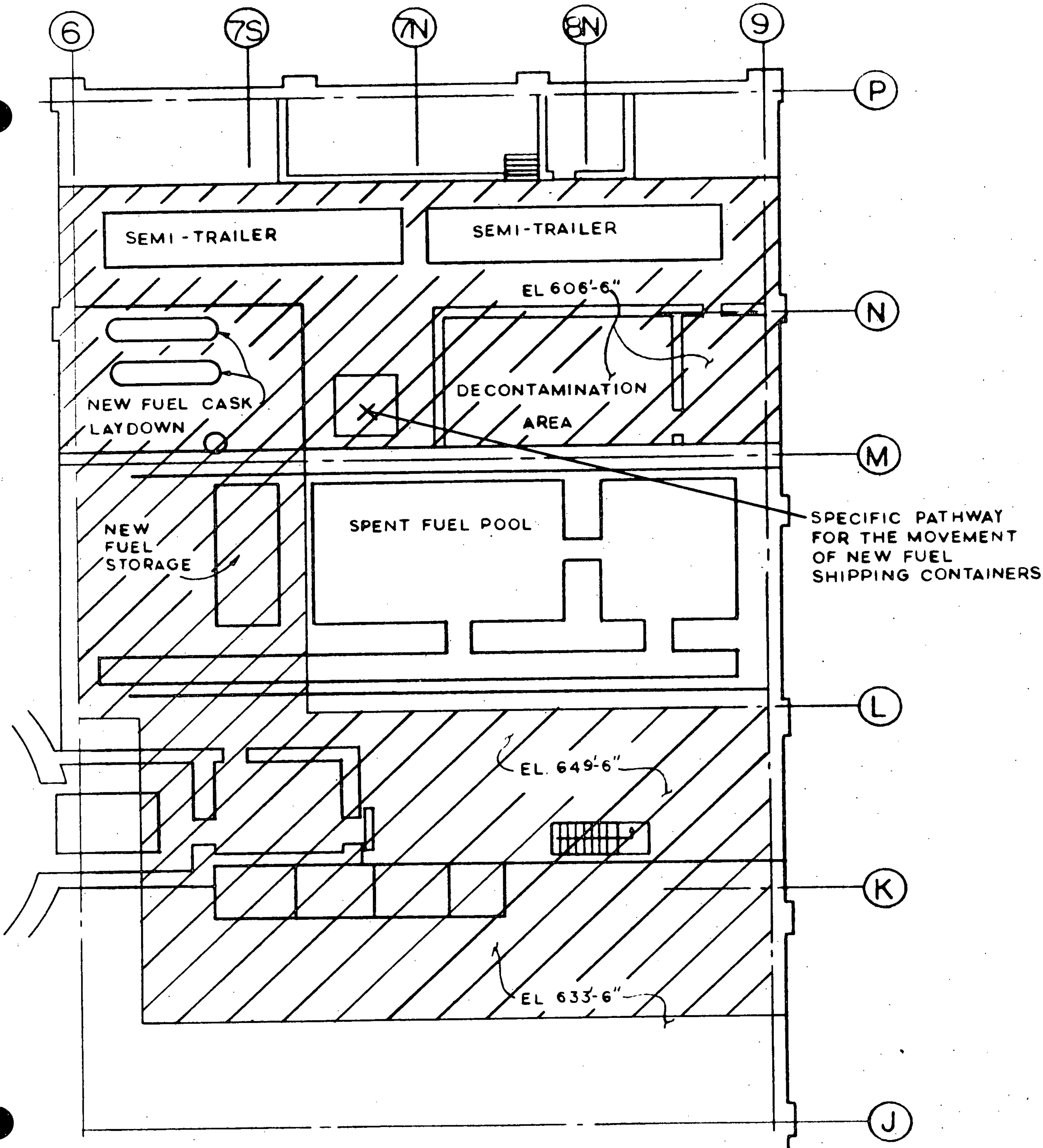
CONTROL OF HEAVY LOADS
AUXILIARY BUILDING FUEL HANDLING CRANE

SKETCH NO ABC-3



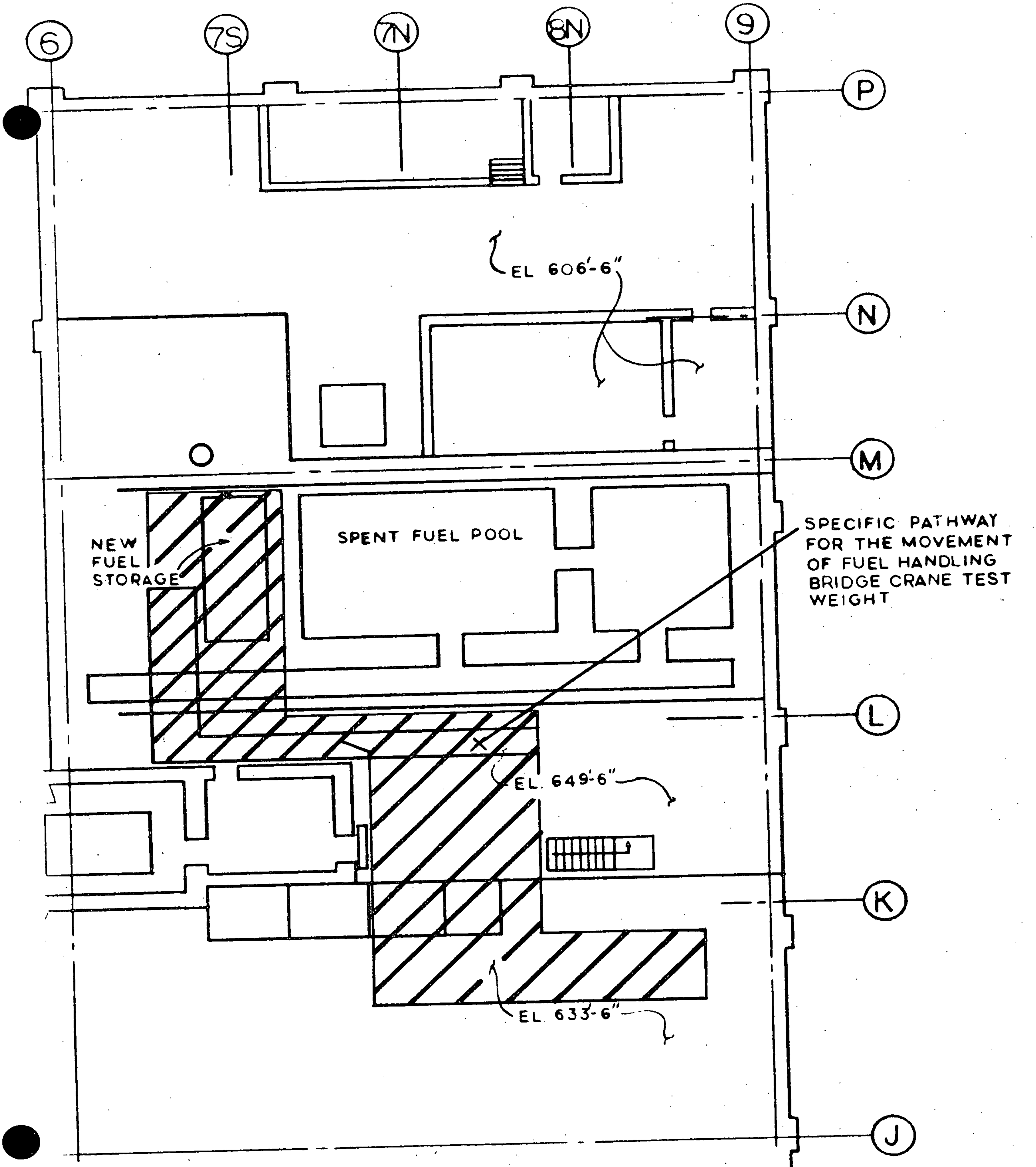
CONTROL OF HEAVY LOADS
AUXILIARY BUILDING FUEL HANDLING CRANE

SKETCH NO. ABC-4



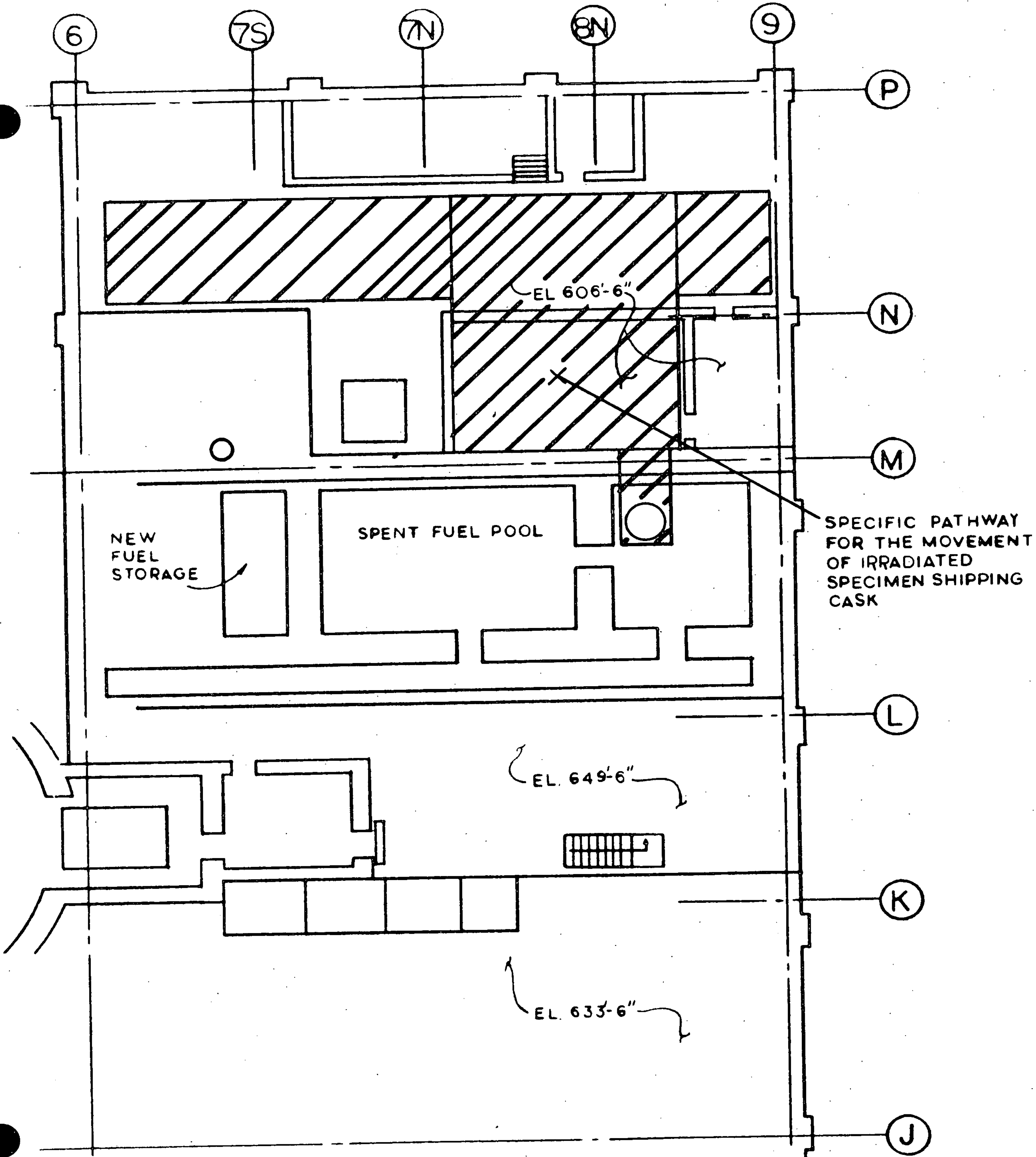
CONTROL OF HEAVY LOADS
AUXILIARY BUILDING FUEL HANDLING CRANE

SKETCH NO. ABC-5



CONTROL OF HEAVY LOADS
AUXILIARY BUILDING FUEL HANDLING CRANE

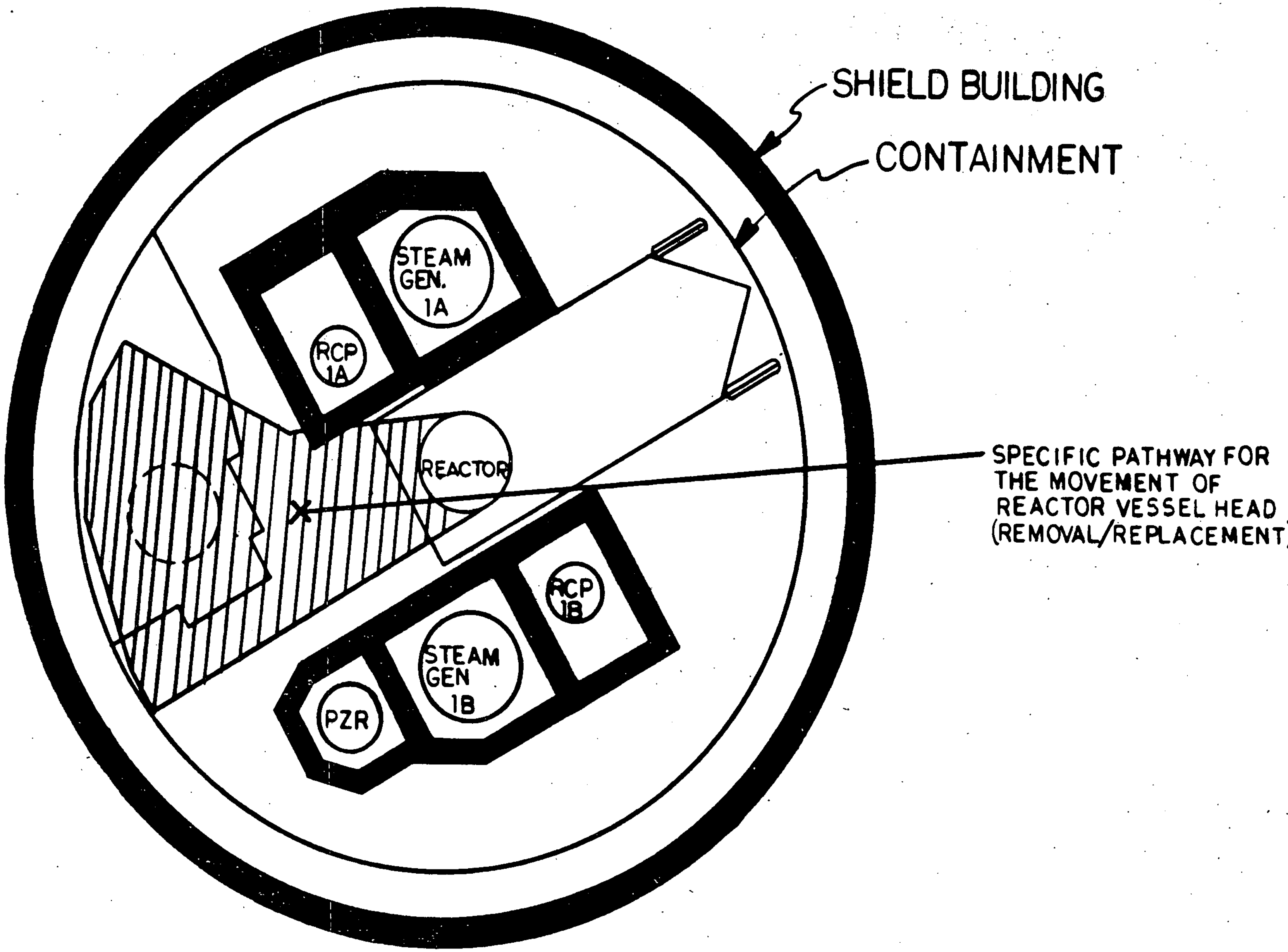
SKETCH NO. ABC-6



CONTROL OF HEAVY LOADS
AUXILIARY BUILDING FUEL HANDLING CRANE

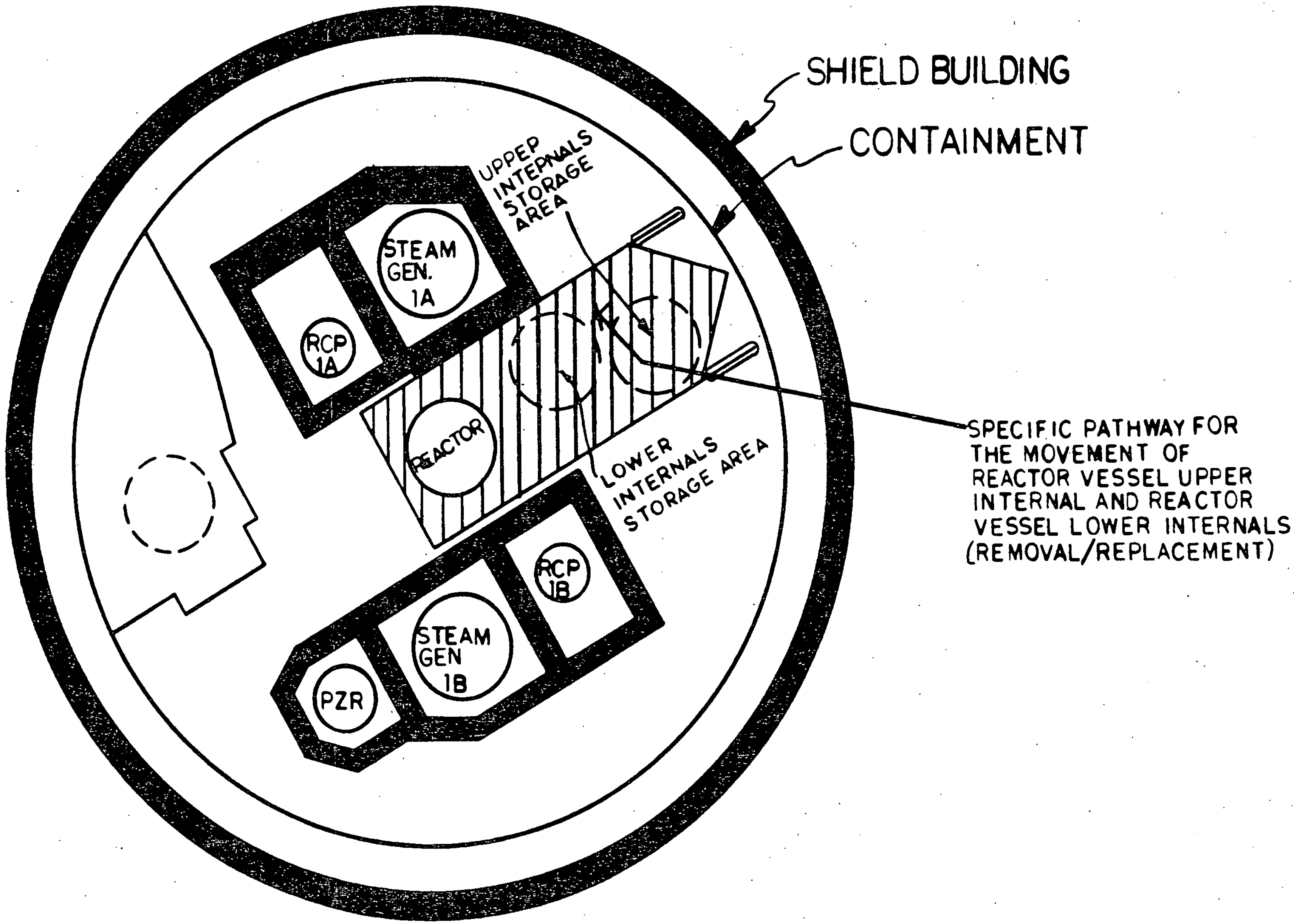
SKETCH NO. ABC-7

CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



SKETCH NO. CPC-1

CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



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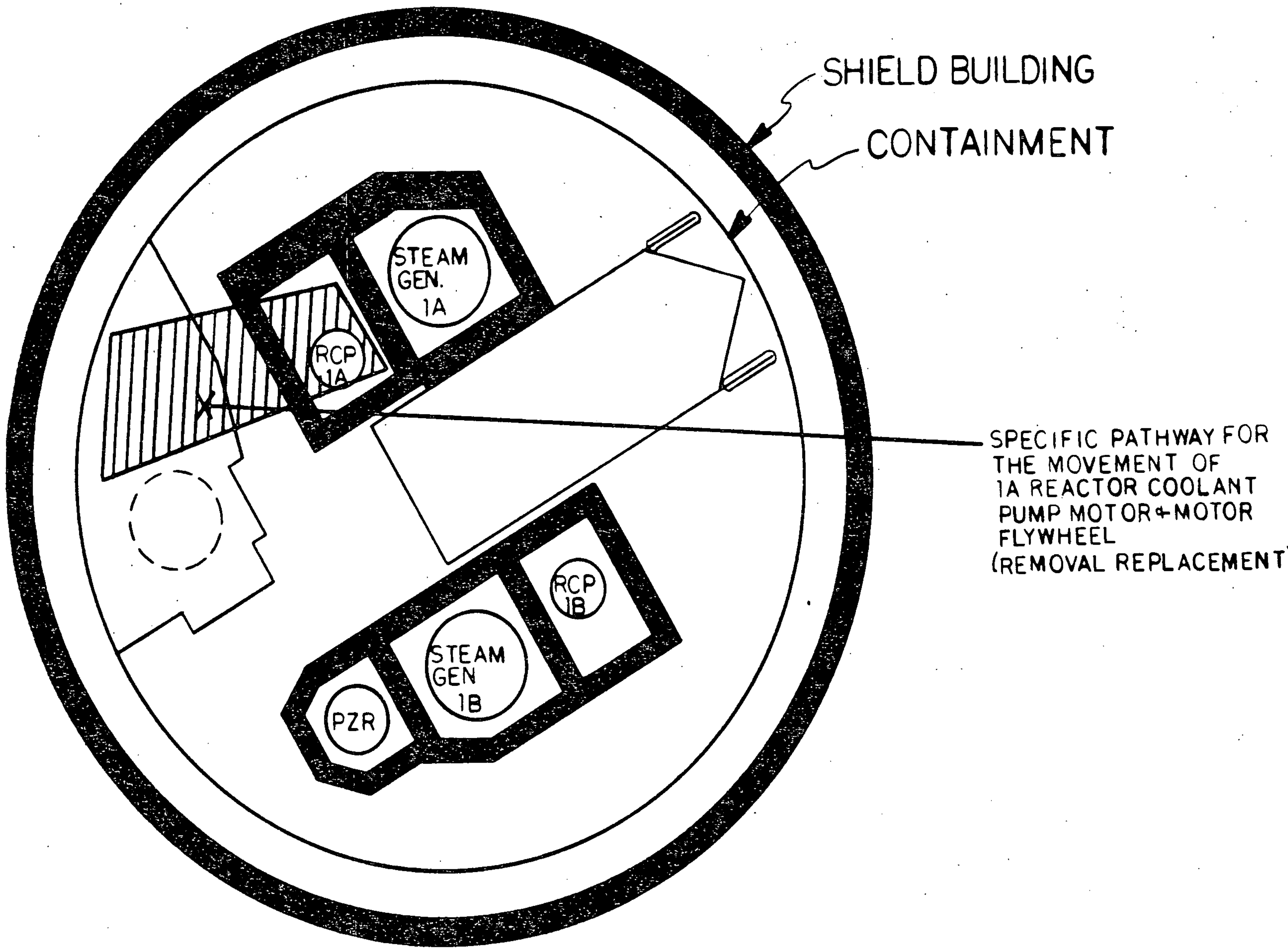
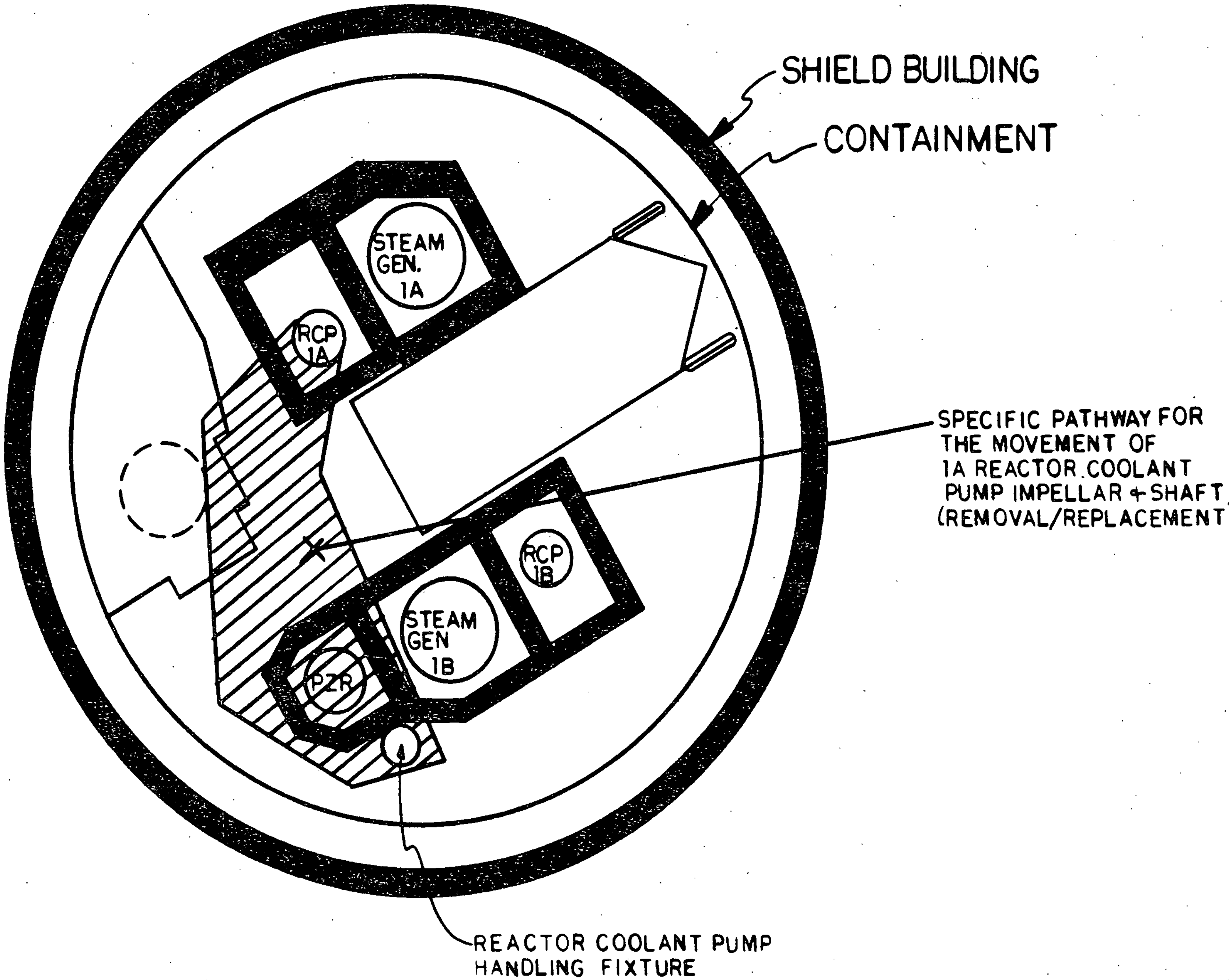
CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



SKETCH NO. CPC-3

CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



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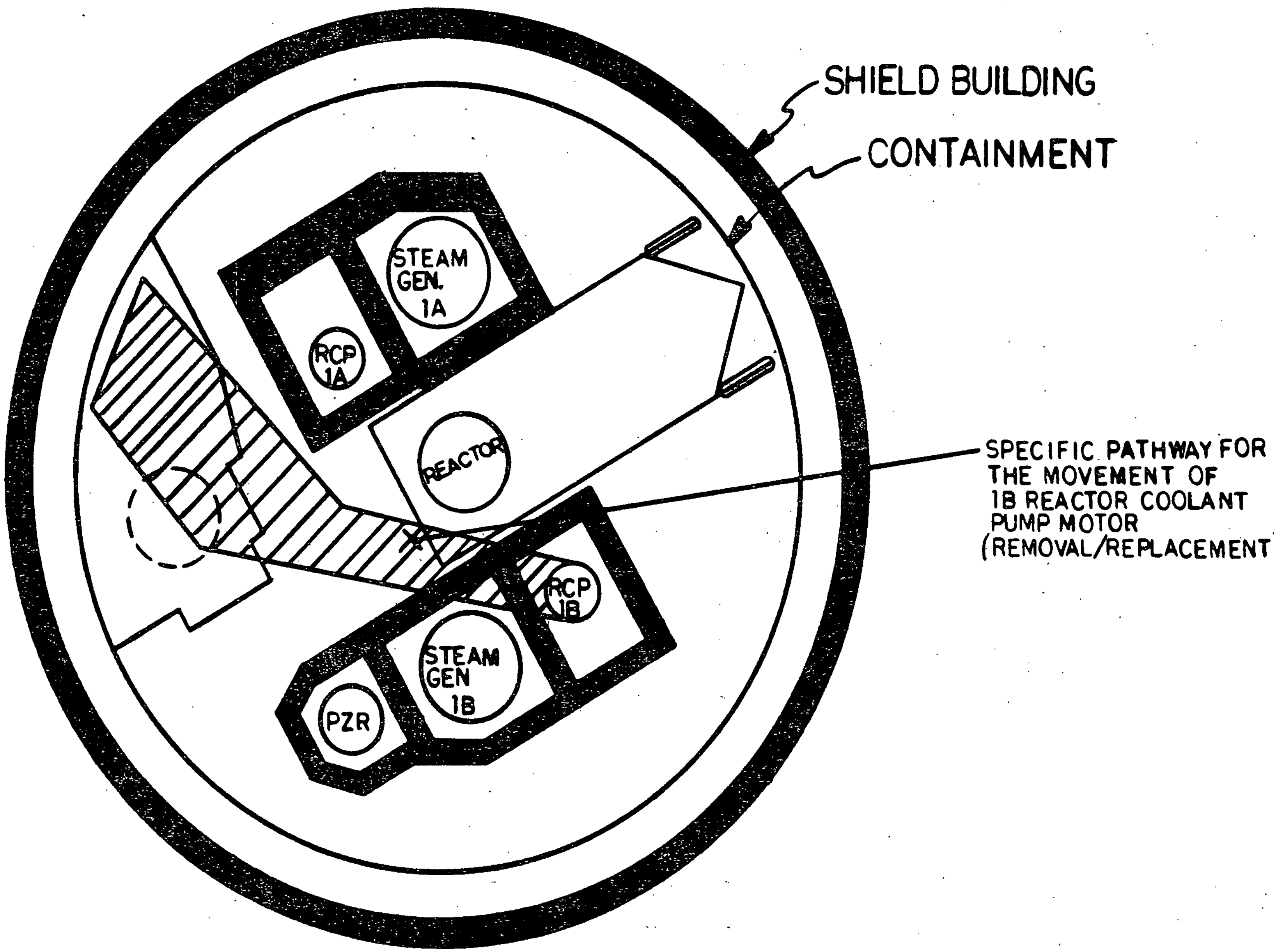
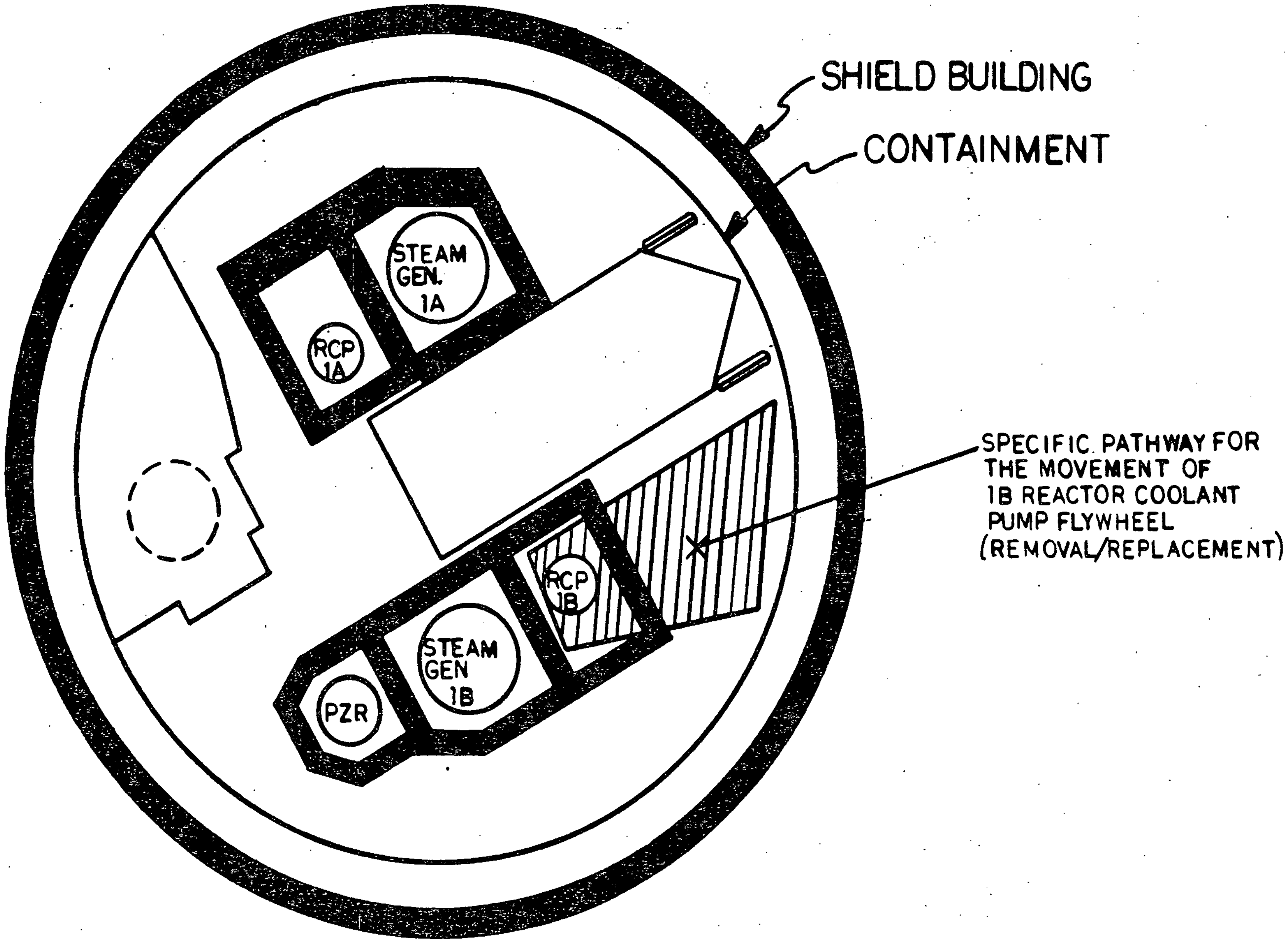
CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



SKETCH NO. CPC-5

CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



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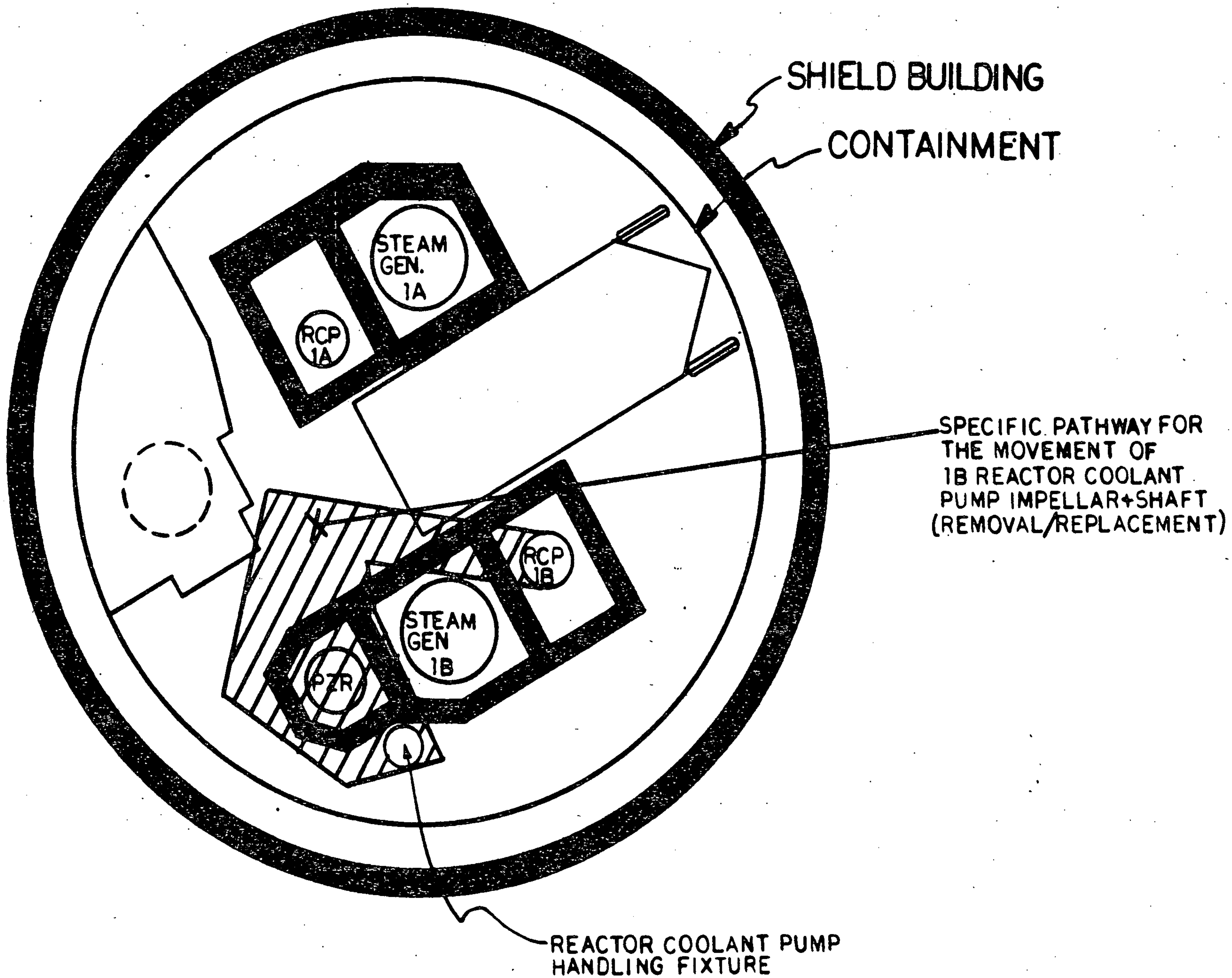
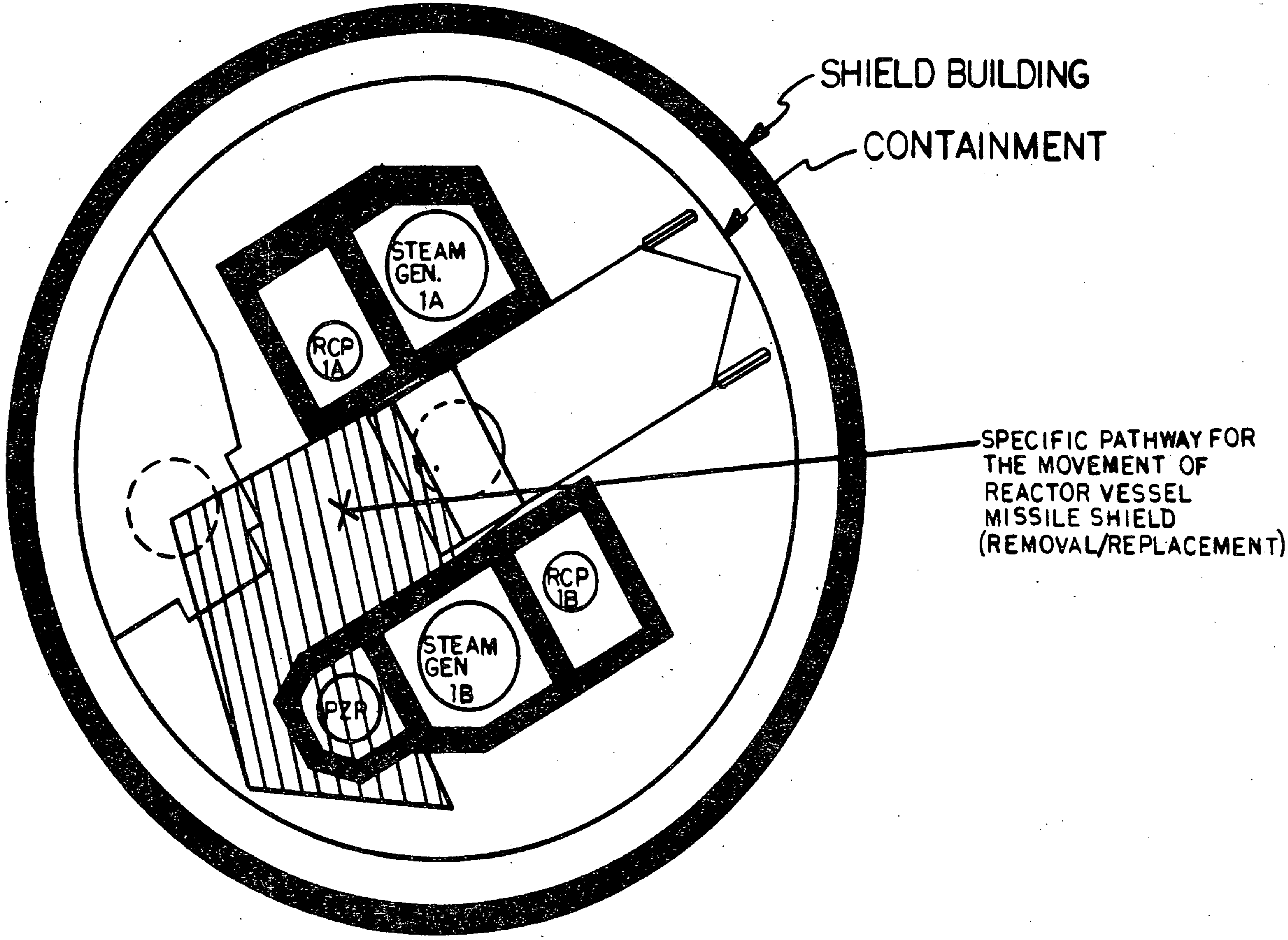
CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



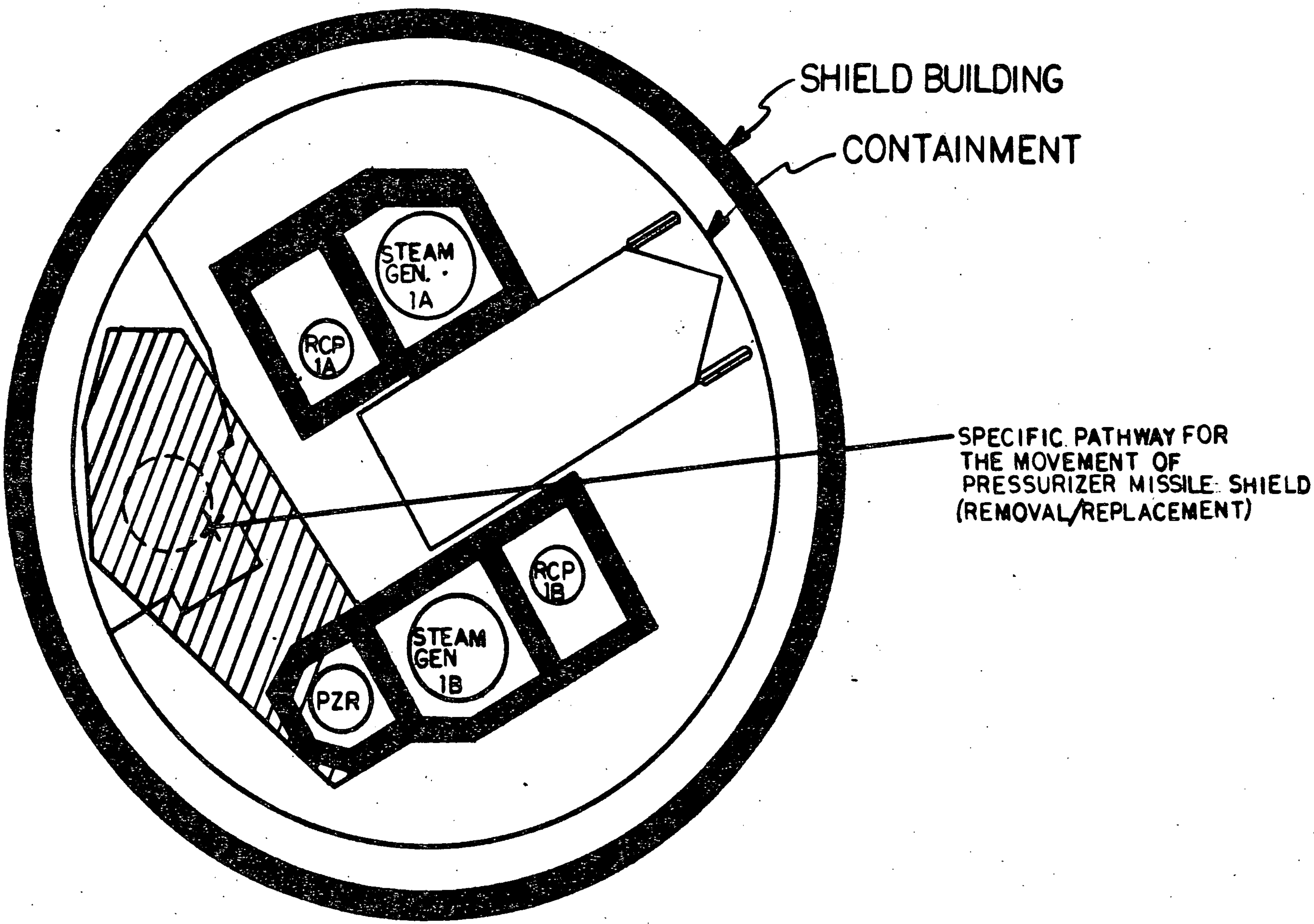
SKETCH NO. CPC-7

CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



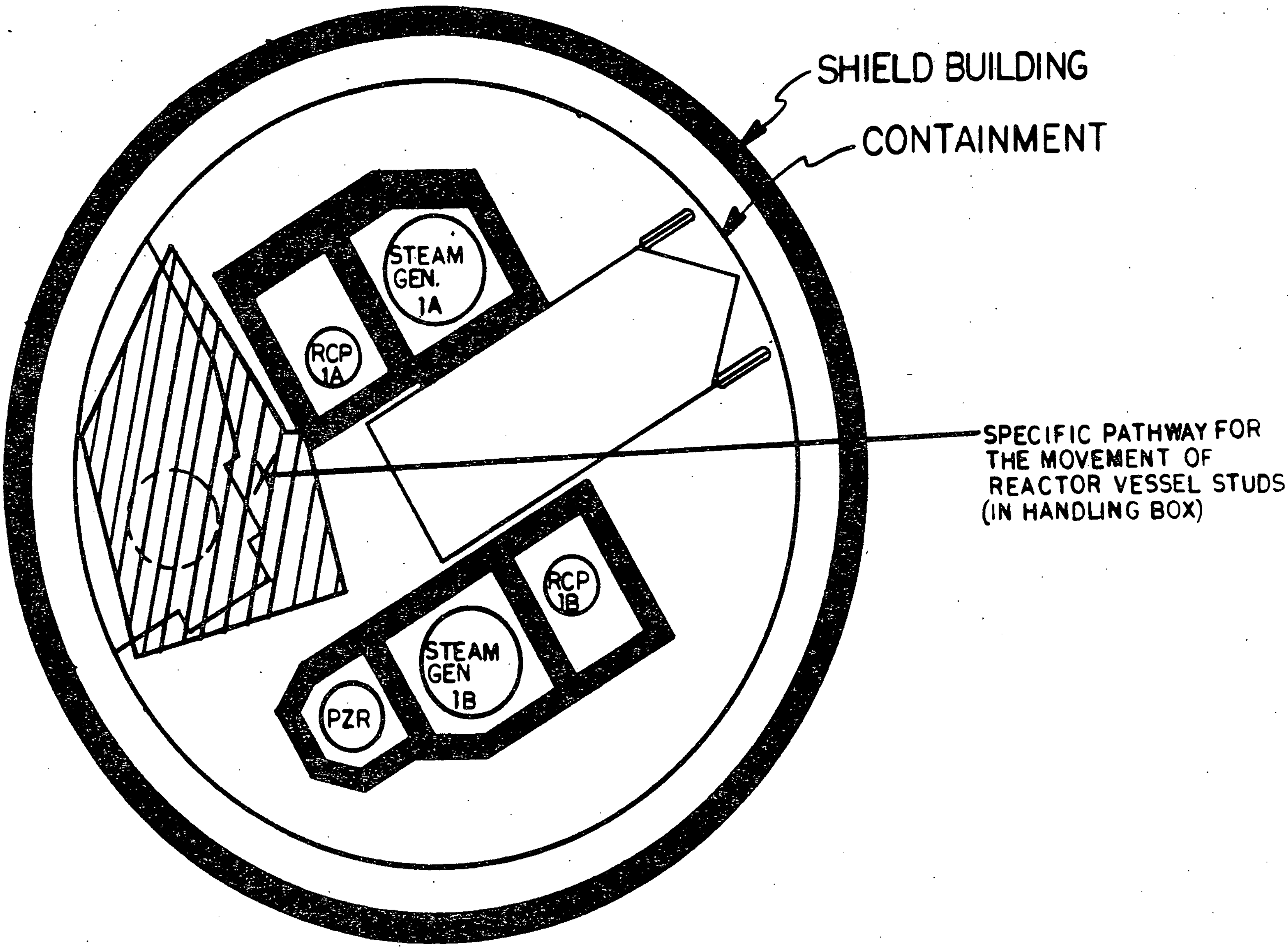
SKETCH NO. CPC-8

CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



SKETCH NO. CPC-9

CONTROL OF HEAVY LOADS
CONTAINMENT POLAR CRANE



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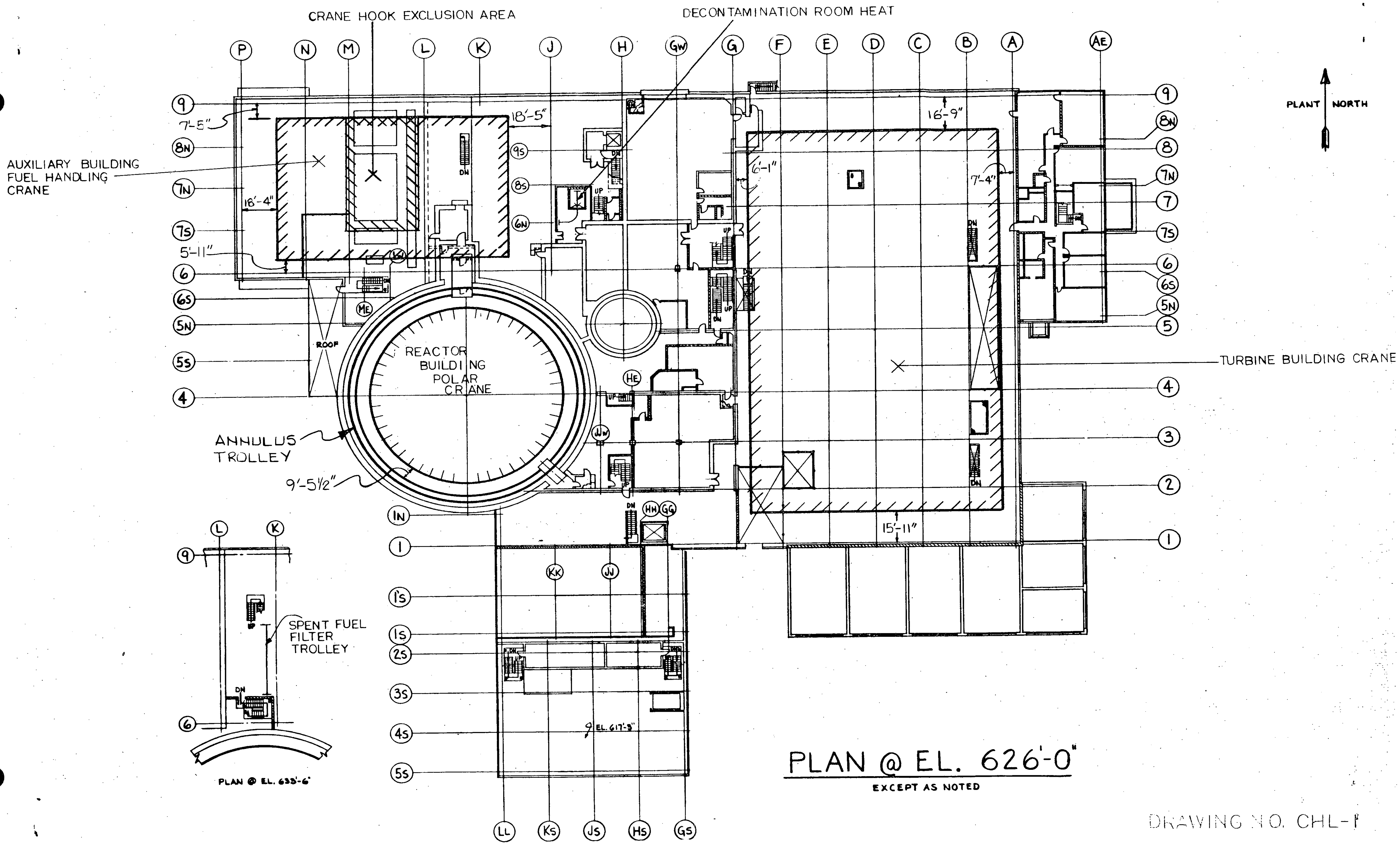
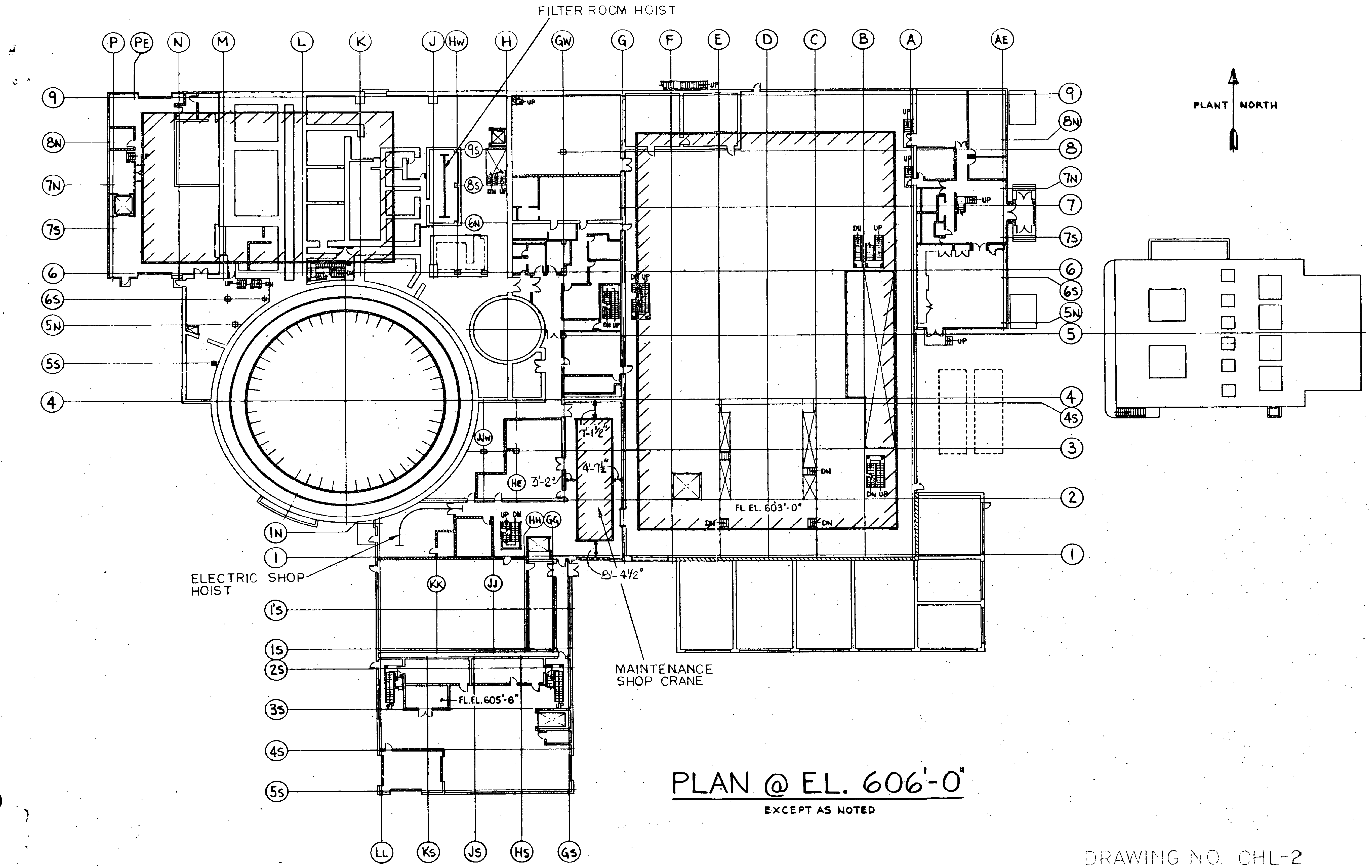


PLAN @ EL. 626'-0"

EXCEPT AS NOTED

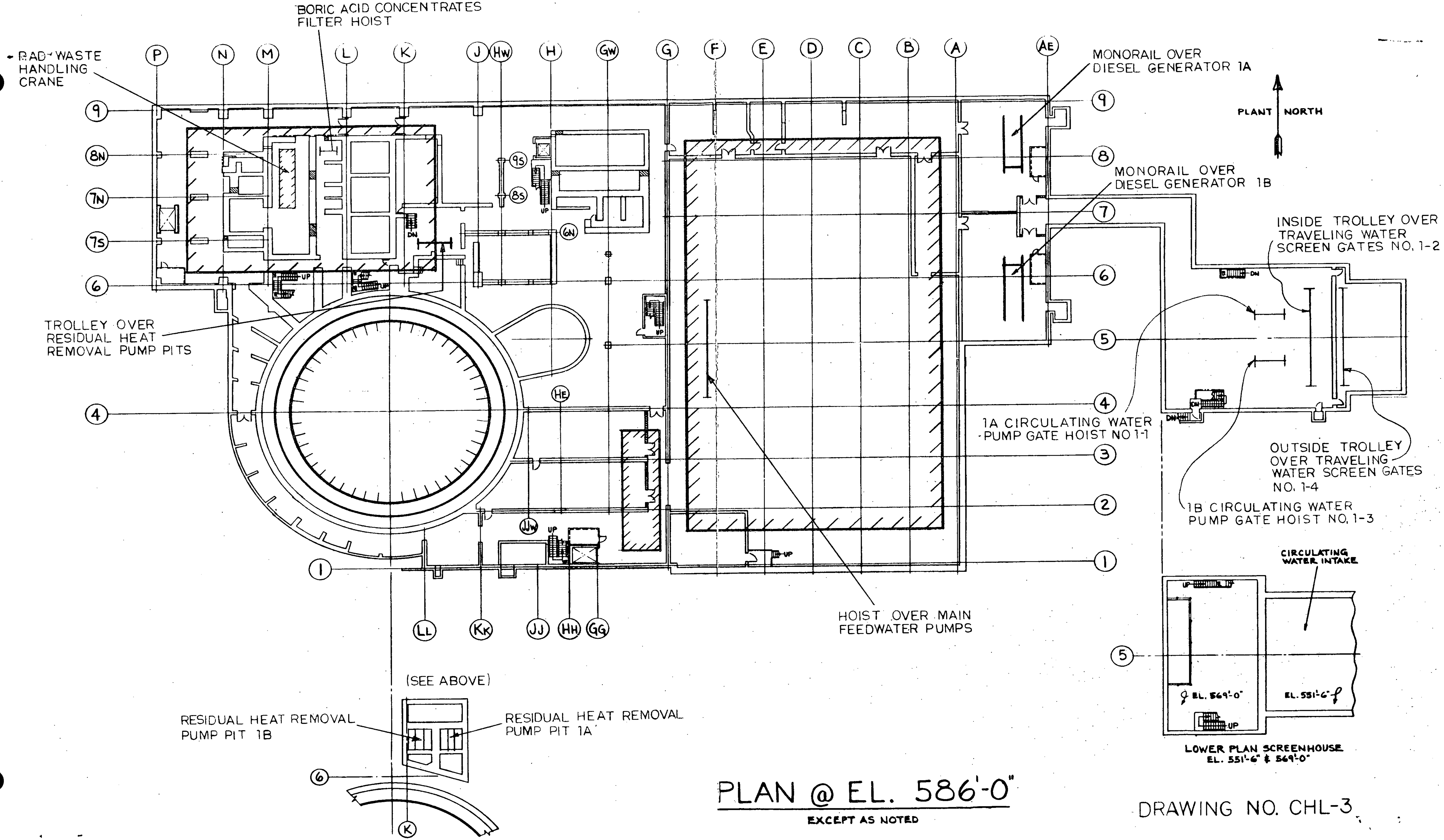
DRAWING NO. CHL-1



PLAN @ EL. 606'-0"

EXCEPT AS NOTED

DRAWING NO. CHL-2



PLAN @ EL. 586'-0"

EXCEPT AS NOTED

DRAWING NO. CHL-3