CONTROL

OF

HEAVY LOADS

Northeast Utilities Service Company
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This report is in response to NRC letters of December 22, 1980, and February 3, 1981, requesting information concerning the handling of heavy loads at Millstone 3. Specifically, the reference letters requested information from Applicants for operating licenses via Enclosure 3. This report is intended to address Items 2.1 through 2.4 of Enclosure 3 as required.

2.1 GENERAL REQUIREMENTS FOR OVERHEAD HANDLING SYSTEMS

NUREG-0612, Section 5.1.1, identifies several general guidelines related to the design and operation of overhead load-handling systems in the areas where spent fuel is stored, in the vicinity of the reactor core, and in other areas of the plant where a load drop could result in damage to equipment required for safe shutdown or decay heat removal. Information provided in response to this section should identify the extent of potentially hazardous load-handling operations at a site and the extent of conformance to appropriate load-handling guidance.

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 heat removal taking no credit for any interlocks, Technical Specifications, operating procedures, or detailed structural analysis.

Response:

APPLICABLE OVERHEAD LOAD HANDLING SYSTEMS

Equipment No.	Identification	Location
3MHR-CRN1	Polar Crane	Containment
3MHF-CRN1	Spent Fuel Shipping Cask Trolley	Fuel Building
3MHF-CRN2	New Fuel Handling Crane	Fuel Building
3MHF-CRN3	New Fuel Receiving Crane	Fuel Building
3MHF-CRN4	Fuel Building Decontamination Crane	Fuel Building
3MHP-CRN1	Auxiliary Building Filter Handling Crane/Monorail	Auxiliary Building
3MHP-CRN2A,B,C	Auxiliary Building Charging Pump Trolley	Auxiliary Building
(-)	Reactor Plant Component Cooling Water Heat Exchanger Monorail	Auxiliary Building
3MHS-CRNB1	Spent Fuel Bridge and Hoist	Fuel Building

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 components 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:

EXCLUDED OVERHEAD LOAD HANDLING SYSTEMS

Mark No.	Identification and Reason
3MHT-CRN-1A,B	Turbine Room Traveling Crane - This crane is located in the turbine building which does not contain any safety-related equipment or systems.
3MHT-CRN-2	Condenser Waterbox Removal Hoist Arrangement - This crane is located in the turbine building which does not contain any safety-related equipment or systems.
3MHT-CRN-3A,B	Turbine Building Strainer Removal Trolley - This trolley is located in the turbine building which does not contain any safety-related equipment or systems.
3MHT-CRN-1	Waste Disposal Building Crane - This crane is located in the waste disposal building which does not contain any safety-related equipment or systems.
3MHT-CRN-3	Auxiliary Building and Waste Disposal Building Filter Handling Monorail - This monorail is in the waste disposal building which does not contain any safety-related equipment or systems and the auxiliary building where a load drop would not result in damage to any system or equipment required for normal plant shutdown.
3MHJ-CRN-4	Waste Disposal Building Demineralizer Removal Hoist - This hoist is located in the waste disposal building which does not contain any safety-related equipment or systems.
3MHJ-CRN-5A,B	Waste Disposal Building Equipment Hatch Trolley - This trolley is located in the waste disposal building which does not contain any safety-related equipment or systems.
3MHZ-CRN-1	Service Building Machine Shop Crane - This crane is in the service building which does not contain any safety-related equipment or systems.
3MHZ-CRN-2	Machine Shop Decontamination Area Trolley - This trolley is located inside the service building which does not contain any safety-related equipment or systems.

Mark No.	Identification and Reason
3HMZ-CRN-3	Machine Shop Weld Area Trolley - This trolley is inside the service building which does not contain any safety-related equipment or systems.
3MHW-CRN-1	Lateral Stop-Log and Trash Cart Monorail - This monorail is located inside the pump house where a load drop would not result in damage to any system or equipment required for normal plant shutdown.
3MHW-CRN-2	Main Stop-Log Hoist Arrangement - This monorail is in the pump house where a load drop would not result in damage to any system or equipment required for normal plant shutdown.
3MHW-CRN-3	Pump House Auxiliary Hoist - This hoist is located in the pump house in an area where a load drop would not result in damage to any system or equipment required for normal plant shutdown.
3MHR-CRN-2	Sigma Refueling Machine - This crane is located inside the reactor containment building. The maximum load this crane will lift is a fuel element with its handling tool. This, by definition (NUREG-0612), is not classified as a heavy load.
3MHR-CRN3A-D	Steam Generator Wall Jib Crane - The travel area of these fixed cranes is such that they cannot carry heavy loads over or near the reactor vessel.
3MHJ-CRN-3	Auxiliary Building/Waste Disposal Building Filter Handling Monorail - This monorail is located in the auxiliary and waste disposal buildings in an area where a load drop would not result in damage to any system or equipment required for normal plant shutdown.
3MHP-CRN-3	Auxiliary Building Equipment Hatch Trolley - This trolley is located in the auxiliary building in an area where a load drop would not result in damage to any system or equipment required for normal plant shutdown.
3MHR-CRN-4,5	Steam Generator Access Platform Jib Crane - This crane is equipped with a load cell, trolley travel limit switch and boom rotation limit switch to limit the load lift over the refueling cavity area to 1800 pounds.

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:

2.1.3a Drawings or sketches sufficient to clearly identify the location of safe load paths, spent fuel, and safety-related equipment.

Response:

Figures 1 through 7 identify, as much as practical, the location of safe load paths, spent fuel, and safe shutdown equipment in the areas of concern.

The safe load paths shown on these figures will not be permanently marked on the plant flooring. This is due to the possibility that when loads are being moved, the flooring may be covered with disposable polyvinyl sheeting. In lieu of the permanent markings a supervising load director will be available to verify the load path and help direct the crane operator.

2.1.3b A discussion of measures taken to ensure that load-handling operation remain within safe load paths, including procedures, if any, for deviation from these paths.

Response:

Administrative procedures will include the general guidelines and evaluation requirements of NUREG-0612. Load-handling operational procedures will be written as necessary in accordance with the guidelines of NUREG-0612 as noted in this submittal. The safe load paths shown in this report will be used as the load-handling paths. Any deviation from defined load paths will require written alternative procedures approved by the Plant Operations Review Committee.

2.1.3c 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:

Table 1 provides a list of heavy loads that will be carried by each crane along with any designated lifting devices. Procedures for the lifting of all heavy loads will incorporate the guidance of NUREG-0612.

2.1.3d Verification that lifting devices identified in 2.1.3c 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:

WCAP-10669, Evaluaton of the Acceptability of the Reactor Vessel Head Lift Rig, Reactor Vessels Internals Lift Rig, Load Cell, and Load Cell Linkage to the Requirements of NUREG-0612 is provided as a separate enclosure. This is provided as a supplement to NUSCo's submittal (to the NRC) of NUREG-0612, Control of Heavy Loads report as a response to Items 2.3.4, Special Lifting Devices, with the following exceptions:

- Table 2-1, page 2-8, lists Fel/pro N-1000 as a lubricant on the vessel head lift rig. Millstone 3 will use Fel/pro N-5000 as an alternative.

- Table 2-1, page 2-12, states "Weld repairs should be performed in accordance with the requirements identified in NF-4000 and NF-5000 (Fabrication and Examination) of the ASME Boiler and Pressure Vessel Code Section III, Division I, Subsection NF." Millstone 3 will perform weld repairs in accordance with Article IWB-4000 (Repair Procedures) of the ASME Boiler and Pressure Vessel Code, Section XI.

2.1.3e 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:

Crane inspection, testing, and maintenance procedures will comply with the intent of the guidelines of ANSI B30.2-1976, Chapter 2-2. Should any deviations from this standard be required, they will be equivalent to the requirements of ANSI B30.2-1976.

2.1.3f 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 are not provided.

Response:

The containment polar crane (3MHR-CRN1), the spent fuel shipping cask trolley (3MHF-CRN1), the new fuel receiving crane (3MHF-CRN3), and the decontamination area crane (3MHF-CRN4) have been designed to meet the criteria and guidelines of CMAA-70, Specification for Electrical Overhead Traveling Cranes, and ANSI B30.2-1967. Although these cranes have been designed to the 1967 ANSI standard, they have been reviewed for compliance with the 1976 standard and there are no significant differences between the two ANSI standards which would affect the operation of the cranes. The new fuel handling crane (3MHF-CRN2) has been designed to comply with the guidelines of CMAA-70 and ANSI B30.2-1976.

The balance of the load-handling devices are not cranes, so CMAA-70 and ANSI B30.2-1976 were not used in their design. Instead, ANSI B30.11, Standard Monorail System and Underhung Cranes, and ANSI B30.16, Standard Overhead Hoists, were used.

2.1.3g Exceptions, if any, taken to ANSI B30.2-1976 with respect to operator training, qualification, and conduct.

Response:

An operator training program is currently being developed and, along with operator qualification and conduct, will be consistent with the intent of ANSI B30.2-1976.

2.2 REQUIREMENTS FOR OVERHEAD HANDLING SYSTEMS IN THE VICINITY OF FUEL STORAGE POOLS

NUREG-0612, Section 5.1.2, provides guidelines concerning the design and operation of load-handling systems in the vicinity of stored, spent fuel. Information provided in response to this section should demonstrate that adequate measures have been taken to ensure that in this area, either the likelihood of a load drop which might damage spent fuel is extremely small, or that the estimated consequences of such a drop will not exceed the limits set by the evaluation criteria of NUREG-0612, Section 5.1, Criteria I through III.

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

Response:

Name: New Fuel Handling Crane
Type: Overhead Bridge, Multiple Girder, Electric Crane
Capacity: 10 Tons
Equipment Designation: 3MHF-CRN2

Name: Spent Fuel Bridge and Hoist
Type: Bridge and Hoist
Capacity: 3 Tons
Equipment Designation: 3MHS-CRN-B1

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 feet 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:

1. Decontamination Area Crane (3MHF-CRN4)

   This crane is excluded because it is physically incapable of carrying heavy loads over or near the spent fuel pool.

2. New Fuel Receiving Crane (3MHF-CRN3)

   This crane is excluded because it is physically incapable of carrying heavy loads over the spent fuel pool.

3. Spent Fuel Shipping Cask Trolley (3MHF-CRN1)

   This crane is excluded because it is physically incapable of carrying heavy loads over the spent fuel pool. Also, an analysis has determined that a cask drop to the head laydown shelf at elevation

25 feet-9 inches, resulting from the cask striking the corner at elevation 52 feet-4 inches and tumbling into the water filled cask storage and loading area, could result in the cask damaging the west wall of the spent fuel pool. Installation of an energy absorption device will preclude the possibility of the cask tumble accident from damaging the spent fuel pool. Based upon this corrective action, it is concluded that a postulated drop or tumble of the shipping cask will not affect the integrity of the fuel pool.

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.

Response:

There are no cranes in this category in the fuel building.

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:

2.2.4a Which alternatives (e.g., 2, 3, or 4) from those identified in NUREG-0612, Section 5.1.2, have been selected.

Response:

Alternative 3 has been selected for the new fuel handling crane identified in Section 2.2.1.

Alternative 4 has been selected for the Spent Fuel Bridge and Hoist identified in Section 2.2.1.

2.2.4b 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.

Response:

The new fuel handling crane spans the northern three quarters of the spent fuel pool. It is used mainly to move new fuel into the fuel transfer canal,

but also has the capacity for placing spent fuel storage racks into the spent fuel pool. The crane is nuclear safety-related, QA Category I, and equipped with electrical interlocks to prevent it from carrying any load over the spent fuel pool. When it becomes necessary to position spent fuel racks in the spent fuel pool, it will be necessary to bypass these electrical interlocks. The bypassing of the electrical interlocks will require written procedures and approval from the shift supervisor.

2.2.4c 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:

When it becomes necessary to bring a spent fuel rack into the spent fuel pool, the interlocks on the new fuel handling crane will not be bypassed unless the stored spent fuel has decayed sufficiently, as defined in Table 2.1-1 of NUREG-0612. This will preclude any offsite dose of more than 1/4 of 10CFR Part 100 limits as defined in Section 5.1 of NUREG-0612. The bypassing of the electrical interlocks will require written procedures and approval from the shift supervisor.

2.2.4d 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:

When it becomes necessary to place any new spent fuel racks into the spent fuel pool, the crane will lower the racks into the pool the maximum possible distance away from any existing spent fuel. It will lower the new racks below the highest elevation of any in-place spent fuel racks and then move it horizontally to its permanent location. This movement will be governed by special written, approved procedures.

2.2.4e Analysis 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:

No analysis is necessary to demonstrate compliance with Criteria I through III of Section 5.1 for the New Fuel Handling Crane due to the responses to 2.2.4c and d.

The Spent Fuel Bridge and Hoist spans the entire length of the spent fuel pool. Its main purpose is to place both new and spent fuel into the storage racks in the fuel pool. The crane is Seismic Category I and is equipped with

interlocks to prevent a load lift of greater than a fuel element and its handling tool. Its secondary purpose is to move the gates to the fuel transfer canal and spent fuel shipping cask areas to their storage locations. The gate move will necessitate a bypass of the load lift interlocks, which will be done by written procedure and under shift supervisor supervision.

At the present time, no fuel racks are located in the area of the fuel transfer canal gate, but racks do exist in the area of the spent fuel shipping cask gate. Prior to the installation of the future racks in the fuel transfer canal gate area and also prior to use of the spent fuel shipping cask if fuel is stored in that area, an analysis of a gate drop will be performed and submitted to satisfy the evaluation criteria of Section 5.1 of NUREG-0612.

2.3 REQUIREMENTS FOR OVERHEAD HANDLING SYSTEMS IN CONTAINMENT

NUREG-0612, Section 5.1.3, provides guidelines concerning the design and operation of load-handling systems in the vicinity of the reactor core. Information provided in response to this section should be sufficient to demonstrate that adequate measures have been taken to ensure that in this area, either the likelihood of a load drop which might damage spent fuel is extremely small, or that the estimated consequences of such a drop will not exceed the limits set by the evaluation criteria of NUREG-0612, Section 5.1, Criteria I through III.

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:

1. Name: Polar Crane
   Type: Electric Overhead Circular Traveling
   Capacity: Trolley No. 1, Main Hook - 217 tons
   Aux Hook - 30 tons
   Trolley No. 2, Main Hook - 217 tons
   Equipment Designation: 3MHR-CRN1

2. Name: Steam Generator Access Platform Jib East and West
   Type: Jib Crane
   Capacity: 2 tons
   Equipment Designation: 3MHR-CRN4&5

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:

1. The sigma refueling machine (3MHR-CRN2) lifts a maximum load of one fuel element and its handling tool. This, by definition of NUREG-0612, is not classified as a heavy load.

2. Steam generator wall jib (3MHR-CRN3A, B, C, D). The travel area of these cranes is such that they cannot carry heavy loads over or near the reactor vessel.

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 compliance supplemented by suitable alternatives 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:

There are no cranes which fall into this category.

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. This response should include the following information for each crane:

2.3.4a Where reliance is placed on the installation and use of electrical interlocks or mechanical stops, indicate the circumstances under which these protective devices can be removed or bypassed and the administrative procedures invoked to ensure proper authorization of such action. Discuss any related or proposed Technical Specification concerning the bypassing of such interlocks.

Response:

For the polar crane, no reliance is placed on mechanical stops or electrical interlocks. In the case of the steam generator access platform jibs, interlocks are provided to prevent loads greater than 1,800 pounds from being lifted or carried over the refueling cavity. To accomplish this, a load cell, trolley travel limit switch and boom rotation limit switch are provided. Bypassing these interlocks will only be by written approved procedures, or shift supervisor approval.

2.3.4b Where reliance is placed on other, site-specific considerations (e.g, refueling sequencing), provide present or proposed Technical Specifications and discuss administrative or physical controls provided to ensure the continued validity of such considerations.

Response:

In all cases, load lifts are governed by procedures. These procedures will be reviewed with operators as part of their qualification and training program, and will be strictly enforced by individuals in charge of lifts by the polar

crane. These administrative procedures are judged to be adequate to preclude postulating that any of these loads drop into or onto an open reactor vessel. Loads lifted only when the reactor vessel head is in place were not considered as loads that could potentially drop into the core.

2.3.4c Analyses performed to demonstrate compliance with Criteria I through III should conform with the guidelines of NUREG-0612, Appendix A. Justify any exception taken to these guidelines, and provide the specific information requested in Attachment 2, 3, or 4, as appropriate, for each analysis performed.

Response:

There are three potential consequences of concern when considering load drops onto the open reactor vessel. These are: (1) loss of reactor vessel integrity, (2) fuel cladding damage and the resultant radiological dose, and (3) fuel crushing and the possibility of a resulting criticality condition. Criteria I through III in Section 5.1 of NUREG-0612 address each of these potential consequences. The evaluations discussed below have been performed to address these issues.

Reactor Vessel Upper Internals Drop Onto the Reactor Core

The bounding load drop for evaluating potential damage to fuel in the core is a postulated drop of the upper internals. The upper internals package is located directly above the reactor core, and is removed as a single component before refueling. It weighs approximately 172,000 pounds with its lifting rig and will be removed and replaced according to plant procedures. The lifting system used to move the upper internals includes the containment polar crane and the internals lifting rig.

The upper internals package consists of a cover, upper grid, control rod assembly, guide tube assemblies, and a core package cylinder with openings for reactor coolant outlet flow. The package (about 134 inches in height) consists of a large cylindrical section with an upper flanged ring from which it is supported, or hung, from its supporting mechanism at the reactor vessel flange.

During removal and replacement of the upper internals, alignment is accomplished by engagement of the internals lifting rig on the reactor vessel guide studs. Because disengagement from the guide studs causes loss of this alignment, and precise alignment is required for the upper internals to fit into the vessel, the maximum postulated drop height corresponds to the height of the guide studs above the upper internals support. For conservatism, the postulated drop height is taken as 18 feet. During removal operations, it is planned that the upper internals will at all times be submerged.

Based on a consideration of the energy absorbing effects of drag as the upper internals travels through water, including the "dashpot" or "flow through an orifice" effect that exists due to the close tolerance of the internals within the core barrel, the kinetic energy of the drop is determined to be about 1394 kip-feet. This external kinetic energy, calculated based on a conservative understanding of the transfer of momentum at impact, is initially transferred to the support system at the upper internals and core barrel flanges.

Several failure scenarios were investigated to assure that the potential consequences from the upper internals drop are acceptable. For example, an initial failure of the core barrel support flange will result in a subsequent impact of the secondary core support at the RPV bottom head. An energy balance analysis of these lower core support columns indicates that while local yielding is predicted, the impact energy can be fully dissipated with no significant impact to fuel or the reactor vessel.

While the expected response to the upper internals drop is described by the above scenario, for conservatism, the Applicant also investigated the potential consequences should the fuel be impacted. For fuel impact to occur, overall failure of the upper internals flange ring would have to occur prior to failure of the core barrel support. Based on this failure scenario, the resulting impact energy imparted to the fuel would be about 800 kip-feet.

The kinetic energy reaching the core loading the fuel assemblies, is transmitted uniformly from the upper grid to the fuel assembly upper end fittings through the control rod guide tubes, and to the fuel assembly lower end fittings. The fuel rods are not significantly loaded unless the upper end fittings are driven into the fuel rods due to deformation of the guide tubes through buckling. The energy absorbed by the guide tubes failing in an inelastic buckling mode has been conservatively ignored.

Individual fuel rods are predicted to buckle elastically between spacer grids at a Euler critical buckling load (P_{cr}) of 88 pounds. Strain energy can be absorbed beyond the point of reaching P_{cr} through bending until the fuel cladding strain reaches a value of 1 percent. This strain criterion is based upon the irradiated properties of the zircaloy-4 cladding material.

The total strain energy absorbed up to an allowable fuel rod response is compared to the externally applied kinetic energy of 800 kip-feet. Based on a criterion of 60 percent of the fuel rod fibres measured along the diameter having reached the yield stress, the total strain energy absorbed by the rods is approximately 1020 kip-feet. At this response level, the strain in the extreme compression and tension fibres is approximately 0.00773 and 0.00676 respectively. These strain values are less than the acceptance strain of 0.01. Therefore, the results of this analysis indicate that the total strain energy absorbed by the fuel rods is greater than the calculated impact energy.

Based upon this evaluation, in the unlikely event that the polar crane or its associated lifting devices fail while the upper internals is at the maximum point of carry at which it could be postulated to impact the core, it is concluded that the fuel cladding will not rupture or experience significant crushing, and radioactive gases will not be released. Accordingly, NUREG-0612 Criterion I is met for drops into the vessel.

In addition, the Applicant has evaluated the potential for a criticality condition. Criterion II, Section 5.1 of NUREG-0612 requires that the resultant k_{eff} not be greater than 0.95. The results of this evaluation indicate that because the pre-drop core k_{eff} is expected to be 0.90 or less, at planned refueling boron concentrations, Criterion II is met based on the evaluation guidance and criteria in NUREG-0612, Appendix A.

Reactor Vessel Head Drop Onto the Reactor Vessel

The bounding load drop for evaluating reactor vessel integrity (Criterion III) is a postulated drop of the reactor vessel head. The reactor vessel (RPV) head is hemispherically shaped and weighs approximately 357,000 pounds with the RPV head lifting rig. The RPV head will be removed and replaced according to plant procedures.

The head is lifted from the RPV flange and raised to the operating floor. While it is currently planned to remove the head while simultaneously raising the refueling canal water level, evaluations were performed considering both a drop through water and a drop through air. The polar crane main hook is used at slow speed to raise the head to above the operating floor level.

Based on the above, a postulated drop of the RPV head of 27 feet-10 inches was considered. Energy dissipation due to a transfer of momentum was accounted for. The RPV is supported at four nozzles by the shield tank. The impact load path is from the RPV flange through the nozzles to the shield tank.

Evaluating the behavior of the RPV and its support system, based on an energy balance approach, it was determined that although local deformation and buckling of the lower portion of the shield tank is expected, sufficient capacity exists to absorb the impact energy without significant damage to the RPV. Accordingly, reactor vessel integrity will be maintained and NUREG-0612 Criterion III is met.

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:

NUREG-0612, Section 5.1.5, provides guidelines concerning the design and operation of load-handling systems in the vicinity of equipment or components required for safe reactor shutdown and decay heat removal. Information provided in response to this section should be sufficient to demonstrate that adequate measures have been taken to ensure that in these areas, either the likelihood of a load drop which might prevent safe reactor shutdown or prohibit continued decay heat removal is extremely small, or that damage to such equipment from load drops will be limited in order not to result in the loss of these safety-related functions. Cranes which must be evaluated in this section have been previously identified in your response to 2.1.1, and their loads in your response to 2.1.3c.

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:

There are no cranes in this category at Millstone 3.

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:

2.4.2a 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 2.1.3c. 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.

2.4.2b For each interaction identified, indicate which of the load and impact area combinations can be eliminated because of separation and redundancy of safety-related equipment, mechanical stops and/or electrical interlocks, or other site-specific considerations. Elimination on the basis of the aforementioned considerations should be supplemented by the following specific information:

1. For load/target combinations eliminated because of separation and redundancy of safety-related equipment, discuss the basis for determining that load drops will not affect continued system operation (i.e., the ability of the system to perform its safety-related function).

2. Where mechanical stops or electrical interlocks are to be provided, present details showing the areas where crane travel will be prohibited. Additionally, provide a discussion concerning the procedures that are to be used for authorizing the bypassing of interlocks or removable stops, for verifying that interlocks are functional prior to crane use, and for verifying that interlocks are restored to operability after operations which require bypassing have been completed.

3. Where load/target combinations are eliminated on the basis of other, site-specific considerations (e.g., maintenance sequencing), provide present and/or proposed Technical Specifications and discuss administrative procedures of physical constraints invoked to ensure the continued validity of such considerations.

Response:

See Table 1 and response to 2.4.2d and 2.2.4e.

2.4.2c For interactions not eliminated by the analysis of 2.4.2b 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 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:

There are no cranes in this category.

2.4.2d For interactions not eliminated in 2.4.2b or 2.4.2c 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). For each analysis so conducted, the following information should be provided:

1. An indication of whether or not, for the specific load being investigated, the overhead crane-handling system is designed and constructed such that the hoisting system will retain its load in the event of seismic accelerations equivalent to those of a safe shutdown earthquake (SSE).

2. The basis for any exceptions taken to the analytical guidelines of NUREG-0612, Appendix A.

3. The information requested in Attachment 4.

Response:

Load drop and impact analyses have been performed for the cranes listed in Table 3 which are in the auxiliary building and fuel building in the areas of reactor shutdown and decay heat removal equipment and piping. No scabbing of concrete or structural failure of impacted slabs will occur if the height limitations as specified in the following summary is observed, with the following exceptions. For the new fuel handling crane load drop on the new fuel pool slab at elevation 34 feet-0 inches, structural failure will not occur, but backface scabbing is possible. However, any concrete fragments will impact the 24 foot-6 inch slab, and no impingement on Category I equipment or components will result. For the new fuel handling crane drop on the 24 foot-6 inch slab, again no structural failure will occur, but backface scabbing of concrete will. These fragments of concrete will impinge upon the Category I piping located at the 11 foot-0 inch elevation below. Scabbing protection will be provided to eliminate this problem.

TABLE I

CRANE HEAVY LOAD LIST AND LIFTING DEVICES

Crane	Capacity (tons)	Heavy Load Identification	Weight (tons)	Safety-Related Equipment Coordinates	Special Lift Device	Hazard Elimination Category	Notes
Polar crane (3MHR-CRN1)	Bridge-434 Trolley 1-217 Trolley 2-217 Aux Hook-30	Reactor vessel head, CRDM motors and lift device	168		Reactor vessel head lift device	C,D	An exception was taken for considering the polar crane load block as a heavy load. Since it was designed and built as an integral part of the Seismic QA Category I polar crane, it was not considered credible to assume failure of the load block when no load is being lifted.
		Reactor vessel upper internals and lift device	76		Upper internals lift rig	C,D	
		CRDM shield and cooling skid	68.1			C	
		CRDM ventilation ducting upper elbows vertical sections lower sections	 0.4 0.8 .1			C	
		Reactor cavity water seal ring	11			C	
		Mat access checkered plate	24			C	
		Containment operating floor removable slabs (heaviest)	22.2			C	
		Reactor coolant pump motor	42			C	
		Reactor coolant pump internals	22.5			C	
		Reactor coolant pump casing	24.8			C	
		Reactor coolant system loop isolation valves	14.3			C	
Spent fuel shipping cask trolley (3MHF-CRN1)	125	Spent fuel shipping cask	23 to 115			B,D	Weight varies depending on type of shipping cask used.

TABLE I (Cont)

Crane	Capacity (tons)	Heavy Load Identification	Weight (tons)	Safety-Related Equipment Coordinates	Special Lift Device	Hazard Elimination Category	Notes
Spent fuel bridge and hoist (3MHS-CRNB1)	3	Transfer gates	2.5			D	
New fuel handling crane (3MHF-CRN2)	10	Spent fuel storage racks	8.4			B,C,D	Weight varies depending on size of storage rack.
New fuel receiving crane (3MHF-CRN4)	10	Spent fuel storage racks	8.4			B,C,D	Weight varies depending on size of storage rack.
Fuel building decon. crane (3MHF-CRN4)	5	Equipment hatch plug	4.5			B,D	
Auxiliary building filter handling crane/ monorail (3MHP-CRN1)	10	Removable slabs (heaviest)	9.5			B,D	
Auxiliary building charging pump trolley (3MHP-CRN2A/B/C)	5	Charging pump Charging pump motor	3.75 1.95			A,C,D	
Reactor plant component cooling water heat exchanger monorail						A,C,D	

General Notes:

Impact area is defined as any area along the safe load path.

Hazard Elimination Categories:

A. System redundancy and separation precludes the loss of capability of a system to perform its safety-related function following a 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 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.

D. Analysis demonstrates that crane failure and load drop will not violate the guidelines of Criteria I through IV, Sect[illegible] of NUREG-0612.

TABLE 2

This table has been deleted

TABLE 3

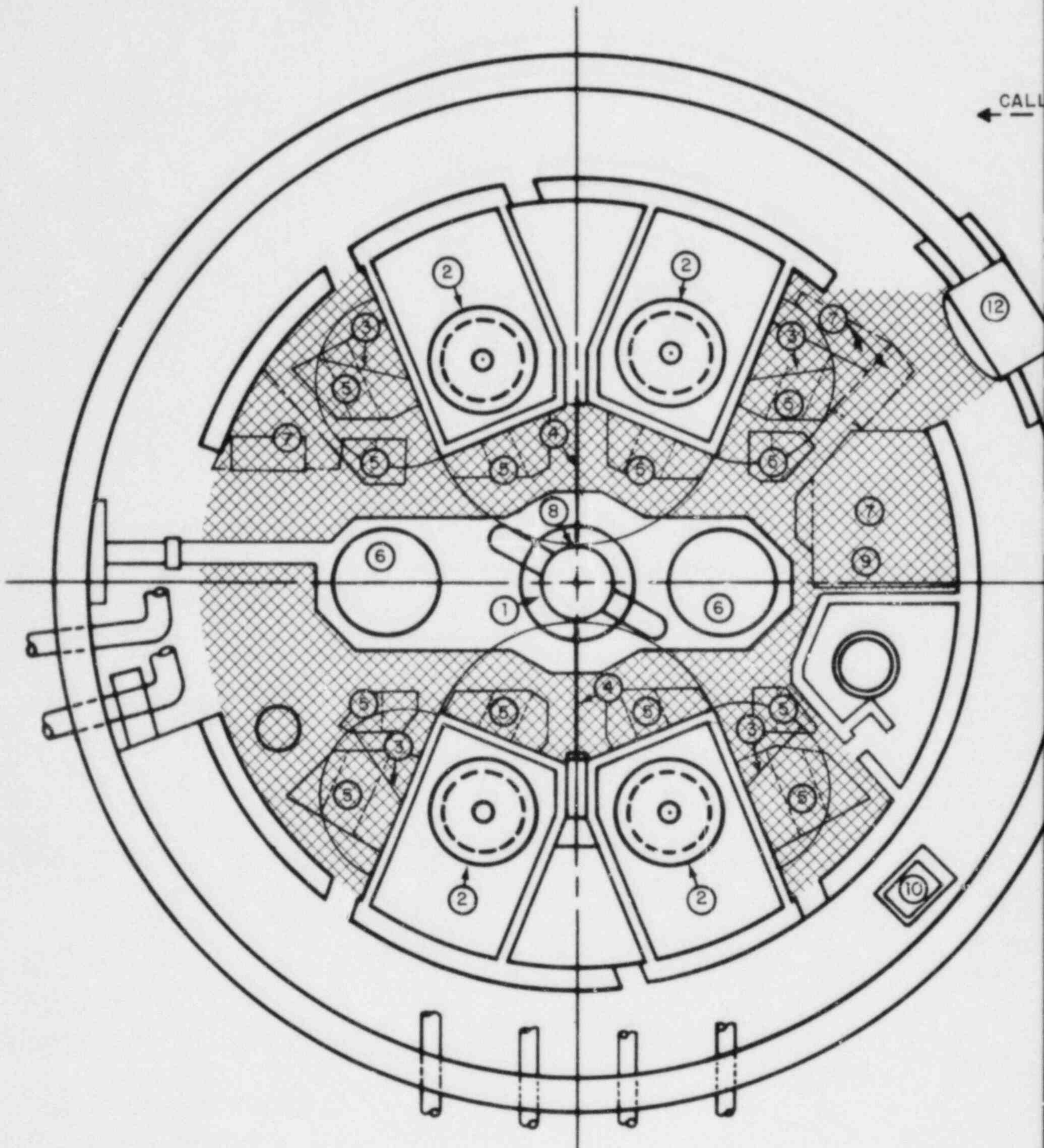
LOAD DROP AND IMPACT ANALYSES

SUMMARY OF RESULTS

Crane	Location of Drop	Heavy Load Height Limitation
AUXILIARY BUILDING		
Filter Handling Crane	2'-0" slab el 43'-6" between F.8-F.9 & 54.4 - 55.9	2'-0"
	Directly over removable concrete plugs el 43'-6"	0'-6"
	Directly over N-S central cubicle wall el 43'-6"	2'-0"
FUEL BUILDING		
Decontamination Crane	2'-0" slab el 24'-6" between G.6-H & 51.2 - 52.8	3'-6"
	Directly over removable concrete plugs el 24'-6"	3'-6"
New Fuel Receiving Crane	2'-0" slab el 24'-6" between G.5-H & 52.8 - 53.8	3'-6"
New Fuel Handling Crane	2'-0" slab el 24'-6" between G.3-G.5 and 52.8 - 53.8	19'-0"[1]
	Directly over filters cubicle roof slab el 43'-0"	10'-0"
	New fuel pool slab el 34.-0"	19'-0"[1]
	Spent fuel pool slab el. 11'-3"	41'-9"

NOTE:

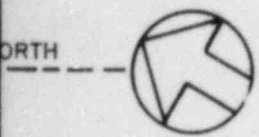
1. Drops where scabbing of concrete will occur.



CONTAINMENT EL. 51'-4"

SAFE LOAD PATH FOR REMOVAL OF MISCELLANEOUS EQUIPMENT FROM EL. 24'-6" AND 51'-4"

VESSEL HEAD REMOVED



TABLE

No.	EQUIPMENT No.	DESCRIPTION	NOTES
1	3RCS * REV 1	REACTOR	S
2	3RCS*SG1A,B,C, & D	STEAM GENERATORS	S
3	3MHR-CRN 3A,B,C & D	STEAM GENERATOR CUBICLE WALL JIB CRANES	
4	3MHR-CRN 4 & 5	STEAM GENERATOR ACCESS PLATFORM JIB EAST/WEST	
5		REMOVABLE SLABS	H
6		UPPER & LOWER INTERNALS (STORAGE)	H
7		REMOVABLE SLAB STORAGE AREA	
8		CRDM MISSILE SHIELD	H
9		REMOVABLE CHECKERED PLATE	H
10		ELEVATOR	
11		STAIRWAY	
12		PERSONNEL HATCH	

LEGEND

- (shaded box) SAFETY RELATED PIPING AND EQUIPMENT
- (cross-hatched box) SAFE LOAD PATH
- H HEAVY LOADS
- S SAFE SHUTDOWN

TI
APERTURE
CARD

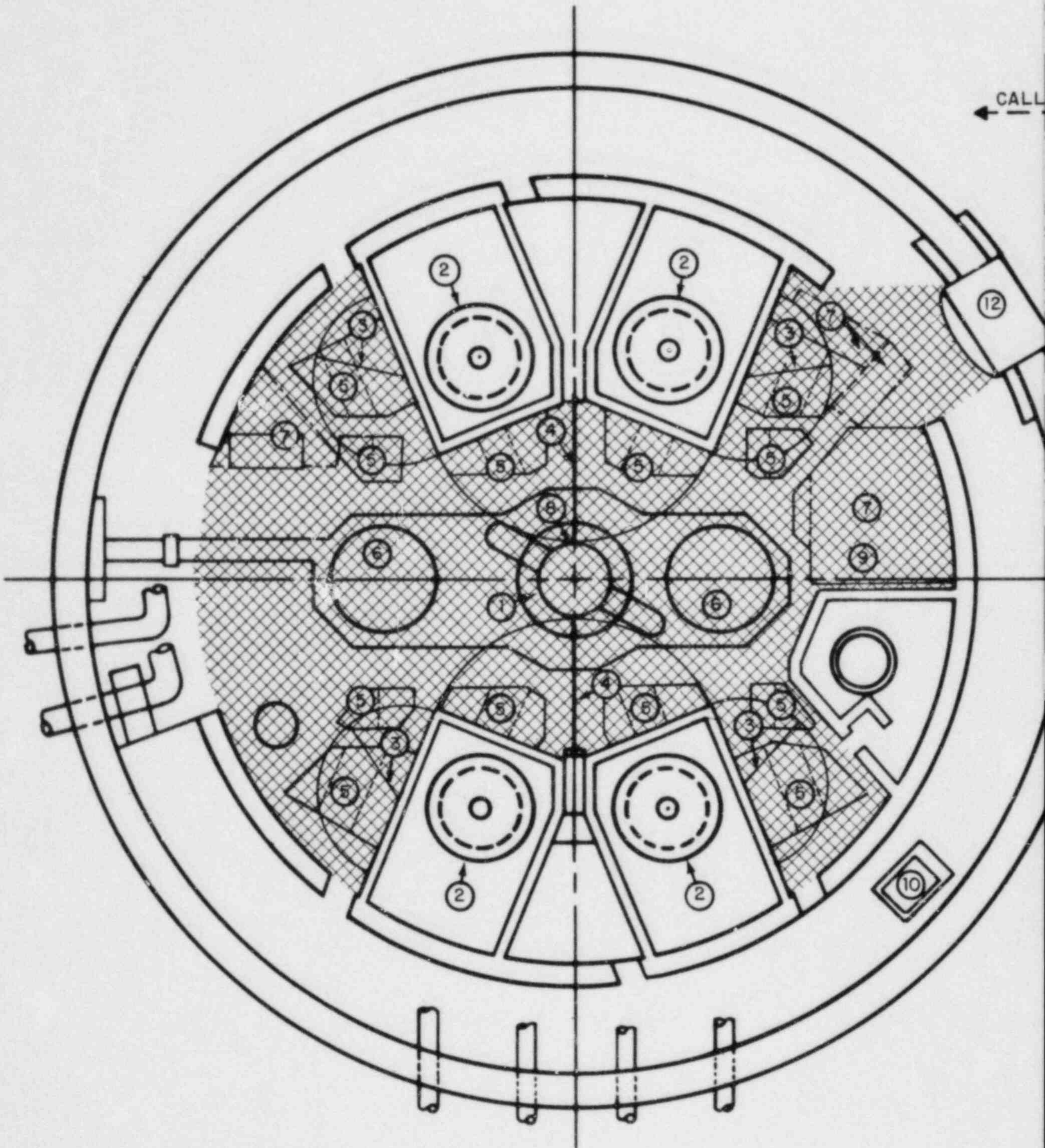
Also Available On
Aperture Card

FIGURE 1

CONTROL OF HEAVY LOADS
CONTAINMENT

MILLSTONE NUCLEAR POWER PLANT
UNIT 3
HEAVY LOADS ANALYSIS

8503200452 -01



CONTAINMENT EL. 51'-4"

SAFE LOAD PATH FOR REMOVAL OF MISCELLANEOUS EQUIPMENT-VESSEL HEAD IN PLACE

RTH

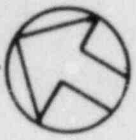


TABLE			
No.	EQUIPMENT No.	DESCRIPTION	NOTES
1	3RCS * REV 1	REACTOR	S
2	3RCS*SG1A,B,C, & D	STEAM GENERATORS	S
3	3MHR-CRN 3A,B,C & D	STEAM GENERATOR CUBICLE WALL JIB CRANES	
4	3MHR-CRN 4 & 5	STEAM GENERATOR ACCESS PLATFORM JIB EAST/WEST	
5		REMOVABLE SLABS	H
6		UPPER & LOWER INTERNALS (STORAGE)	H
7		REMOVABLE SLAB STORAGE AREA	
8		CRDM MISSILE SHIELD	H
9		REMOVABLE CHECKERED PLATE	H
10		ELEVATOR	
11		STAIRWAY	
12		PERSONNEL HATCH	

LEGEND

- SAFETY RELATED PIPING AND EQUIPMENT
- SAFE LOAD PATH
- H HEAVY LOADS
- S SAFE SHUTDOWN

Also Available On Aperture Card

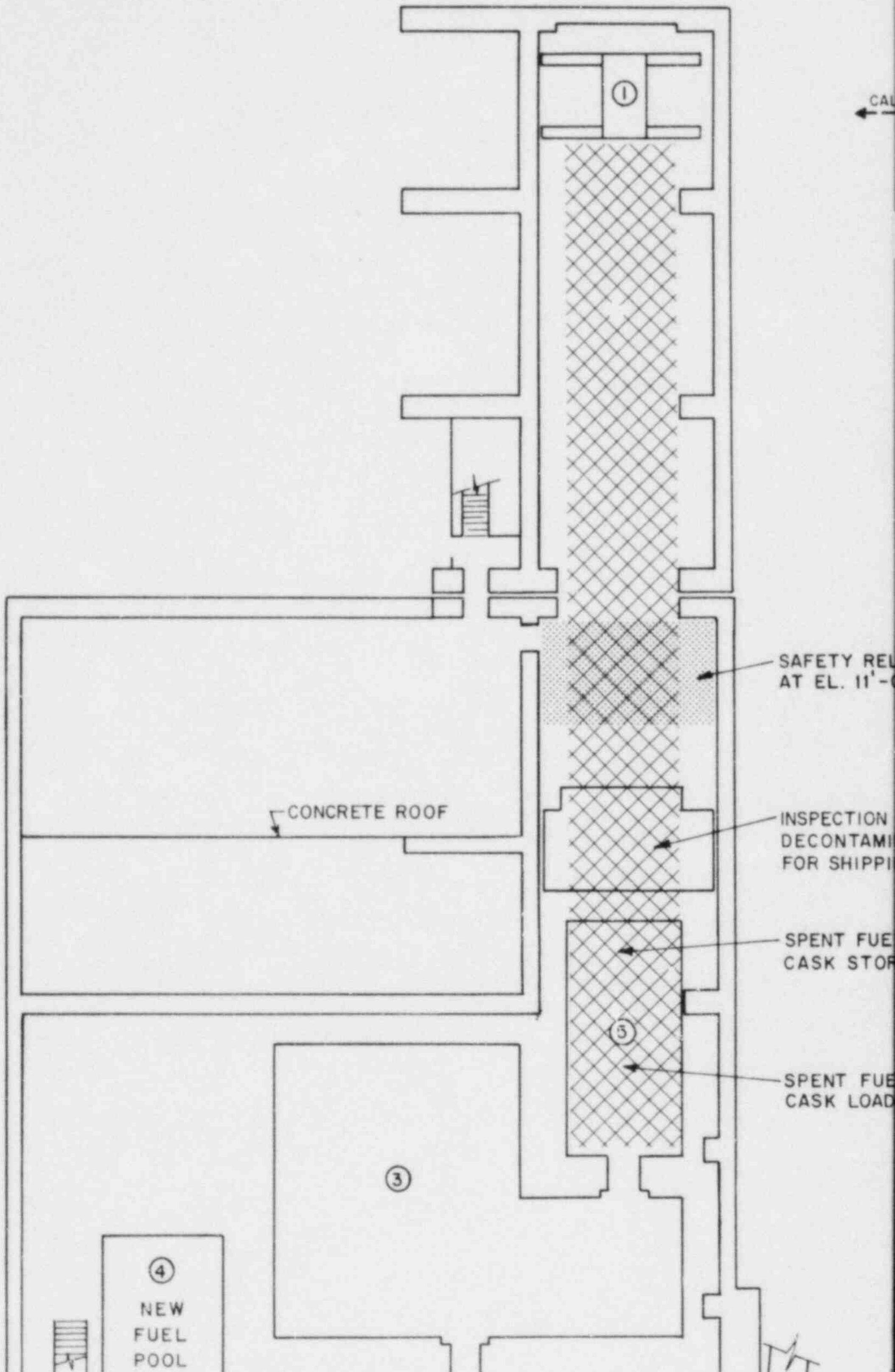
TI APERTURE CARD

FIGURE 2

CONTROL OF HEAVY LOADS CONTAINMENT

MILLSTONE NUCLEAR POWER PLANT
UNIT 3
HEAVY LOADS ANALYSIS

8503200452 -02



FUEL BUILDING EL. 52'-4"

SAFE LOAD PATH FOR SPENT
FUEL SHIPPING CASK CRANE

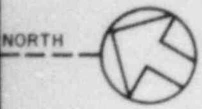


TABLE			
No.	EQUIPMENT No.	DESCRIPTION	NOTES
1	3MHF-CRN-1	SPENT FUEL SHIPPING CASK CRANE	
2	3MHF-CRN-2	NEW FUEL HANDLING CRANE	
3		SPENT FUEL POOL	
4		NEW FUEL POOL	
5		CASK LOADING/STORAGE AREA	
6		FUEL TRANSFER CANAL	

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AREA

LEGEND

- SAFE LOAD PATH (cross-hatched box)
- SAFETY RELATED PIPING AND EQUIPMENT (shaded box)
- H HEAVY LOAD
- S SAFE SHUTDOWN EQUIPMENT

Also Available On
Aperture Card

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APERTURE
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FIGURE 3
CONTROL OF HEAVY LOADS
FUEL BUILDING
MILLSTONE NUCLEAR POWER STATION
UNIT 3
HEAVY LOADS ANALYSIS

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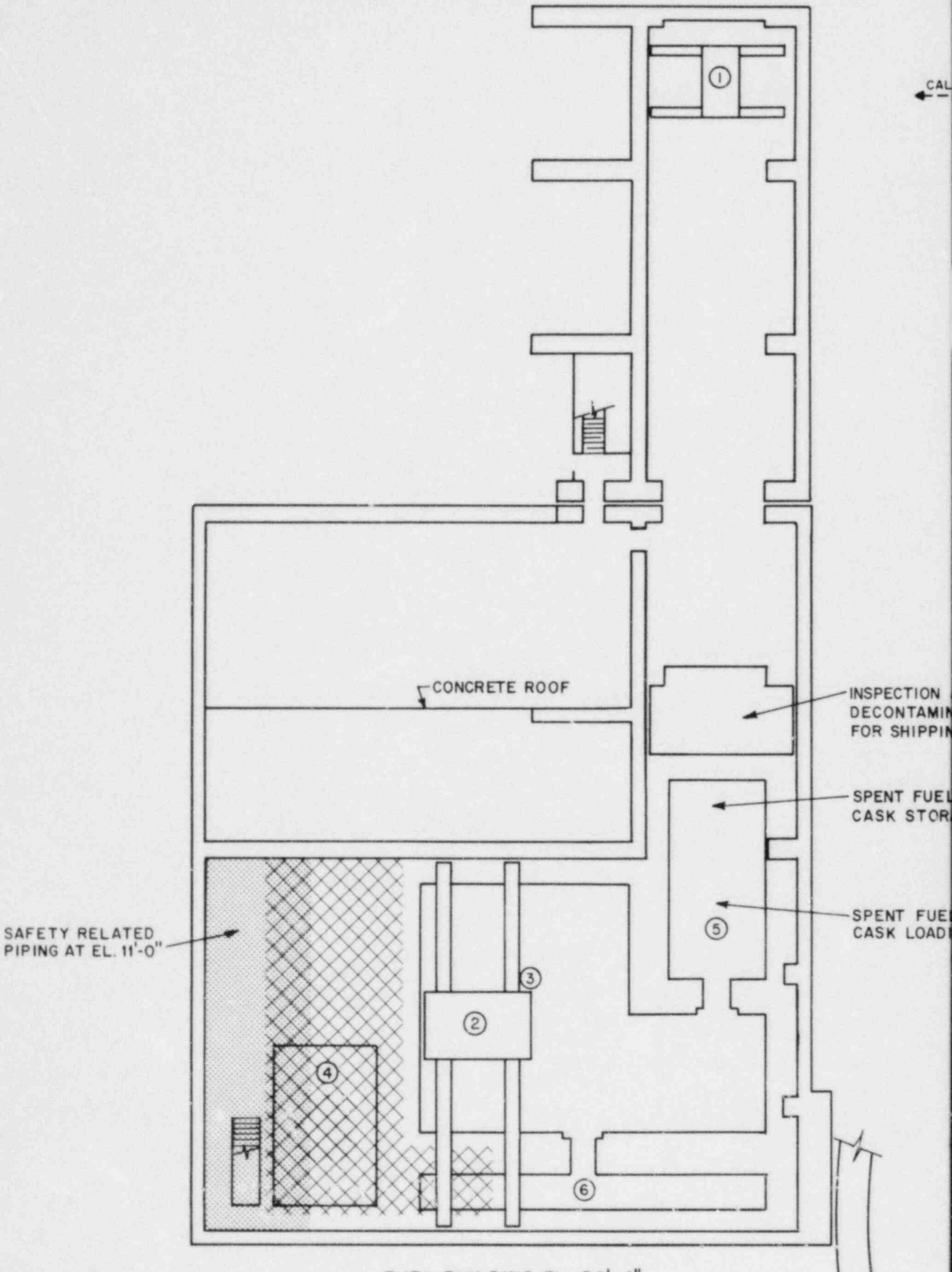

FUEL BUILDING EL. 54'-4"

SAFE LOAD PATH FOR THE
NEW FUEL HANDLING CRANE

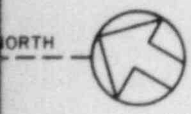

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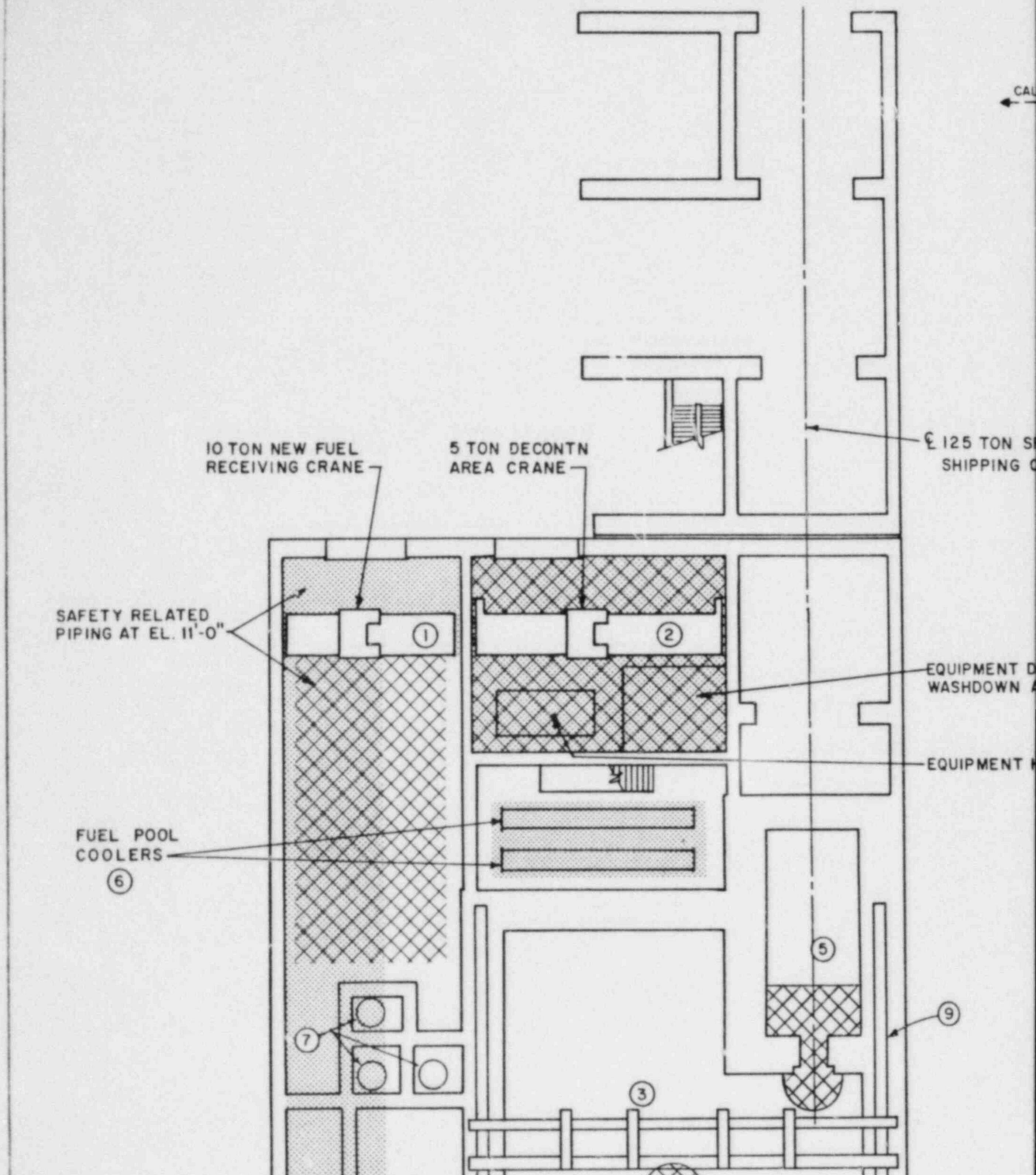
TABLE			
No.	EQUIPMENT No.	DESCRIPTION	NOTES
1	3MHF-CRN-1	SPENT FUEL SHIPPING CASK CRANE	
2	3MHF-CRN-2	NEW FUEL HANDLING CRANE	
3		SPENT FUEL POOL	
4		NEW FUEL POOL	
5		CASK LOADING/STORAGE AREA	
6		FUEL TRANSFER CANAL	

LEGEND

- [cross-hatched box] SAFE LOAD PATH
- [shaded box] SAFETY RELATED PIPING AND EQUIPMENT
- H HEAVY LOAD
- S SAFE SHUTDOWN EQUIPMENT

FIGURE 4
CONTROL OF HEAVY LOADS
FUEL BUILDING
MILLSTONE NUCLEAR POWER STATION
UNIT 3
HEAVY LOADS ANALYSIS



FUEL BUILDING EL. 35'-10"

SAFE LOAD PATH FOR THE NEW
FUEL RECEIVING CRANE AND
DECONTAMINATION AREA CRANE

ORTH

FUEL
CRANE

TAMINATION

10

TABLE			
No.	EQUIPMENT No.	DESCRIPTION	NOTES
1	3MHF-CRN3	NEW FUEL RECEIVING CRANE	
2	3MHF-CRN4	DECONTAMINATION CRANE	
3		SPENT FUEL POOL	
4		NEW FUEL POOL	
5		CASK LOADING/STORAGE AREA	
6	3SFC*E1A, B	FUEL POOL COOLERS	H
7	3SFC-FLT1,3A,3B	SFC FILTERS	H
8		FUEL TRANSFER CANAL	
9	3MHS-CRN1	SPENT FUEL BRIDGE & HOIST	
10		EQUIPMENT HATCH	H

LEGEND

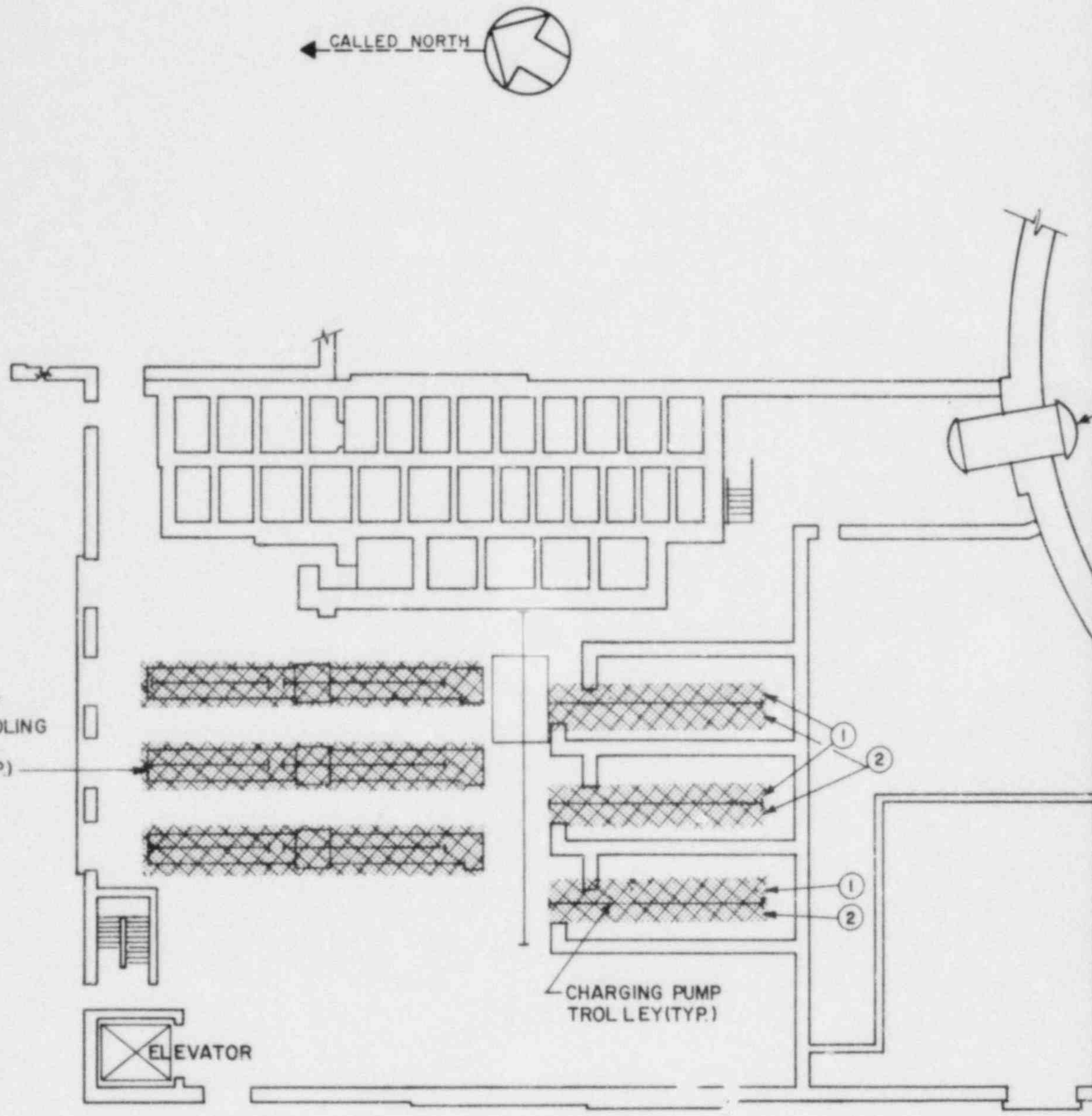
SAFE LOAD PATH

SAFETY RELATED PIPING AND EQUIPMENT

H HEAVY LOAD

S SAFE SHUTDOWN EQUIPMENT

FIGURE 5
CONTROL OF HEAVY LOADS
FUEL BUILDING
MILLSTONE NUCLEAR POWER STATION
UNIT 3
HEAVY LOADS ANALYSIS



PLAN EL. 24'-6"
(LOWER ELEVATION)

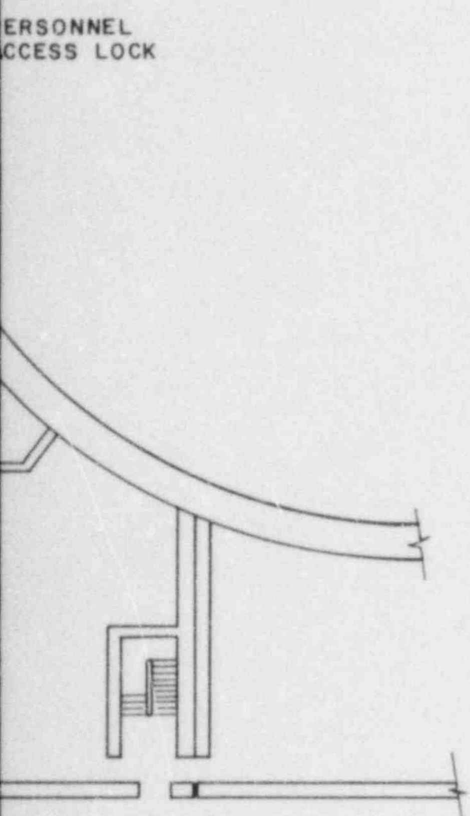


TABLE			
No.	EQUIPMENT No.	DESCRIPTION	NOTES
1	3CHS * P3A, B, C	CHARGING PUMPS	H, S
2	3MHP - CRN2A, B, C	CHARGING PUMP TROLLEYS	
3	3CCP * E1A, B, C	CCP HEAT EXCHANGER	H, S

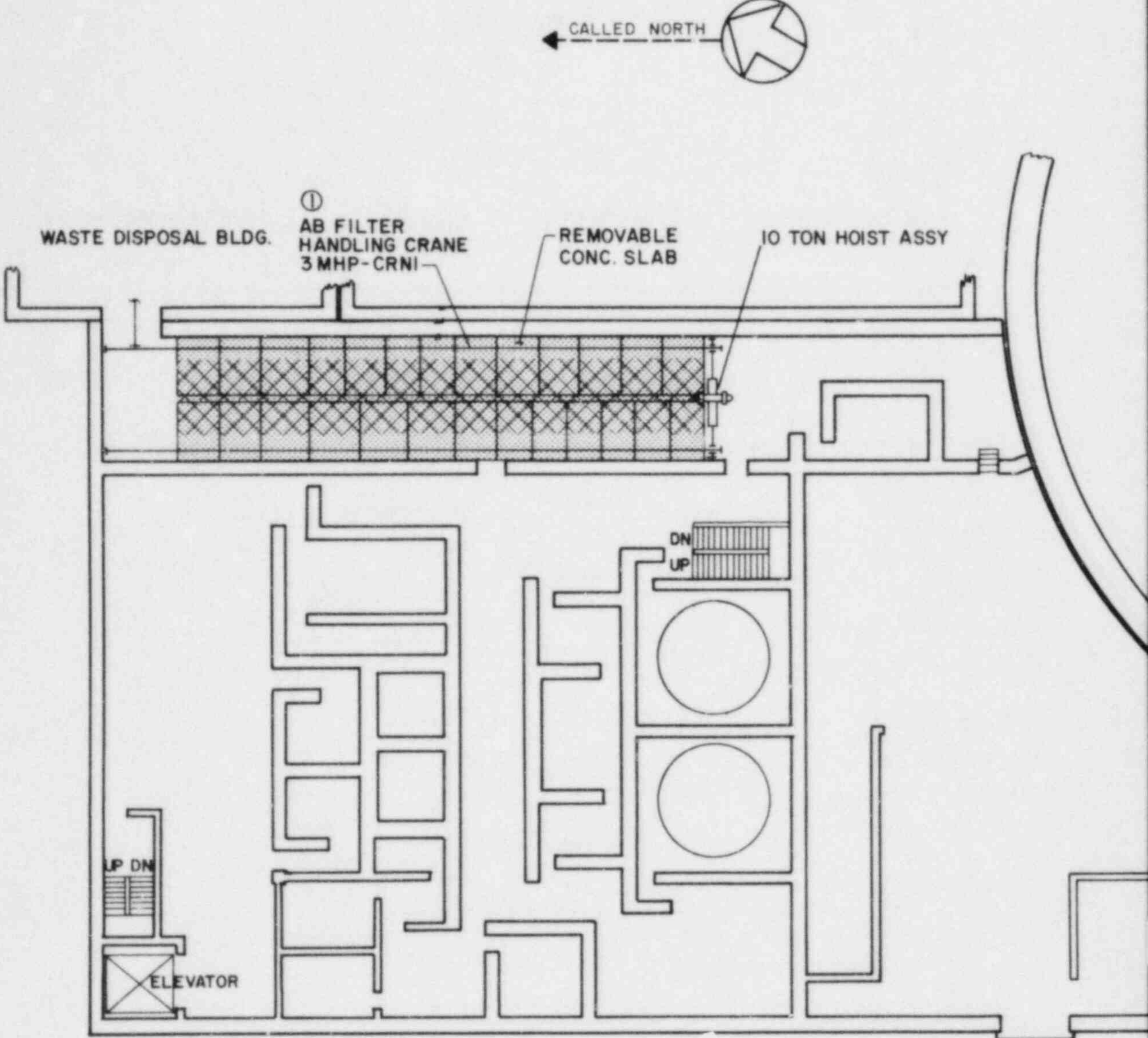
LEGEND

- SAFE LOAD PATH
- SAFETY RELATED PIPING AND EQUIPMENT
- H HEAVY LOAD
- S SAFE SHUTDOWN EQUIPMENT

FIGURE 6

CONTROL OF HEAVY LOADS
AUXILIARY BUILDING

MILLSTONE NUCLEAR POWER STATION
UNIT 3
HEAVY LOADS ANALYSIS



PLAN EL. 43'-6"
(UPPER ELEVATION)

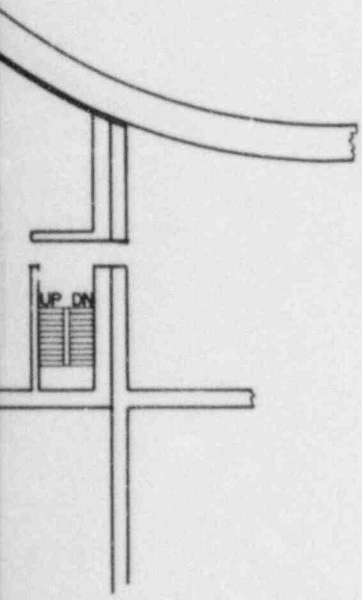


TABLE			
No.	EQUIPMENT No.	DESCRIPTION	NOTES
1	3MHP-CRN1	AB FILTER HANDLING CRANE	
2		REMOVABLE SLABS OVER FILTERS (31)	H

LEGEND

- SAFE LOAD PATH
- SAFETY RELATED PIPING AND EQUIPMENT
- H HEAVY LOAD
- S SAFE SHUTDOWN EQUIPMENT

FIGURE 7
CONTROL OF HEAVY LOADS
AUXILIARY BUILDING
MILLSTONE NUCLEAR POWER STATION
UNIT 3
HEAVY LOADS ANALYSIS