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| Niagara Mohawk Power Corporation<br>Syracuse, New York 13202<br>Philip D. Raymond | 7-26-73 | 7-27-73 | x | | | |

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| | XXX | | XXX | 11 | 50-220 |

| DESCRIPTION: | ENCLOSURES: |
|---|---|
| Ltr requesting change in Tech Specs to auth installation of a crane with a redundant hoist system in the reactor building.....trans the following: | Safety Evaluation of Redundant Hoisting System and Crane Movement Controls. |
| PLANT NAME: Nine Mile Point Unit # 1 | ACKNOWLEDGED<br>DO NOT REMOVE<br>(11 cys rec'd) |

**FOR ACTION/INFORMATION** 7-28-73 fod

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NIAGARA MOHAWK POWER CORPORATION

NIAGARA MOHAWK

300 ERIE BOULEVARD WEST
SYRACUSE, N.Y. 13202

Regulatory File Cy.

July 26, 1973



Mr. Donald J. Skovholt
Assistant Director for Operating Reactors
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Skovholt:

Re: Nine Mile Point Unit 1
AEC Docket No. 50-220

Pursuant to Section 50.59 of the Commission's Regulations, Niagara Mohawk plans to make a change in its facility under Provisional Operating License No. DPR-17. Briefly, this change consists of providing the reactor building crane with a redundant hoist system.

For your information, a description of the proposed modification, including a safety evaluation, is attached. This evaluation shows that the probability of occurrence and the consequences of an accident or malfunction would be decreased, and margins of safety for operation of the crane increased by this change.

The proposed modification has been reviewed and approved by the Safety Review and Audit Board, which is of the opinion that no additional possibility for an accident or malfunction of a different type than evaluated previously in the Safety Analysis Report would be created. The Board has also concluded that this change will not present a significant hazards consideration, but rather will enhance plant safety.

We are enclosing ten additional copies for your convenience.

Very truly yours,

Philip D. Raymond
Philip D. Raymond
Vice President-Engineering

GKR/vk
Enclosures



5766

50-220

Regulatory File Cy.

Received w/Ltr Dated 7-26-73

NINE MILE POINT - UNIT NO. 1

REDUNDANT HOISTING SYSTEM

And

CRANE MOVEMENT CONTROLS

5766

## I. Introduction

This submittal describes a proposed change to the Nine Mile Point Unit 1 facility. The change involves a modification to the existing reactor building crane. A new crane trolley is proposed with a redundant hoisting system.

II. Summary

Niagara Mohawk proposes to modify the 125 ton capacity crane presently installed in the Nine Mile Point Unit 1 Reactor Building. The modification consists of replacing the present crane trolley with a new trolley unit providing a redundant rope system for the 125 ton capacity main hoist.

The purpose of the redundant system is to prevent load drop, and especially drop of a spent fuel cask, in the event of rope failure. The new trolley's main hoist will also incorporate safety features to prevent load drop in the event of failure of other hoist components.

The modified crane will be used to move spent fuel casks from the hatchway to the hydraulic guide structure at the northwest corner of the spent fuel pool. The path for this movement is described in previous submittals.[1,2] This path is chosen so that a cask drop over critical reactor components is precluded, and so that entry of a cask into the spent fuel pool is possible only through the hydraulic guide cylinder (cask drop protection system).

The controlled transfer path for the fuel cask, described in previous submittals,[1,2] is to be expanded to include the entire designated path for travel from the hatchway to the hydraulic guide structure and return. This is to prevent possible cask contact with any other object during its transfer over the Reactor Building operating floor. To accomplish this purpose, the crane is to be equipped with a series of controls for containing its movements when transferring the fuel cask over the controlled path.

The new crane trolley and hoist, the controlled cask movement path, and the cask drop protection system (hydraulic guide cylinder) together form a very effective system of protection against cask drop accidents. The crane's redundant ropes and gear trains, as well as its other safety features, make drop of a fuel cask in the event of any credible crane failure virtually impossible.

The controlled transfer path positively restricts movement of the cask to areas where no critical reactor component would be damaged should a cask be dropped. The path also limits the amount of energy absorbed by the operating floor in the event of a cask drop by restricting the height of the cask.

Finally, the cask drop protection system, described in previous submittals, [1,2] precludes the possibility of damage to the spent fuel pool floor in the event of a cask drop over the pool.

## III. Discussion

### A. Design Basis

The new trolley with redundant hoisting system is designed to be compatible with all existing bridge mounted controllers and operating systems on the present crane. The system will be structurally sound and capable of sustaining loads of rated capacity, and will comply with the following codes and regulations:

1. American Nuclear Standards Inst. (ANSI) Safety Code for Overhead and Gantry Cranes, ANSI B30.2.0-1967.

2. Specifications for Electric Overhead Traveling Cranes, Crane Manufacturers Association of America, (C.M.A.A.) Specification No. 70-1971.

3. Overhead and Gantry Cranes, 29CFR 1910.179, Federal Register, Vol. 36, No. 105.

4. Occupational Safety and Health Act - 1971

5. National Electrical Manufacturer's Association - NEMA

6. National Electric Code, ANSI C1-1971-(National Fire Protection Assn. 70-1971)

7. American Welding Society, AWS D14.1

8. Steel Structure Painting Council, Standard SSP-SP-3

The proposed revision will provide redundant rope systems for the main hoist. Each will be independently capable of continued support of any load up to 125 tons, and will withstand all impacts associated with that load, within the yield strength of its components.

The structure and components will be able to withstand a horizontal acceleration of 0.50g and a vertical acceleration of .25g acting simultaneously. These accelerations have been ascertained from the maximum credible earthquake of 0.11g, as described in the FSAR.[3]

The proposed system will be equipped with mechanisms that will prevent the trolley from leaving its rails and will prevent dislocation of any part of its equipment during earthquake conditions.

B. System Design

The Reactor Building 125 ton capacity overhead crane was manufactured by Whiting Corporation, Harvey, Ill., in 1966 and installed at the job site that fall. The new trolley with its redundant 125 ton capacity hoisting system and 25 ton capacity auxiliary hoist is also being manufactured by Whiting Corporation.

The crane, which will weigh 323,600 lbs., may be operated from either the cab or the floor through a pendant operated push button station. The present crane weighs 315,600 lbs. The effect of the additional 8,000 lbs. on the existing bridge girders has been considered; the girders are adequate to safely support the additional weight. A description of the crane with the proposed modifications follows.

1. Crane Bridge

   Installation of the new trolley will require no modifications of the crane bridge. A description of the bridge has been presented in a previous submittal.[2]

2. Trolley

   The new trolley, weighing 118,000 lbs (an increase of 8,000 lbs.) will be operated from the present push button station. It will draw its power from the existing bridge conductors. The trolley will travel 96 feet, as does the present trolley.

   The new trolley is driven by a G.E. 7.5 HP, 1200 RPM, type MR-256-X motor. This is a totally enclosed, non-ventilated, moisture protected, ball bearing, wound rotor, crane type motor with class H insulation. It is provided with manual restart, and is protected against thermal overload, under-voltage, and overcurrent.

   The new trolley has a minimum speed of 9 FPM and a maximum full load speed of 50 FPM. Its brake is a G.E. IC-9516-461E shoe type solenoid electric brake with a 4-15/32 inch drum. It is push button operated, and will set automatically if power is lost. The brake is capable of sustaining 50 percent of motor rated full load torque.

3. Auxiliary Hoist

The design of the new trolley's auxiliary hoist is identical to that of the present auxiliary hoist. It is a 25 ton capacity conventional type hoist, operated from the present push button station and controlled by G.E. Maxspeed 320 D.C. adjustable voltage controllers.

The hoist motor is a G.E. 40 HP, 650/2180 RPM, type CD-504-AY. It is a totally enclosed, non-ventilated, moisture protected, ball bearing, shunt wound, crane type motor with class H insulation. The hoist has a minimum speed of 2.2 FPM, a maximum full load speed of 22 FPM, and a maximum no load speed of 66 FPM.

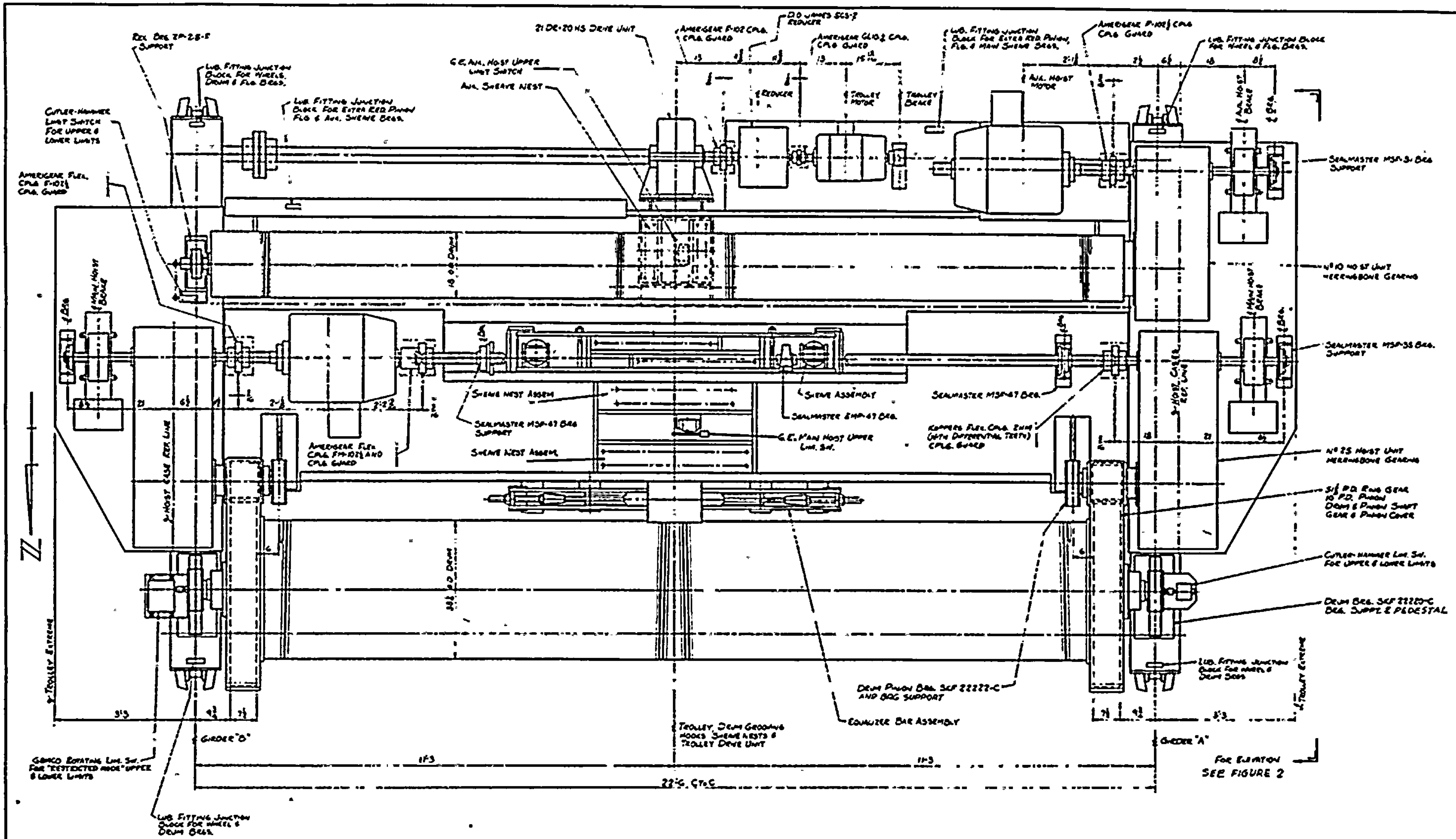
The brake is a G.E. IC-9528-A-102 shoe type, magnetic, D.C. electric brake with a 13 inch drum. It is capable of sustaining more than 150 percent of the motor's full load torque (550 ft-lbs) and will set automatically if the controller is returned to the neutral (off) position, or if power is lost.

The reeving is a single 12 part system using 9/16 inch diameter special flexible improved plow steel wire rope (6 strand, 37 wire) with independent wire rope center. The drum has an 18 inch outside diameter.

A single hook with safety latch, guarded to exclude dirt, is used. This hook is made from single piece forged AISI 4140 heat treated steel. It has anti-friction thrust bearings, and will rotate 360 degrees. It will be tested for cracks, flaws, and other defects by ultrasonic and magnetic particle means. In its highest position the hook's bottom is 34 feet above the operating floor. The hoist is equipped with one screw type and one weight type limit switch to prevent overtravel in the upward direction, and one screw type limit switch to prevent overtravel in the downward direction. Figures 1 and 2 show plan and elevation of the new auxiliary hoist.

4. Redundant Main Hoist.

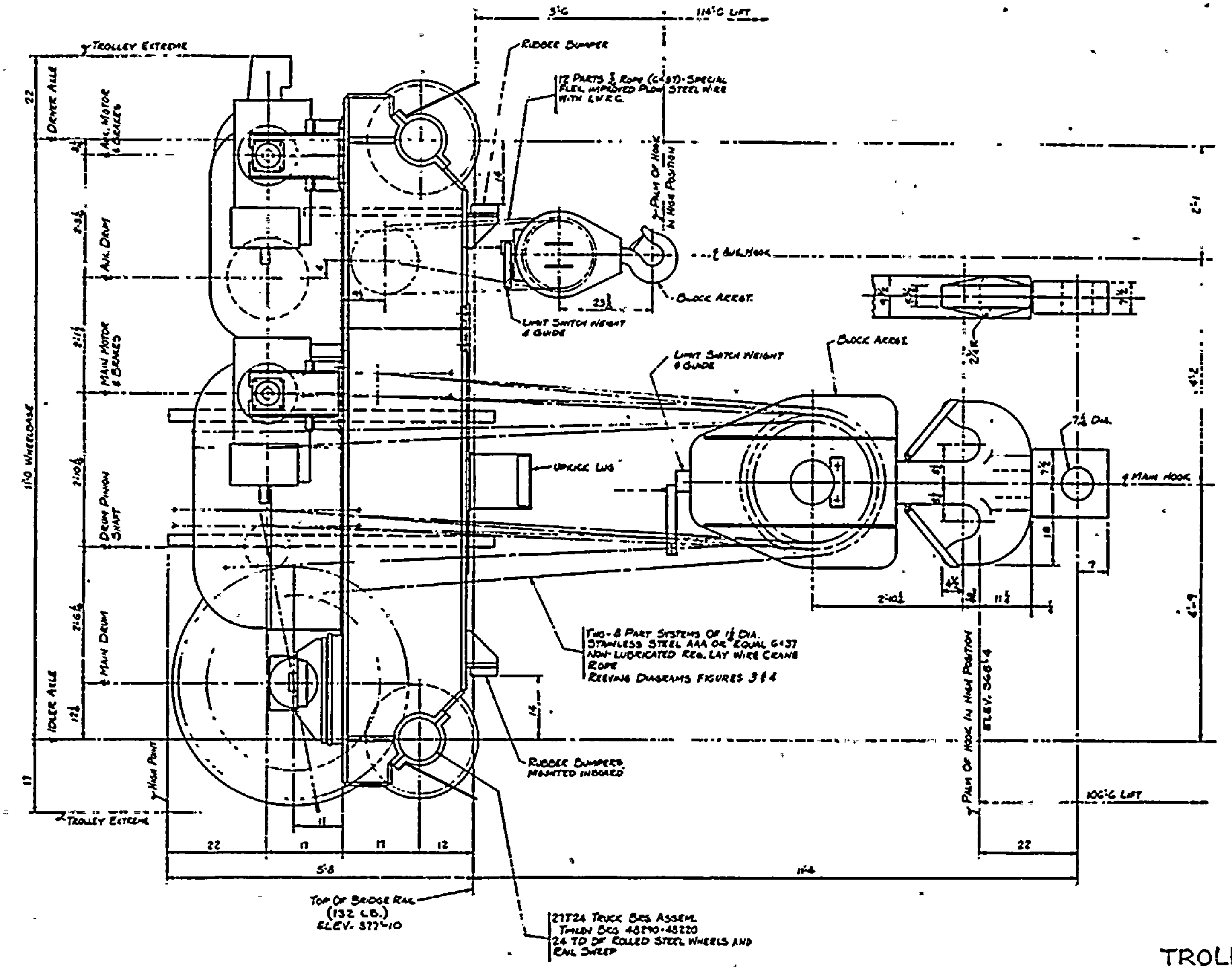
The new trolley's 125 ton capacity redundant main hoist will be operated from the present push button station and controlled by G.E. Maxspeed 320 D.C. adjustable voltage controllers. The motor is a G.E. 40 HP, 650/2180 RPM, type CD-504-AY. It is a totally enclosed, non-ventilated, moisture protected, ball bearing, shunt wound, crane type motor with class H insulation. Minimum speed is 0.4 FPM, maximum full load speed is 4.0 FPM. Maximum no load speed is 12 FPM.




| MAIN EQUIPMENT DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| UNIT | RATIO | SPEED FPM | HP (G.E. MOTORS) | RPM (G.E. MOTORS) | FRAME (G.E. MOTORS) | GE MAGNETIC BRAKES | HOIST LIMIT SWITCHES | CURRENT & CONTROL |
| MAIN HOIST | 42.6:1 ÷ 2.133:1 | 4 | 40 | 650/280 | CD-506-AT | (TWO) 13" IC-9528-A102 | MAIN & AUX. HOIST UPPER LIMIT SWITCHES G.E. IC-9445-C200 (WEIGHT TYPE) | 3 PH. 60 HZ. 600 V. |
| AUX. HOIST | 22.58:1 | 22 | 40 | 650/280 | CD-506-AT | 13" IC-9528-A102 | MAIN & AUX. HOIST UPPER & LOWER LIMIT SWITCHES CUTLER-HAMMER 0316 TYPE J (ROTATING CAM) | MAXSPEED 320 |
| TROLLEY DRIVE | 29.95:1 ÷ 3.06:1 | 50 | 7½ | 1200 | MR-256-K | 4 1/2" IC-9456-4618 | MAIN HOIST "RESTRICTED MODE" UPPER & LOWER LIMIT SWITCH GEMCO BULL 1980 (ROTATING CAM) | |

TROLLEY & HOISTS
PLAN VIEW

FIGURE 1




TROLLEY & HOISTS ELEVATION

FIGURE 2

Redundancy of machinery components is provided by two complete gear trains between the hoist motor and the drum assembly. All gearing is designed with a minimum factor of safety of 5, based on the maximum rated capacity of the crane. That is, the calculated static stress in the material does not exceed 20 percent of the average ultimate strength of the material. In case of failure of either gear train, the hoist remains sufficiently operable to permit positioning of load under normal power or by gravity loading using manual operation of the hoist brakes. In the event of failure of the shaft coupling in either of the two units, or failure of the motor shaft, connecting shaft, or power, the brakes will support the load.

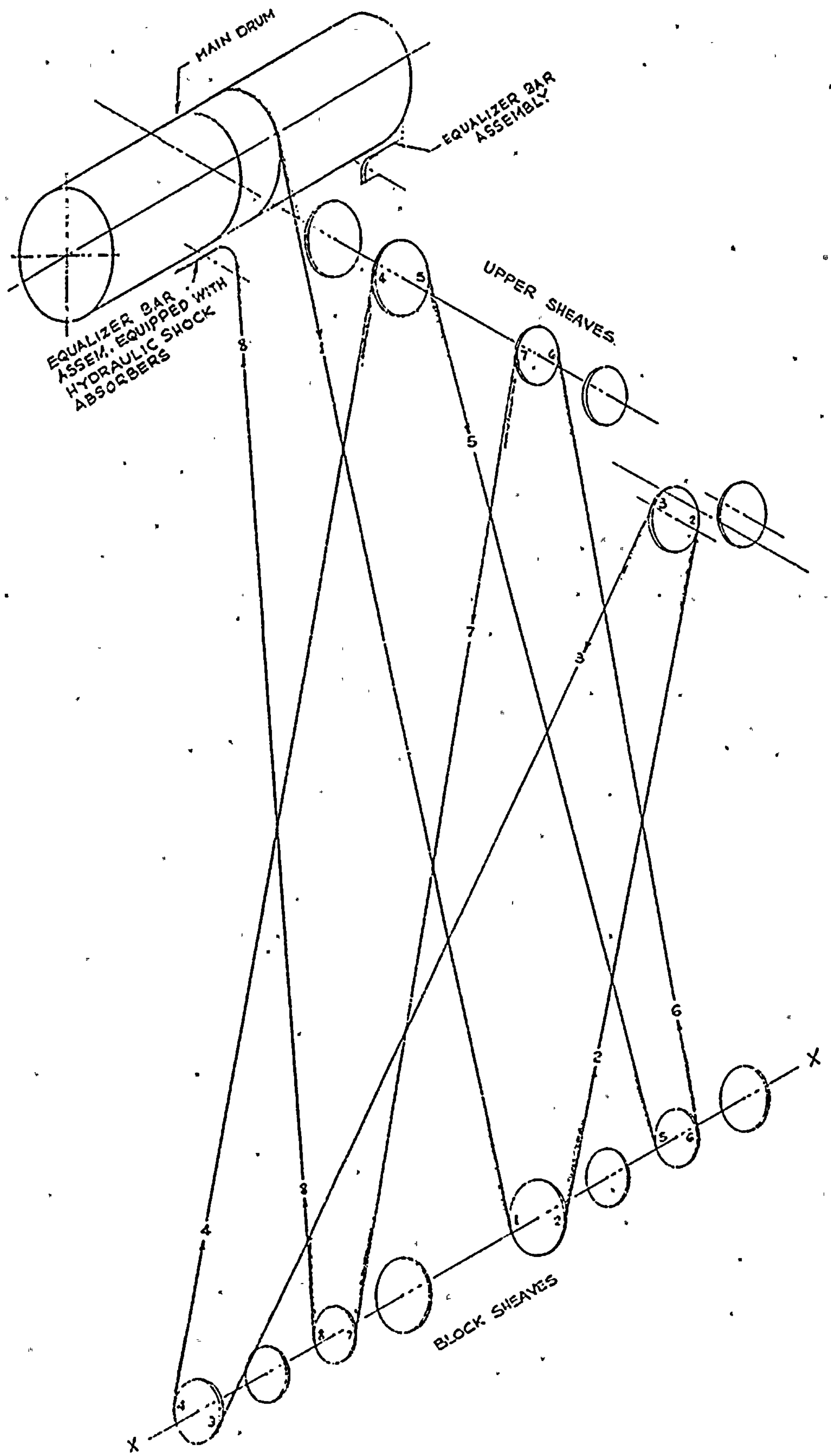
Each gear train has its own brake. These are G.E. IC-9528-A-102 shoe type, magnetic, D.C. electric brakes with 13 inch drums. Each is capable of sustaining more than 150 percent of the motor's full load torque (550 ft-lbs). The brakes set automatically if the controller is returned to the neutral (off) position, or if power is lost.

Redundancy of rope is provided through the use of two 1-1/8 inch diameter stainless steel ropes with independent wire centers. Each rope is anchored to the 38 - 1/4 inch outside diameter hoist drum and the equalizer bar assembly. Provisions are made for adjustments to equalize the two lengths of rope. The drum hub is contained in a bracket to support drum and load in case of drum shaft or bearing failure. Thus, droppage of the drum is limited to a fraction of an inch. Pinions are designed to remain engaged with the drum gear to prevent load drop. A factor of safety of 5 remains in effect.

The equalizer bar is fitted with double acting hydraulic shock absorbers to minimize impact energy in the event of failure of a single rope. The bar is contained within structural steel components so that if it or its pivot should break, the parts would be retained within the trolley and preclude drop of load.

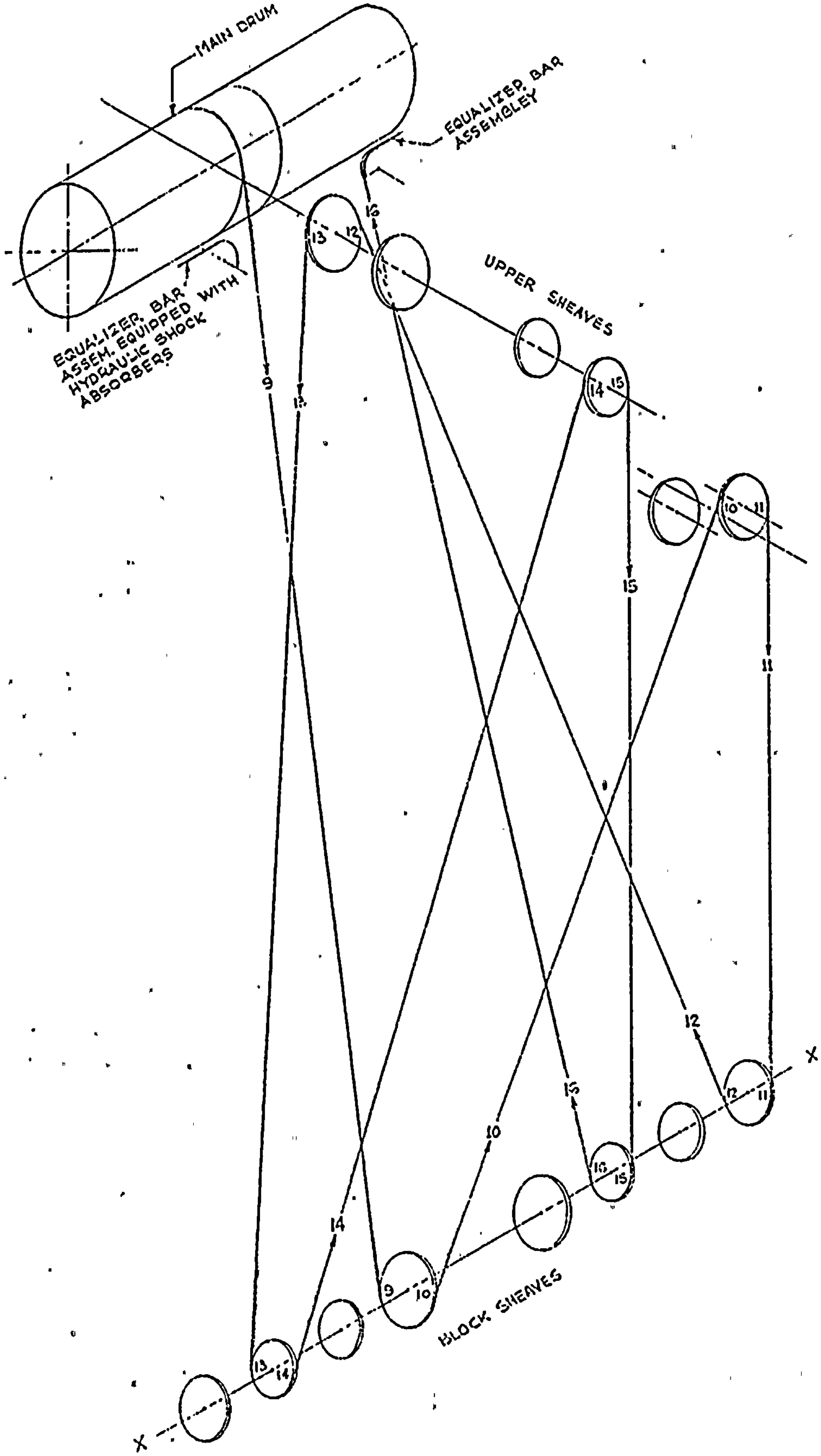
The ropes are reeved over the lower block sheave and upper sheave assemblies so that its 8 parts provide 2 parts in each quadrant of the load block about the vertical axis of the hook as shown in Figures 3 and 4. There are two 33 inch, two 30 inch, and four 27 inch diameter pulleys in the bottom load block. The top sheave contains four 33 inch and two 41 inch diameter pulleys. The sheaves are encased in heavy structural steel. Retainers are incorporated to sustain the rated load if a sheave pin or swivel should fail.

In the high position, vertical centerline distance between lower block pulleys and upper sheave pulleys is 9 feet 8 inches. The block and load follow a true vertical path at all times.




ROPE REEVING DIAGRAM - ROPE Nº 1 - 8 PARTS

FIGURE 3




ROPE REEVING DIAGRAM - ROPE Nº 2 - 8 PARTS

FIGURE . 4

With both ropes effective, the load is shared equally by all 16 parts of rope. If one rope loses its effectiveness, the load will be supported by the eight parts of the remaining rope. The load will continue to hang vertically and the block will retain its rotational capabilities.

The load block assembly includes two load carrying devices, a sister hook and a lifting eye. Each device is made from single piece forged slab ASTM-A-235 class E steel and is guarded to exclude dirt. The hook is equipped with anti-friction thrust bearings and will rotate 360 degrees. The hook, lifting eye, and block assembly weighs approximately 14,000 lbs. The hook and eye will be tested for cracks, flaws, and other defects by both ultrasonic and magnetic particle means.

In the hoist's high position the palm of each half of the sister hook is 28 feet 4 inches above the operating floor. The bottom of the lifting eye is 25 feet 11 inches above the floor. For the present hoist these heights are 29 feet 2 inches, and 28 feet 8 inches, respectively. The vertical centerline distance between the lower block pulleys and the upper sheave pulleys is 9 feet 8 inches. Upward overtravel is prevented by one screw type and one weight type limit switch. Downward overtravel is prevented by one screw type limit switch. Figure 2 shows key clearances in the main hoisting system.

C. <u>Hoist Safety Features</u>:

Load drop for all postulated credible component failures is precluded by:

1. Redundant ropes in case of rope failure.

2. Retainers to sustain load in the event of sheave pin or swivel failure.

3. Brackets to retain drum in case of shaft or bearing failure. Pinions remain engaged to sustain load in the event of such failure.

4. Shock absorbing equalizer bar, with components to retain bar and sustain load if bar or its pivot should break.

5. Two complete independent gear trains between hoist motor and drum.

6. Brake for each gear train to sustain load in event of motor, motor coupling component or power failure.

D. Hoist Shock Loadings

Computations show that for main hoist shock loading the factor of safety with all 16 parts of stainless steel rope effective is 7.2. In the event of failure of one rope, all dynamic loading on the remaining rope would produce a factor of safety against shock loading of 2.4.

The above factors of safety were derived from the fact that the load is supported on a total of sixteen parts of rope. Thus, the load in each part of rope under normal conditions is 1/16th of the total weight, or 15,625 lbs. In the event of failure of one rope, the total weight would still be supported by a total of 8 parts of rope. The load in each of these 8 parts of rope would be doubled.

Such failure would produce first an acceleration of the load, then a deceleration, as the remaining rope stretched. The force required to decelerate the load is equal to the weight transferred from the broken rope to the remaining rope. This weight is 125,000 lbs, and is shared equally by the eight parts of the remaining rope. Thus, the maximum impact load in each part of the remaining rope is 15,625 lbs. The impact load is added to the total static load, resulting in a total load of 46,875 lbs. for each part of rope.

This value is three times the rope load before the break. Therefore, the factor of safety is reduced from 7.2 before the break to 2.4 after the break. These calculations are conservative in that they do not consider the cushioning effect of the sheave nests, trolley load girt and bridge girders, or the shock absorbing action built into the equalizer assembly.

The maximum rope stress value was used in the design of the components of the mechanical gear trains driving each end of the drum. All of these components have a higher factor of safety than does the rope.

E. Effect on Existing Bridge Girders

The maximum credible earthquake acceleration of 0.11g produces a horizontal acceleration of 0.5g and a vertical acceleration of 0.25g at the bridge, as described in the FSAR[3]. This produces a combined stress in each girder of 23,649 psi, which is about 72 percent of its yield strength.

Failure of one of the main hoist ropes would produce a vertical stress in each girder of 17,832 psi, which is 54 percent of its yield strength. The stress value resulting from failure of one rope is thus lower than the value resulting from maximum seismic conditions.

Bridge girder stresses and deflections under normal conditions were calculated according to Crane Manufacturers Association of America (C.M.A.A.) Specification No. 70. The results are:

Vertical Stress = 15,742 psi

Deflection = 1.32 inches

Allowable values under this standard (using A-7 materials with average ultimate strength of 65,000 psi) are:

Allowable stress = 16,000 psi

Allowable deflection = 1.65 inches

F. Crane Failure Analysis

As has been shown, the new trolley and hoist are designed to preclude load drop for all postulated credible crane failures. Potential crane failures which could make the crane inoperable while handling a spent fuel shipping cask fall into two categories:

a. Failures which can be repaired without unloading the crane (e.g., control system malfunctions, motor failures, loss of power, etc.)

b. Failures which can be repaired only after unloading crane (e.g., failure of a drive train component which is located between the brake and the load).

In the case of the former, expeditious action will be taken to repair any failure which occurs during handling of a fuel cask. This will minimize the period of time that the load is supported be the crane. In the case of postulated crane failures which require unloading of the crane, auxiliary support equipment, independent of the crane, will be used to unload the overhead crane and support the fuel cask while repairs to the crane are made. A more detailed description of the methods which will be used to support the fuel cask has been presented in a previous submittal.[2]

G. Quality Control and Assurance

The Whiting Corporation and its subsuppliers will have in their shops at all times an inspection, testing, and documentation program manual approved by Niagara Mohawk. Adherence to this manual will ensure that the crane equipment meets ANSI N45.2-197 requirements, the codes listed above under "A. Design Basis", and Niagara Mohawk's other specifications.

1. Design Verification

All design computations will be performed by fully qualified personnel. These computations will also be checked and signed by qualified personnel. The computations, and the qualificiations of the designing and checking personnel, will be audited by Niagara Mohawk.

2. Non-Destructive Testing

a Welds

The following welds will be tested by liquid penetrant means:

(1) All main load girt welds except those for deck plate and secondary stiffeners.

(2) Main load girt to structural truck connecting angle welds.

(3) Structural truck web plate to cover plate welds.

(4) All welds on main hoist drum.

b Gears and Shafts

All important gears and shafts in both main hoist drive trains will be tested by magnetic particle means.

c Motors

Each motor shall be given routine factory tests as defined in NEMA MG1-18.516.

d Hooks

Both the auxiliary hoist and the main hoist hooks will be tested by magnetic particle and by ultrasonic means.

e Shop Test

The Whiting Corporation will assemble the crane in its plant and perform no load testing.

f Full Load Test

Testing at 125 percent of full load will be performed when the crane is installed at Nine Mile Point. This testing will comply with OSHA 29CFR1910, subpart N, Material for Handling and Storage, Section 1910.179 Overhead and Gantry Cranes.

3. Documentation

The Whiting Corporation must provide Niagara Mohawk with certified copies of reports of all tests performed on load bearing and seismic members of the crane.

4. Inspection

Niagara Mohawk has reserved the right to make inspections and tests of any portion of the crane at any time during its construction.

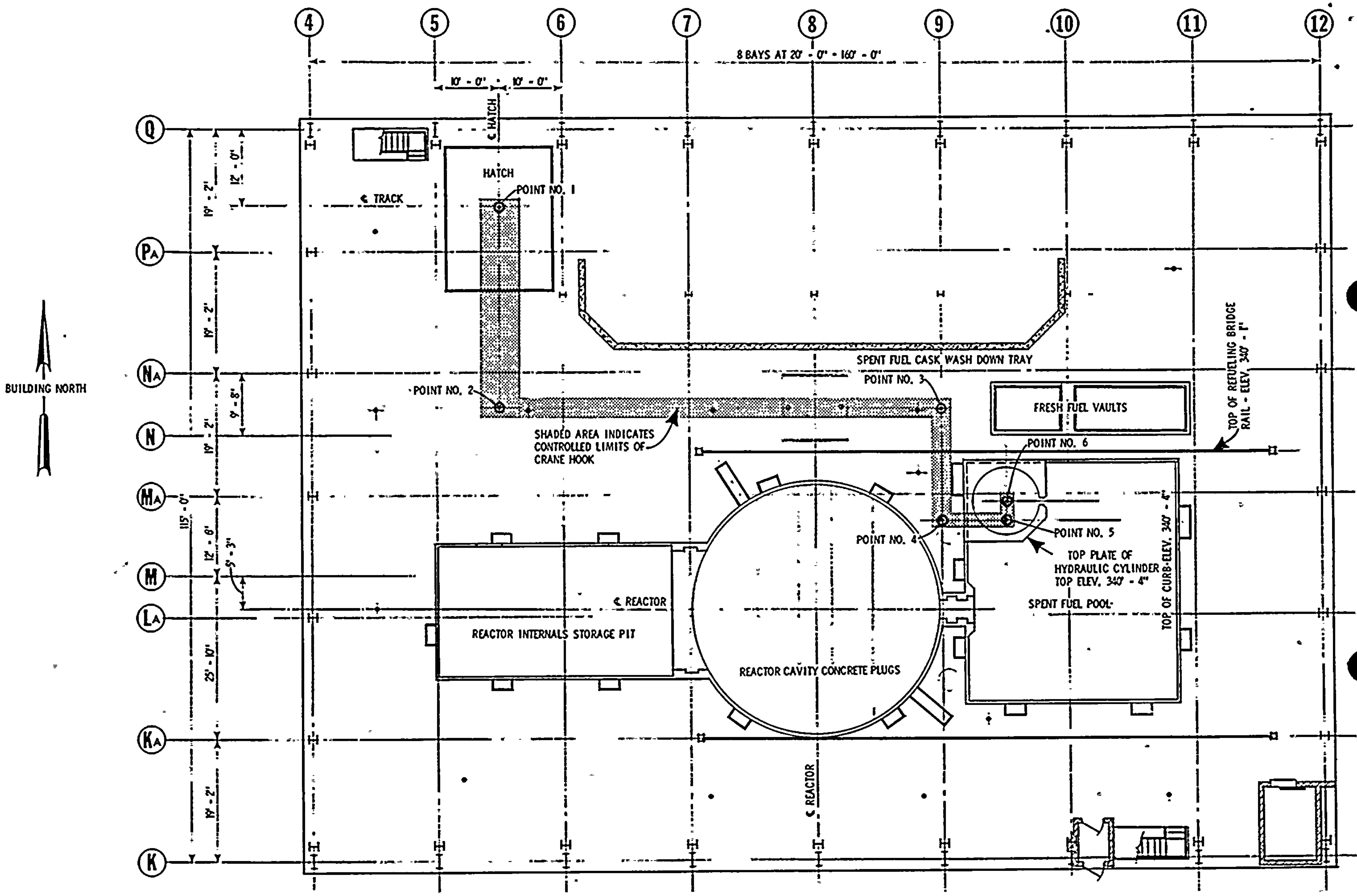
5. Operation

Operation will be in compliance with U.S.A.S. B30.2.0-1967, Chapters 2-3.

H. <u>Fuel Cask Handling Procedures and Crane Movement Controls</u>

The path of the fuel cask from the hatchway to the hydraulic guide cylinder in the spent fuel pool has been discussed in previous submissions[1,2], and is shown in Figure 5. This path avoids passing the cask over critical reactor components and assures that a cask dropped over the spent fuel pool will enter the guide cylinder. A cask dropped over the pool would be decelerated by the guide cylinder and thus cause no damage to the pool. The width of the path for the cask centerline is 6 inches in the vicinity of the guide cylinder (between points 4 and 6 on Figure 5)[2].

For controlled movement of the fuel cask along the entire path, the 125 ton capacity reactor building crane is being equipped with a system of limit switches and logic circuitry providing two modes of crane operation. "Mode 1" is normal (unrestricted) crane operation. "Mode 2" restricts crane travel so that all movement of the fuel cask in the Reactor Building is within the designated control path shown in Figure 5. A key operated selector switch controls the mode of operation.




**PLAN AT ELEV. 340 -0**

**Horizontal Controlled Path of Spent Fuel Cask** **Figure 5**

The key may be removed when the switch is in the "Mode 2" position, but not when it is in the "Mode 1" position. All movement of spent fuel casks will be solely under "Mode 2". Station operating procedures provide that "Mode 2" operation be allowed only when under control of designated supervisory personnel and with the key removed.

The operational control system which functions only under "Mode 2", exercises the following protective controls:

1. Immediate loss of all horizontal bridge or trolley motions if the fuel cask base plate is not at the critical elevation defined by hoist limit switch. This critical elevation is 6 inches above the operating floor, and 3 inches above the curb around the spent fuel pool.

2. Immediate negation of all hoist, trolley and bridge travel if the vertical center line of the fuel cask is permitted to stray beyond the bounds of the control path. Crane motion, regardless of direction, cannot be resumed until the selector switch is turned to "Mode 1" position.

These controls are accomplished using limit switches of two types. Compound adjustable screw type limit switches will be used on the main hoist in order to limit upper travel. Track type limit switches with appropriate trips will be mounted on one runway on the crane bridge, and on the trolley trucks to limit the horizontal travels of the fuel cask to within the bounds of its designated control path as shown in Figure 5.

## References

1. Letter from T. J. Brosnan to J. F. O'Leary, September 29, 1972.

2. Letter from P. D. Raymond to D. L. Ziemann, May 31, 1973.

3. Nine Mile Point Unit 1 FSAR, Vol. I, Section VI.