b. The operating environment including maximum and minimum pressure, temperature, humidity and emergency, corrosive or hazardous conditions should be specified for the crane. The minimum specified operating temperature should be equal to or higher than 60°F above the nil-ductility transition temperature (NDTT) for the ferritic materials. If the minimum specified operating temperature is less than 60°F above the manufacturer's guaranteed NDTT for the ferritic crane materials, testing of the material toughness should be required. The NDTT should be determined by a drop weight test (DWT) performed in accordance with ASTM specification E-208.

CP&L: The crane is designed for outdoor service with weather protection provided for the mechanical and electrical components. Outside temperature can be expected to range from 20°F to 105°F. Since it has not been a practice for past cranes to include NDTT consideration into crane specifications, no NDTT drop weight tests were performed for this crane. However, it has been determined from the steel manufacturers for the steel used in this crane that typical values for NDTT are at 40°F. A requirement to have the minimum operating temperature at 60°F above NDTT is not feasible or necessary as shown by the following:

(1) CMAA #70 specifies a minimum operating temperature of 0°F. Operating experience for all Whiting Corporation cranes built to CMAA #70 and the preceding EOCI specification # 61 has shown no failures due to brittle fracture.

(2) Failures due to brittle fracture result from high stress concentrations, impact loadings and low temperature. High stress concentrations are prevented in this crane by design practices which eliminate high stress risers and by providing low allowable stresses. The maximum basic allowable stress for any member under tension or compression subject to repeated loading is 17,600 psi. The basic allowable stress includes the dead weight, live load and impact allowance as required by CMAA #70. This gives a minimum safety factor of two based on the yield stress of 36,000 psi for ASTM-A36. The crane is designed for 20,000 to 100,000 loading cycles compared to actual loading cycles of less than 2,500 which will take place over a 40-year life.

(3) The crane will receive 125% of capacity load test as required by ANSI B.30.2.0 which will prove the capability of the crane to handle a capacity load safely.

Based on the above the minimum specified operating temperature for the main hoist will not be less than the temperature recorded at the time of the 125% load test. The load test will not be performed at less than 45°F.

c. The crane should be classified as Seismic Category I and should be capable of retaining the maximum design load during an SSE, although the crane may not be operable after the seismic event. The bridge and trolley should be provided with means for preventing them from leaving their runways with or without the design load during operation or under any seismic excursions. The design rated load plus operational and seismically induced pendulum and swinging load effects on the crane should be considered in the design of the trolley, and they should be added to the trolley weight for the design of the bridge.

CP&L: Seismic Category I criteria were not considered in the design of the replacement crane. Seismic Category I was unnecessary since the support structure is a seismic Class III as described in the H. B. Robinson FSAR and was designed for seismic loads in accordance with the Uniform Building Code. The structure was also designed to carry a 150-ton capacity crane and all of its associated loads.

Based on the overdesign of the fuel handling building structure for a 150-ton capacity crane and the induced impact due to longitudinal loads associated with the design of the crane and its supports, no failure of the fuel handling building structure is expected for the design basis earthquake. The crane is not stored in a position over the spent fuel pit. Hold-down lugs have been provided to prevent the wheels of the trucks and trolley from lifting from the rails when subject to a vertical acceleration of .2g. The replacement crane is conservatively designed on the basis of a static analysis for vertical accelerations of .2g and horizontal accelerations of .2g acting simultaneously. The effects of a swinging load induced by an earthquake with same vertical and horizontal accelerations have been analyzed and found to be negligible.

d. All weld joints for load bearing structures including those susceptible to lamellar tearing should be inspected, including nondestructive examination for soundness of the base metal and weld metal.

CP&L: All load bearing welds on the crane have undergone examinations to assure that the welds and adjoining base metal are free from defects. All weld joints on the crane were made using qualified welders and weld procedures. The load bearing welds in the trolley were examined by magnetic particle examination. All load bearing welds in the bridge were qualified by examination of the macro test specimens for the automatic welding process. All welds have received a thorough visual examination.

An examination for lamellar tearing has not been performed on the load bearing welds since no acceptable industry standards for detecting or defining lamellar tearing by nondestructive examination have been developed. A review of the weld joints on the crane using the guideline of the AISC "Commentary on Highly Restrained Welded Connections" shows that some joints could possibly, but

not conclusively, have the joint geometry required for highly restrained welded connections. However, the AISC points out that for the great majority of welded connections, the conditions which provide the potential for lamellar tearing or other distress, do not exist. Therefore, since it is impossible to determine the exact conditions to cause lamellar tearing and since acceptable inspection standards have not been developed, the safety of the weld joints must be based on expertise of experienced designers and load testing as follows:

(1) As pointed out by the AISC "this commentary is not intended in any sense to be a substitute for individual expertise in a particular application". The expertise in this area has been adequately demonstrated by Whiting Corporation in their crane design. The weld joints used in this crane are identical to those used in many other Whiting cranes. No failures have ever been attributed to lamellar tearing on Whiting cranes.

(2) To verify crane safety and to demonstrate that no detrimental lamellar tears exist, a 125% of capacity load test will be performed as required by ANSI B20.2.0.

e. A fatigue analysis should be considered for critical load bearing structures and components of the crane handling system. The cumulative fatigue usage factors should reflect effects of the cyclic loading from both the construction and operating periods.

CP&L: The crane load bearing structures and components were designed to meet the requirements of CMAA #70 for Class A1 cranes which are standby service cranes. The number of loading cycles for the new crane will be less than 2500 during the service life. CMAA #70 requires that a Class A1 crane be designed for 20,000 to 100,000 loading cycles. A detailed fatigue analysis is not required due to low usage.

f. Preheat and postheat treatment (stress relieving) temperatures for all weldments should be specified in the weld procedure. For low-alloy steel, the recommendations of Regulatory Guide 1.50 should be applied.

CP&L: Welding on this crane meets the requirements of AWS D14.1 "Specification for Welding Industrial and Mill Cranes"

which specifies preheat and postheat temperature where required. The recommendation of Regulatory Guide 1.50 does not apply since weldments are made of ASTM A-36 steel.

2. Safety Features

a. The automatic controls and limiting devices should be designed such that when disorders due to inadvertent operation, component malfunction, or disarrangement of subsystem control functions occur singly or in combination during the load handling and failure has not occurred in either subsystems or components that these disorders will not prevent the handling system from being maintained at a safe neutral holding position.

CP&L: All automatic controls and limiting devices on the new crane are designed so that the load will be maintained in a safe neutral holding position if disorders occur either by operator action, redundant controls, mechanical stops or limit switches.

b. Auxiliary systems, dual components, or ancilliary systems should be provided such that in case of subsystem or component failure, the load will be retained and held in a stable or immobile safe position.

CP&L: A description of the redundant main hoist and other safety features of the crane is provided in Reference (1) of the cover letter. The redundant main hoist and other safety features are designed to retain the load in a safe position in event of a component failure.

c. Means should be provided for devices which can be used in repairing, adjusting or replacing the failed component(s) or subsystem(s) when failure of an active component or subsystem has occurred, and the load is supported and retained in the safe (temporary) position with handling system immobile. As an alternative to repairing the crane in place, means may be provided for safely moving the immobilized handling system with load to a safe lay-down area that has been designed to accept the load while making the repairs.

CP&L: The crane is engineered to preclude failures of components or subsystems when it is properly maintained. The crane will be maintained in accordance with manufacturer's instructions and ANSI B30.2.0 which will preclude failures that would require special devices for repair, adjustment or replacement of a failed component when handling a load. However, in the unlikely event of a failure, the plant staff is prepared to use methods and devices required to place the load in a safe position. Since the type of failure cannot be predicted, any methods or devices would have to be determined when the failure occurs. This will be accomplished by qualified plant engineering and maintenance personnel. The minimum requirements for plant personnel are outlined in the H. B. Robinson FSAR. Work on the crane will comply with the H. B. Robinson continuing Quality Assurance Program which meets the requirements of 10 CFR50 Appendix B.

d. The design of the crane and its operating area should include provisions that will not impair the safe operation of the reactor or release radioactivity when corrective repairs, replacements and adjustments are being made to place the crane handling system back into service after component failure(s).

CP&L: The crane is located outside the reactor containment building and cannot be operated over critical safety systems or equipment important to reactor safety. In the unlikely event a failure should occur (See 2.c above) over the cask sit-down area, consideration would be given for moving the load away from the spent fuel building for making repairs, replacements, or adjustments.

3. Equipment Selection

a. Dual load attaching points (redundant design) should be provided as part of the load block assembly which are designed so that each attaching point will be able to support a static load of 3W (W is weight of the design rated load), without permanent deformation of any portion of the load block assembly other than localized strain concentration in areas for which additional material has been provided for wear.

CP&L: The dual load attaching points are a sister hook and concentric lifting eye attached to a load block. A description and figure are included in Reference (1)

of the cover letter. The sister hook and lifting eye are each designed to handle a static load not less than 375 tons (3W).

b. Lifting devices which are attached to the load block such as lifting beams, yokes, ladle or trunnion type hooks, slings, toggles, clevises should be of redundant design with dual or auxiliary devices or combinations thereof. Each device should be designed to support a static load of 3W without permanent deformation.

CP&L: The casks and cask lifting rigs discussed in Reference (1) of the cover letter are the NL 1/2 truck cask and the NL 10/24 rail cask. The lifting yokes for these casks will be of redundant type and designed to support a static load of 3W without permanent deformation. A GE IF-300 shipping cask is also being considered as discussed in Reference (2) of the cover letter. A study has been initiated to determine the feasibility of fabricating a redundant yoke for this cask prior to the expected shipping date.

c. The vertical hoisting (raising and lowering) mechanism which uses rope and consists of upper sheaves (head block), lower sheaves (load block), and rope reeving system, should provide for redundant designed dual hoisting means. Maximum hoisting speed should be no greater than 5 fpm.

CP&L: The redundant hoist system for this crane is discussed in Reference (1) of the cover letter. The maximum hoisting speed is 3 fpm.

d. The head and load blocks should be designed to maintain a vertical load balance about the center of lift from load block through head block and have a dual designed reeving system. The load block should maintain alignment and a position of stability with either system being able to support 3W and maintain load stability and vertical alignment from center of head block through all hoisting components through the center of gravity of the load.

CP&L: An approximate 2 1/2 inch shift will occur in the position of the load block in event that one rope of the redundant rope reeving system fails, however, this has no effect on the ability of the main hoist to hold the load safely. Each rope in the redundant reeving system is capable of holding a static load of 3.6 W (W = 250,000 lbs) based on the rope breaking strength.

e. Design of the rope reeving system(s) should be dual with each system providing separately the load balance on the head and load blocks through configuration of ropes and rope equalizer(s). Selection of the hoisting rope or running rope should consider the size, construction, lay, and means or type of lubrication to maintain efficient working of the individual wire strands when each section of rope passes over the individual sheaves during the hoisting operation. The effects of impact loadings, acceleration, and emergency stops should be included in selection of rope and reeving system. The wire rope should be 6 x 37 IWRC or comparable classification. The lead line stress to the drum during hoisting (dynamic) at the maximum design speed with the design rated load should not exceed 20% of the manufacturer's published rated strength of the wire rope. The design rated load for static stress on rope (load is stationary) should not exceed 12 1/2% of the manufacturer's published rated strength. Line speed during hoisting (raising or lowering) should not exceed 50 fpm.

CP&L: The rope reeving system is a redundant reeving system with each rope sharing the load equally through the trolley sheaves, load block, drum and equalizer assembly. The

balanced beam type equalizer assembly assures the even distribution of load between the two ropes. Each rope is 1 1/8 inches diameter stainless steel, 6 x 37 1.W.R.C. with a lay of approximately 7". This rope is selected to provide good flexibility, maximum strength and minimum enlongation under load. The rope will be field lubricated and lubricated periodically to maintain effective working of the individual wire strands. The calculated load for the lead lines under dynamic conditions is 20,760 pounds each with all parts effective which is 17% of the published strength rating of 118,650 pounds. The design rated load on the wire rope under static conditions with all 16 parts effective is 16,500 pounds which is 14.0% of the published strength rating. The rope design loads provide adequate safety margin to allow for impact loads. Maximum line speed during hoisting is 26 fpm.

f. The maximum fleet angle from drum to lead sheave in the load block should not exceed 3 1/2 degrees at any one point during hoisting and should have only one 180° reverse bend for each rope leaving the drum and reversing on the first or lead sheave on the load block with no other reverse bends other than at the equalizer if sheave equalizer is

used. The fleet angles between individual sheaves for rope should not exceed 1 1/2 degrees. Equalizers may be beam or sheave type. For the recommended 6 x 37 IWRC classification wire rope, pitch diameter of lead sheave should be 30 times rope diameter for the 180° reverse bend, 26 times rope diameter for running sheaves, and drum with 13 times rope diameter for equalizers. The pitch diameter is measured from the center of the rope on the drum or sheave groove through the drum or sheave center. The dual reeving system may be a single rope from each end of a drum terminating at a beam type load and rope stretch equalizer with each rope designed for total load, or a two rope system may be used from each drum or separate drums using a sheave equalizer or beam equalizer, or any other combination which provides two separate and complete reeving systems.

CP&L: The maximum fleet angles encountered during the hoisting cycle are illustrated on the attached Whiting Drawing T-53326 which shows rope No. 1. Rope No. 2 has identical fleet angles. These fleet angles are within the ratio of one to 12, or 4° 45' which is a Whiting Corporation standard published in 1955 and also appears in Whiting Crane Handbook published in 1967. Minimum fleet angles are necessary to keep wear between the rope and sheave at a minimum. The

4° 45' maximum fleet angle has been established to provide good rope life. Experience with this fleet angle standard on other Whiting cranes at the H. B. Robinson Plant and the Brunswick Unit No. 2 Plant has shown no wear problem. Whiting also reports no problems with this fleet angle standard on their cranes since the 4° 45' requirement was published in 1955.

The only reverse bend in the reeving arrangement is from the main drum to the lead sheave in the load block, however, this reverse bend is not in the category of a reverse bend type addressed in the guide. This is because the distance of the rope between the tangent points on the drum and the sheave is 9' 4". Tangent points must be close coupled on less than two lays of the rope in order for the bend to be considered as a reverse bend. Each lay for the rope is approximately 7". All other rope bends in the reeving arrangement over the load block sheaves and trolley sheaves are direct bend and are not subject to the effects of reverse bending. The trolley sheaves are oriented 90° from the load block sheaves. As the rope passes over one sheave, the greatest strained fiber will be in a neutral axis as it passes over the next sheave oriented 90°. The design of this reeving system has the effect of

increasing the life of the rope. The point of tangency between the load block sheaves and the trolley sheaves is approximately 9' which eliminates any possibility of reverse bends even if the sheaves were oriented to achieve reverse bends.

Sheave diameters are shown on the attached Dwg. T-53326. The sheave diameters meet the minimum requirements of CMAA #70. The sheave diameters are selected to be consistent with experience and to keep the flexing stress from becoming excessive. The trolley and hoisting arrangements are shown on attached Whiting Drawings U-70624, U-70625, U-66666, T-53326 and T-53327.

The number of cask handling operations (8 lifts per operation) which can occur prior to rope failure has been calculated to be 2500. Neglecting the effects of wear, the ropes will last for 400 years or 20,000 capacity lifts. These calculations are based on examinations of test data from Drucker and Tachar who found that the best correlation to rope life is based on the relation between the bearing pressure of the rope on the sheaves

and the fatigue strength of the wire. It should be noted that 2500 cask operations or 20,000 capacity lifts provide a very conservative design due to the following:

1. Actual cask shipments over the 40-year life of the plant using a 10 element cask will be 212 or less than 1/10 of the calculated life of the rope when neglecting the effects of wear.

2. The actual loaded cask weight including lifting yoke will be approximately 110 tons. The rope life calculations were based on 125 tons.

3. Calculations were based on a sheave diameter to rope diameter ratio of 24 to 1. Most sheave diameters are larger as illustrated on Drawing T-53326.

4. The calculations were based on the maximum fiber stress occurring each time the rope passed over a sheave. Since trolley sheaves are oriented 90° from the load block sheaves the maximum fiber stress only occurs on alternate sheaves for a given fiber.

5. Calculations were based on 6 x 37 wire rope. Actual rope used is 6 x 37 I.W.R.C. wire rope which has better fatigue life.

Failure of a rope due to wear is considered very unlikely due to the following:

1. The ropes are operated in a nonabrasive atmosphere.

2. Fleet angle requirements are consistent with good design practice and confirmed by operating experience resulting in no problems.

3. Inspection and maintenance of the crane are performed under a Quality Assurance Program which meets the requirements of 10 CFR50 Appendix B. Under plant procedures the ropes will be inspected to assure compliance with ANSI B30.2.0 and the manufacturer's instructions. These requirements are listed for information as follows:

   ANSI B30.2.0

   a. All running ropes in continuous service should be visually inspected once every working day.

A thorough inspection of all ropes shall be made at least once a month and a full written, dated and signed report of rope condition kept on file where readily available to appointed personnel. All inspections shall be performed by an appointed or authorized person. Any deterioration, resulting in appreciable loss of original strength such as described below, shall be carefully noted and determination made as to whether further use of the rope would constitute a safety hazard:

(1) Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion or wear of outside wires.

(2) A number of broken outside wires and the degree of distribution or concentration of such broken wires.

(3) Worn outside wires.

(4) Sections of rope which are normally hidden during inspection or maintenance procedures, such as

parts passing over sheaves, should be given close inspection as these are points most likely to fail.

(5) Corroded or broken wires at end connections.

(6) Corroded, cracked, bent, worn or improperly applied end connections.

(7) Severe kinking, crushing, cutting or unstranding.

b. All rope which has been idle for a period of a month or more due to shutdown or storage of a crane on which it is installed shall be given a thorough inspection before it is placed in service. This inspection shall be for all types of deterioration and shall be performed by an appointed or authorized person whose approval shall be required for further use of the rope. A written and dated report of the rope condition shall be filed.

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Replacement of the rope should be considered when any of the following conditions have occurred.

(1) Twelve randomly distributed broken wires in one rope lay, or four broken wires in one strand in one rope lay.

(2) Wear of one-third the original diameter of outside individual wires.

(3) Kinking, crushing, bird caging or any other damage resulting in distortion of the rope structure.

(4) Evidence of any heat damage from any cause.

(5) Reductions from nominal diameter of more than:

3/64 inch for diameters to and including 3/4 inch; 1/16 inch for diameters 7/8 inch to 1 1/8 inches inclusive; 3/32 inch for diameters 1 1/4 inches to 1 1/2 inches inclusive.

g. The portions of the vertical hoisting system components, which includes the head block, rope reeving system, load block, and dual load attaching device, should each be designed to sustain 200% of the design rated load. Each

reeving system and each one of the load attaching devices should be assembled with approximately a 6-inch clearance between head and load blocks and should support 200% of the design rated load without permanent deformation other than localized strain concentration or degradation of the components. A 200% static type load test should be performed for each reeving system and a load attaching point at the manufacturer's plant. Measurements of the geometric configuration of the attaching points should be made before and after test followed by nondestructive examination, which should consist of combinations of magnetic particle, ultrasonic, radiograph, and dye penetrant examinations to verify the soundness of fabrication and assure the integrity of this portion of the hoisting system. The results of examinations should be documented and recorded for the hoisting system for each overhead crane.

CP&L: Each portion of the redundant hoisting components is designed to sustain not less than 250% of the design rated capacity.

A 200% load test will not be performed at the manufacturer's plant in view of the following considerations.

1. It is very unlikely that component failures would occur during a 200% test, and the test could produce a negative effect. It is possible that testing at twice the normal rating could precipitate a failure-initiating mechanism such as a nondetectable crack which would act as a subsequent stress riser leading to an eventual failure. Testing at lesser loads such as the ability of the hoist to perform at its design rating while reducing the probability of initiating a failure mechanism. Whiting does not recommend a 200% load test.

2. Verification of the adequacy of the crane to make rated capacity lifts without deformation or failures is demonstrated by the following tests:

   a. A 200% capacity load test has been performed on the sister hook and the lifting eye which makes up the redundant main hook.

   b. A 125% capacity load test will be performed on the installed crane as required by ANSI B30.2.0

h. Means should be provided to sense such items as electric current, temperature, overspeed, overloading and overtravel.

Controls should be provided to stop the hoisting movement within 3" maximum of vertical travel, through a combination of electrical power controls and mechanical braking systems and torque controls, should one rope or one of the dual reeving systems fail.

CP&L: All electric systems required for crane movement are protected by three 80 amp fuses. The control circuit is protected by two 20 amp fuses. All motors are protected by current sensing overload relays. A slack line and overload sensing arrangement is designed into the trolley to stop hoist motion in event of a slack line or overload condition. The main hoist is protected by two centrifugal overspeed switches. Hoisting motion will stop within 3" when power is interrupted to the hoist motor.

i. The control systems should be designed as combination electrical and mechanical and may include such items as contractors, relays, resistors, and thyristors in combination with mechanical devices and mechanical braking systems. The electric controls should be selected to provide a maximum breakdown torque limit of 175% of the required rating for a.c. motors or d.c. motors (series or shunt

wound) used for the hoisting drive motor(s). Compound wound d.c. motors should not be used. The control system(s) provided should consider hoisting (raising and lowering) of all loads, including the maximum design rated load, and the effects of the inertia of the rotating hoisting machinery such as motor armature, shafting and coupling, gear reducer, and drum.

CP&L: The control system for the crane is shown on the attached Whiting Drawing U-71279. The brakes are discussed in Reference (1) of the cover letter. A control to limit the breakdown torque to 175% of the motor rating is unnecessary due to the following:

1. The criteria and material selections provide mechanical parts capable of handling stall torque of the motor as limited by controllers to approximately 275% of rated motor torque, without producing stresses in mechanical parts in excess of 90% of the material yield strength.

2. The overload device stops the hoist when hook load exceeds its calibrated setting.

The control system is designed to handle all hoisting operations at rated load including the effects of inertia.

j. The mechanical and structural components of the complete hoisting system should have the required strength to resist failure should the hoisting system "two block" or the load hangup during hoisting. The designer should provide means, within the reeving system located on the head or on the load block combinations, to absorb the kinetic energy of rotating machinery at the instant of "two blocking" or load hangup. The location of mechanical brakes and their controls should provide positive, reliable, and capable means to stop and hold the hoisting drum(s) for the conditions described in the design specification and regulatory positions 1.0 and 2.0. This should include the maximum breakdown torque of the driving motor if a malfunction occurs and power to the driving motor cannot be shut off at the time of the emergency condition of load hangup or "two blocking".

CP&L: Although the mechanical and structural components are designed such that failure is unlikely in the event the hoisting system should "two block" or hangup, the control system is designed to prevent this from occurring. Two blocking is prevented by the use of two independent limit switches. One is a weight type switch which stops the hoist when contacted by the load block. The second is a screw type limit

switch actuated by revolutions of the drum. A two-blocking situation could cause some damage to the slack line and overload sensing device. Since control protection is designed into the crane to prevent two blocking, a kinetic energy absorber is unnecessary. Also, the crane will be operated in accordance with ANSI B.30.0 which states that "the hoist limit switch which controls the upper limit of travel of the load block shall never be used as an operating control". In event of a load hangup, the hoist motor is deenergized by the overload sensing device.

Brakes are described in Reference (1) of the cover letter. Each main hoist electric stopping brake is designed to hold 222% of rated motor torque. The electric brakes release when the main hoist motor is energized and automatically set when the hoist motor is deenergized.

Since two blocking is prevented by limit switches and operator action and load hangup trips the overload sensing device, and in view of the fact that the electric brakes do not operate independently of the hoist motor, it is unnecessary to design the brakes for rated break-down torque of the motor.

k. The load hoisting drum on the trolley should be provided with structural and mechanical safety devices to prevent the drum from dropping, disengaging from its holding brake system, or rotating should the drum of any portion of its shaft or bearings fail or fracture.

CP&L: A structural safety device is considered unnecessary to prevent the drum from dropping since the drum is designed with a safety factor of eight based on ultimate strength and considering combined stress from bending and crushing. In the unlikely event of a failure of a drum bearing or shaft on either side of the drum, a receptacle built into the trolley frame on both sides of the drum will come into contact with the drum hub to prevent the drum from falling. The drum will not rotate or disengage from its holding brake system due to the redundant design of the main hoist system.

l. To preclude excessive breakdown torque the rating (HP) of the electrical motor drive for hoisting should be no more than 10% greater than the calculated design HP required to hoist the design rated load at the maximum design hoist speed.

CP&L: The calculated power requirements for the main hoist motor at full speed with rated load is 34.4 HP. The motor selected for this application is rated at 40 HP or 14% more than the calculated requirement. Excessive breakdown torque is not a problem with this crane as discussed in the CP&L response to 3.1 above.

m. The minimum hoisting braking system should include one power control braking system (not mechanical or drag brake type) and two mechanical holding brakes. The holding brakes should be activated when power is off and should be automatically mechanically tripped on overspeed to the full holding position if malfunction occurs in the electrical brake controls. Each holding brake should be designed to 125% - 150% of breakdown torque at point of application (location of the brake in the mechanical drive). The minimum design requirements for braking systems that will be operable for emergency lowering after a single brake failure should be two holding brakes for stopping and controlling drum rotation. Provisions should be made for manual operation of the holding brakes. Emergency brakes or holding brakes which are to be used for manual lowering should be capable of operation with full load and at full travel and provide adequate heat dissipation. Design for manual brake operation during emergency lowering should include features to limit the lowering speed to less than 3.5 fpm.

CP&L: The main hoist braking system includes two electrical stopping and holding brakes (Whiting type 13" SESA) and two mechanical control brakes built into each main hoist reduction gear (Whiting Type #25). Operation of the brakes is described in Reference (1) of the cover letter. A requirement to have a minimum of two holding brakes for emergency lowering after a single brake failure is unnecessary. Each of the four brakes (two holding, two control) on the main hoist system are designed to hold the load at any point and can be manually operated for stopping and controlling drum rotation. Therefore, in event of any single brake failure, there are three other brakes available for stopping and controlling the load. The mechanical load brake employed as the power control brake is the most positive and, consequently, the best form of braking means that can be employed for retention of the load under all circumstances including power failure. The action of the load locks the brake and stops the load. Positive direction must be given by the motor and control systems to continue lowering. A malfunction of the components upstream of the load brake, including a mechanical component failure, will stop and hold the load. All brakes are capable of operation at full load and full travel and provide adequate heat dissipation. Lowering speed during emergency lowering would be less than 3 fpm, as monitored by operating personnel.

n. The dynamic and static alignment of all hoisting machinery components including gearing, shafting, couplings, and bearings should be maintained throughout the range of loads to be lifted with all components positioned and anchored on the trolley machinery platform.

CP&L: Alignment of all machinery will be verified during operational tests following installation. Frequent inspections will be performed as required by ANSI B30.2.0 to detect any deficiencies.

o. Increment drives for hoisting may be provided by stepless controls or inching motor drives. Plugging should not be permitted. Controls to prevent plugging should be included in the electrical circuits and the control system. Floating point in the electrical power system when required for bridge or trolley movement should be provided only for the lowest operating speeds.

CP&L: The main hoist motor is controlled by a magnetic controller to provide selected speeds for hoisting or lowering by means of variance of the motor secondary currents through resistors. This gives the motor five steps of control for either hoisting or lowering with each step providing a speed change of approximately 20% of the

full speed when handling the cask. This type of step control prevents the momentary application of full line power to the motor (plugging) since the controller must pass through all five steps to apply full motor torque. Floating points are not used on this crane.

p. To avoid the possibility of overtorque within the control system, the horsepower rating of the driving motor and gear reducer for trolley and bridge motion of the overhead bridge crane should not exceed 110% of the calculated HP requirement at maximum speed and with design rated load attached. Incremental or fractional inch movements when required should be provided by such items as variable speed or inching motor drives. Control and holding brakes should each be rated at 100% of maximum drive torque at the point of application. If two mechanical brakes are provided, one for control and one for holding, they should be adjusted with one brake in each system for both the trolley and bridge leading the other and should be activated by release or shutoff of power. The brakes should also be mechanically tripped to the "on" or "holding" position in the event of a malfunction in the power supply or an overspeed condition. Provisions should be made for manual operation of the brakes. The holding brake should be designed so that it cannot be used as a foot-operated

slowdown brake. Drag brakes should not be used. Opposite wheels on bridge or trolley which support bridge or trolley on their runways should be matched and have identical diameters. Trolley and bridge speed should be limited. A maximum speed of 30 fpm for the trolley and 40 fpm for the bridge is recommended.

CP&L: The calculated power requirement including acceleration considerations for the trolley drive motor is 4.32 HP. The motor selected for the trolley drive is rated at 5 HP which exceeds the calculated requirement by 14%. The calculated power requirement including acceleration considerations for the bridge drive motor without wind is 10.7 HP. The motor selected for the bridge drive is rated at 15 HP which exceeds the calculated requirement by 30% without wind. Under a wind load the calculated requirement is approximately the same as the motor rating.

Both the trolley and bridge drive motors are controlled by magnetic controllers to provide selected speeds for forward and reverse by means of variance of motor secondary currents through resistors. Each motor has five steps of control in both directions with each step providing a speed change of approximately 20% of the full speed while handling

the cask. Control brakes are not required for bridge and trolley since (a) speed is not increased by application of load, and (b) motors are AC motor which operate at essentially constant speeds. The holding brake for the trolley is rated at 100% of the rated motor torque. The holding brake for the bridge is rated at 128% of rated motor torque. These brakes meet the requirements of ANSI B30.2.0 and CMAA #70. A description of brake operation for trolley and bridge is included in Reference (1) to the cover letter. Both brakes can be operated manually. The holding brake for the bridge is a foot-operated brake as described in Reference (1) to the cover letter. This brake has an automatic electric parking brake feature which operates any time power is interrupted to the crane. CP&L has found this type of brake on other cranes to be desirable as it provides smooth controlled stopping of the bridge. Excessive wear has been found not to be a problem on Class A cranes as defined by CMAA #70.

Maximum speed for the trolley is 40 fpm and for the bridge 60 fpm. The magnetic controllers for the trolley and bridge provide minimum speeds of approximately 8 fpm and 12 fpm, respectively. Operating experience on the installed crane with the above-referenced maximum speeds proved to be acceptable for service.

q. The complete operating control system and provisions for emergency controls for the overhead crane handling system should be located in the main cab on the bridge. Additional cabs located on trolley or lifting devices should have complete control systems similar to the bridge cab. Manual controls for hoisting and trolley movement may be provided on the trolley. Manual controls for the bridge may be located on the bridge. Remote control or pendant control for any of these motions should be identical to those provided on the bridge cab control panel. Provisions and locations should be provided in the design of the control systems for devices for emergency control or operations.

Limiting devices, mechanical and electrical, should be provided to indicate control and prevent overtravel and overspeed of hoist (raising or lowering) and for both trolley and bridge travel movements. Buffers for bridge and trolley travel should be included.

CP&L: All controls are located within the cab on the bridge. Limiting devices have been discussed elsewhere in this attachment and in Reference (1) to the cover letter. Buffers have been provided for both bridge and trolley.

r. Safety devices such as limit type switches provided for malfunction, inadvertent operation, or failure, should be in addition to and separate from the limiting means or devices provided for operation as mentioned in the preceding. These would include buffers, bumpers and devices or means provided for control of malfunction(s).

CP&L: The following safety devices have been provided:

(1) Mechanical stops for bridge and trolley.

(2) Limit switches for hoisting

(a) Slack Cable
(b) Overload
(c) Hoist Limit - Weight Type
(d) Hoist Limit - Screw
(e) Critical Path Limits During Cask Movement
(f) Equalizer Unbalance
(g) Lower Limit
(h) Overspeed - 2 Switches

(3) Limit switches for trolley

(a) Critical Path
(b) End of Travel

(4) Limit switchs for bridge

(a) Critical Path

s. The operating requirements for all travel movements (vertical and horizontal movements or rotation, singly or in combination) incorporated in the design for the permanent plant crane(s) should be clearly defined in the operating manual for hoisting and for trolley and bridge travel. The designer should establish the maximum working load (MWL). The MWL should not be less than 85% of the design rated load (DRL) capacity for the new crane at time of operation. The redundancy in design, design factors, selection of components, and balance of auxiliary-ancilliary and dual items in the design and manufacture will provide or dictate the maximum working load for the critical load handling crane system(s). The MWL should not exceed the DRL for the Overhead Crane Handling System.

CP&L: The operating requirements for all movements are provided in the operation and maintenance instructions provided with the crane. The maximum working load has been established as the crane capacity or 125 tons.

t. When the permanent plant crane is to be used for construction and the operating requirements for construction are not identical to those required for permanent plant service, the construction operating requirements should be completely defined separately. The crane should be designed structurally and mechanically for the construction loads, plant service loads and their functional performance requirements. At the end of the construction period, the crane handling system should be adjusted for the performance requirements of the nuclear power plant service. The design requirements for conversion or adjustment may include the replacement of such items as motor drives, blocks, and reeving system. After construction use, the crane should be thoroughly inspected, using nondestructive examination, and performance tested. If the load and performance requirements are different for construction and plant service periods, then the crane should be tested for both phases. Its integrity should be verified by designer and manufacturer with load testing to 125% of the design rated load required for the operating plant before it is used as permanent plant equipment.

CP&L: The replacement crane will not be used for construction.

u. Installation instructions should be provided by the manufacturer. These should include a full explanation of the crane handling system, its controls and the limitations for the system and should cover the requirements for installation, testing, and preparations for operation.

CP&L: Installation instructions and operation and maintenance instructions have been provided by the manufacturer which includes a full explanation of the crane handling system, its controls, limitation for the system requirements for installation testing and preparations of operation.

4. Mechanical Check, Testing, and Preventive Maintenance

a. A complete mechanical check of all the crane systems as installed should be made to verify the method of installation and to prepare the crane for testing. During and after installation the proper assembly of electrical and structural components should be verified. The integrity of all control, operating, and safety systems should be verified as to satisfaction of installations and design requirements.

The crane designer and crane manufacturer should provide a manual of information and procedures for use in checking, testing and crane operation. The manual should also describe a preventive maintenance program based on the approved test results and information obtained during the testing; it should include such items as servicing, repair, and replacement requirements, visual examinations, inspections, checking, measurements, problem diagnosis, nondestructive examination, crane performance testing, and special instructions.

Information concerning proof testing on components and subsystems as required and performed at the manufacturer's plant to verify components or subsystems ability to perform should be available for the checking and testing performed at the place of installation of the crane system.

CP&L: The manufacturer has provided necessary drawings, installation instructions, operation and maintenance instructions, procedures and Quality Assurance Documentation and will provide a service representative to assure complete mechanical checks, correct installation, complete testing, system integrity, operation instructions, preventative maintenance instructions, servicing, repair and replacement instructions and information concerning proof testing, performance testing, nondestructive examination and material certifications at the manufacturer's plant.

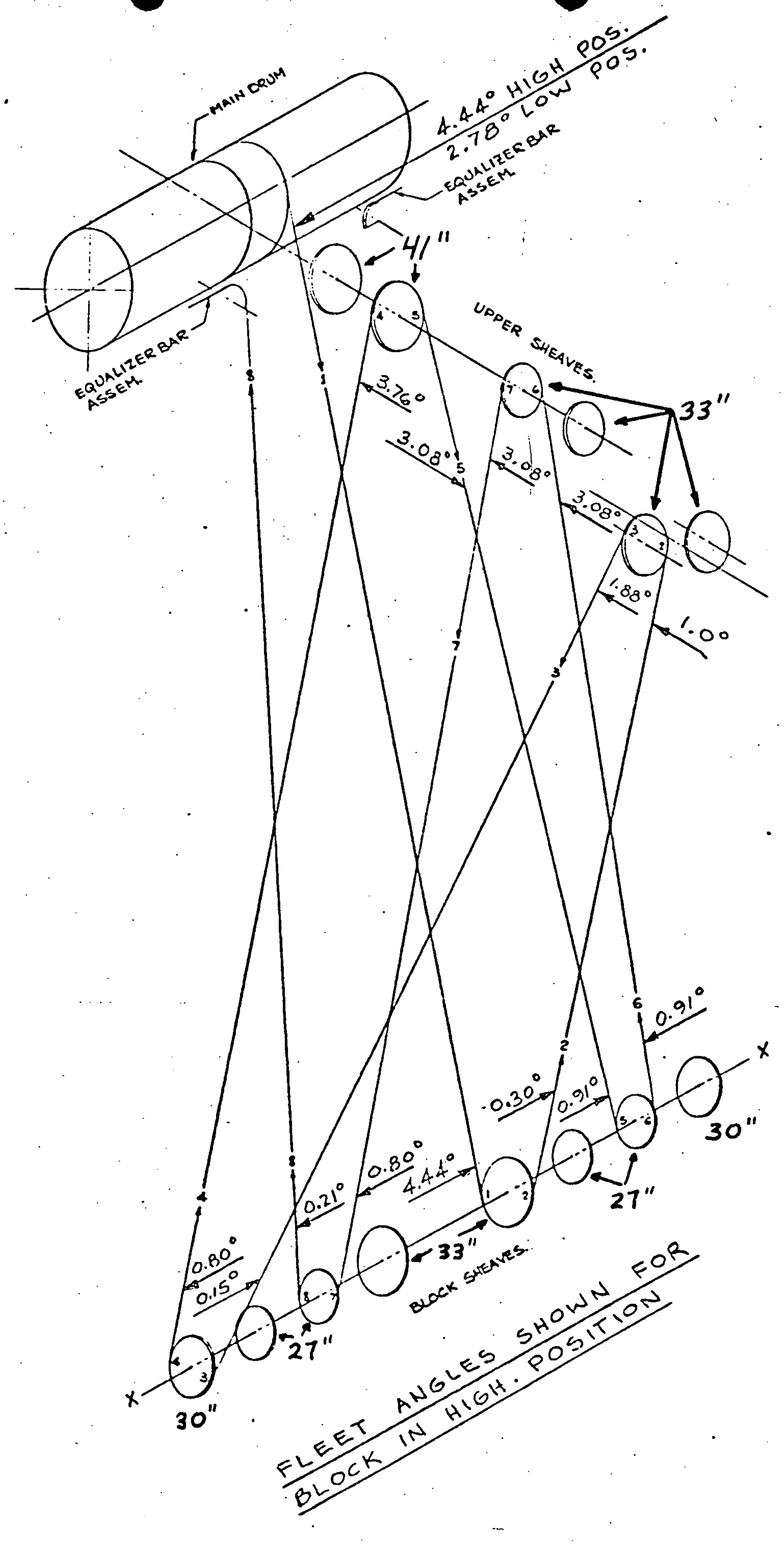
b. The crane system should be prepared for the static test of 125% of the design rated load. The tests should include all positions of hoisting, lowering, and trolley and bridge travel with the 125% rated load and other positions as recommended by the designer and manufacturer. After satisfactory completion of the 125% static test and adjxstments required as a result of the test, the crane handling system should be given full performance tests with 100% of the design rated load for all speeds and motions for which the system is designed. This should include verifying all limiting and safety control devices. The crane handling system with the design rated load should demonstrate its ability to lower and move the load by manual operation and with the use of emergency operating controls and devices which have been designed into the handling system.

The complete hoisting machinery should be able to "two block" during the hoisting test (load block limit and safety devices are bypassed). This test conducted with and without load should provide assurance of the integrity of the design, the equipment, the controls, and the overload protection devices when the maximum torque that can be developed by the driving system, including the inertia of the rotating parts at the overspeed and overtorque condition existing at the instant of full load stalling and impact, is applied.

CP&L: A static test of 125% of the design rated load will be performed as required by ANSI B30.2.0. All movements of the crane will be checked with the test load. Full performance tests with 100% of design rated capacity will be performed on the main hoist for all speeds. Operation of the upper limit switches will be verified during this test. The ability to lower the load by manual operation will be verified. A two blocking test will not be performed and is not necessary since adequate safety limit switches have been incorporated into the design to prevent two-blocking. See CP&L position 3.j above for a discussion on two-blocking.

c. The preventive maintenance program recommended by the designer and manufacturer should also prescribe and establish the MWL for which the crane will be used. The maximum working load should be plainly marked on each side of the crane for each hoisting unit. It is recommended that the critical load handling cranes should be continuously maintained at 95% of DRL capacity for the MWL capacity.

CP&L: The crane will be maintained in order to operate at its design rated capacity of 125 tons.



T-53326

REQN 627606

2-8-72

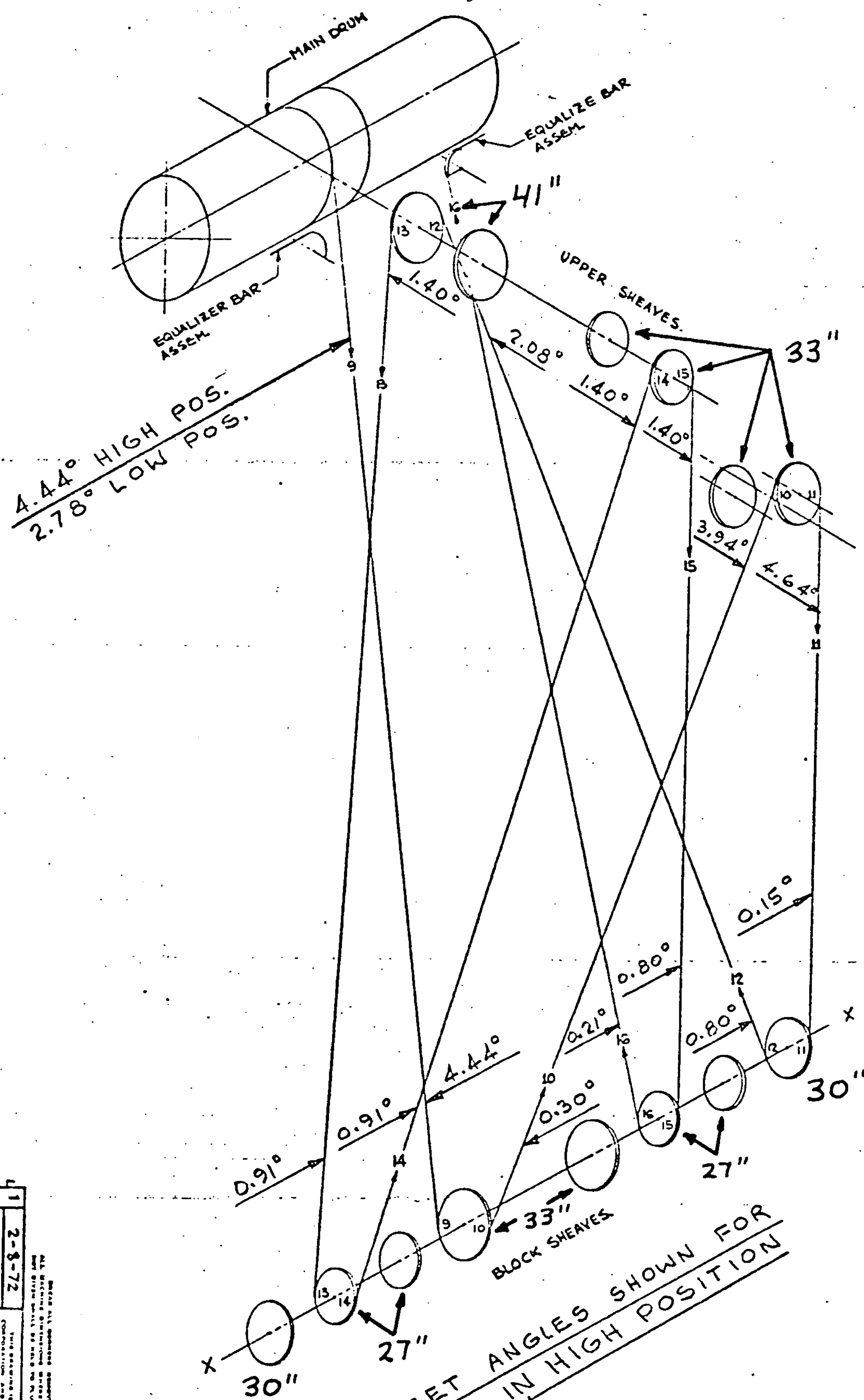
WHITING CORPORATION

TITLE ROPE REEVING DIAGRAM & PARTS OF 16 - ROPE No. 1

DATE 2-17-72

T-53326

T-53327.



627C6
REQ'N

2-8-72

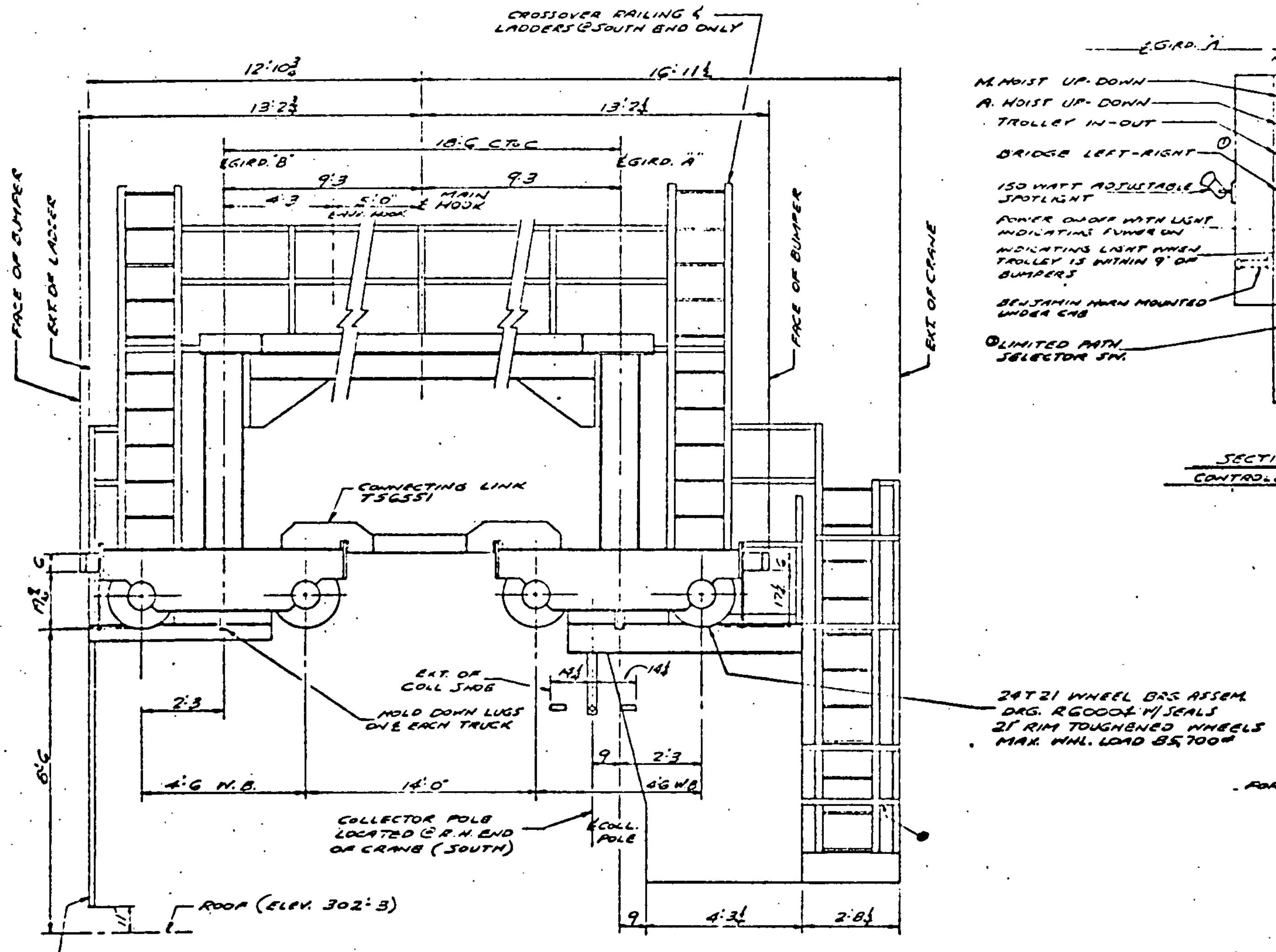
WHITING CORPORATION

TITLE ROPE REEVING DIAGRAM
8 PARTS OF 16 ROPE No. 2

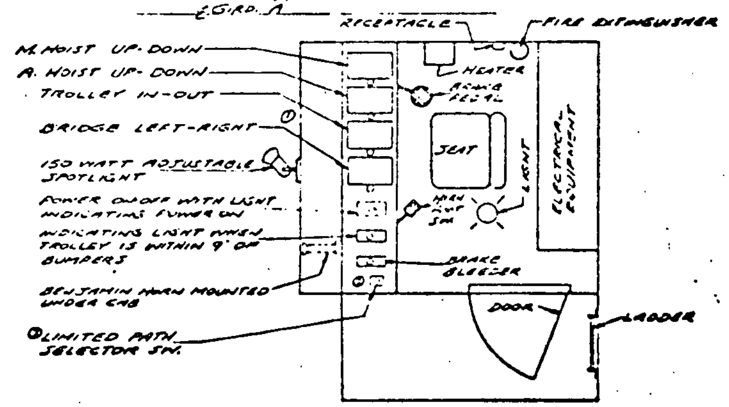
DATE 2-17-72

T-53327

MAT'L	DESCRIPTION	MARK



VIEW "A-A"
LOOKING SOUTH



SECTION "B-B"
CONTROLLER LAYOUT

FOR PLAN & ELEV. VIEWS SEE U70453

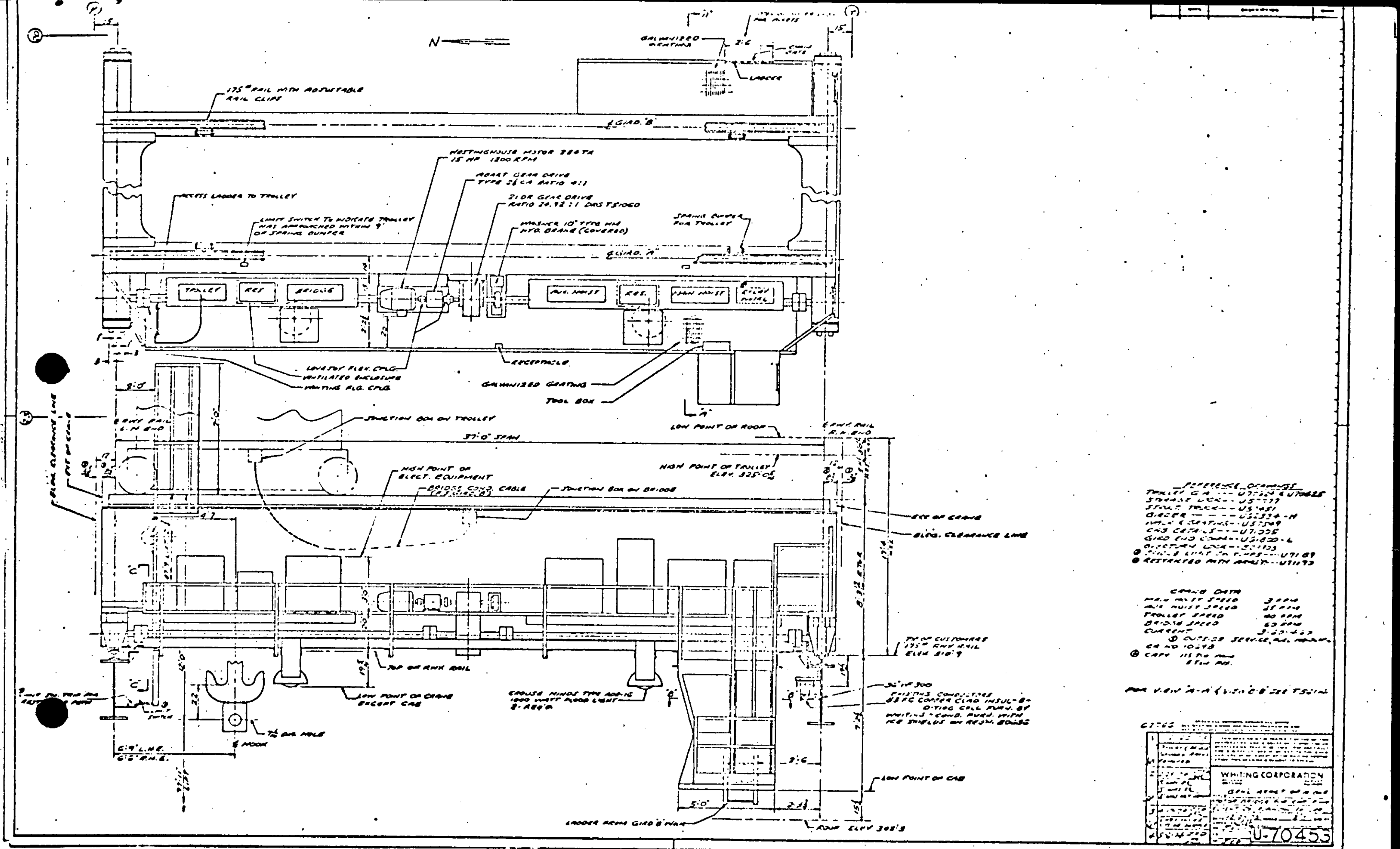
62756

1		
2	2-25-74	WAS BRIDGE & TROLLEY LATCH BY-PASS. WAS NOT SHOWN
3	4-16-74	
4	5-6-74	

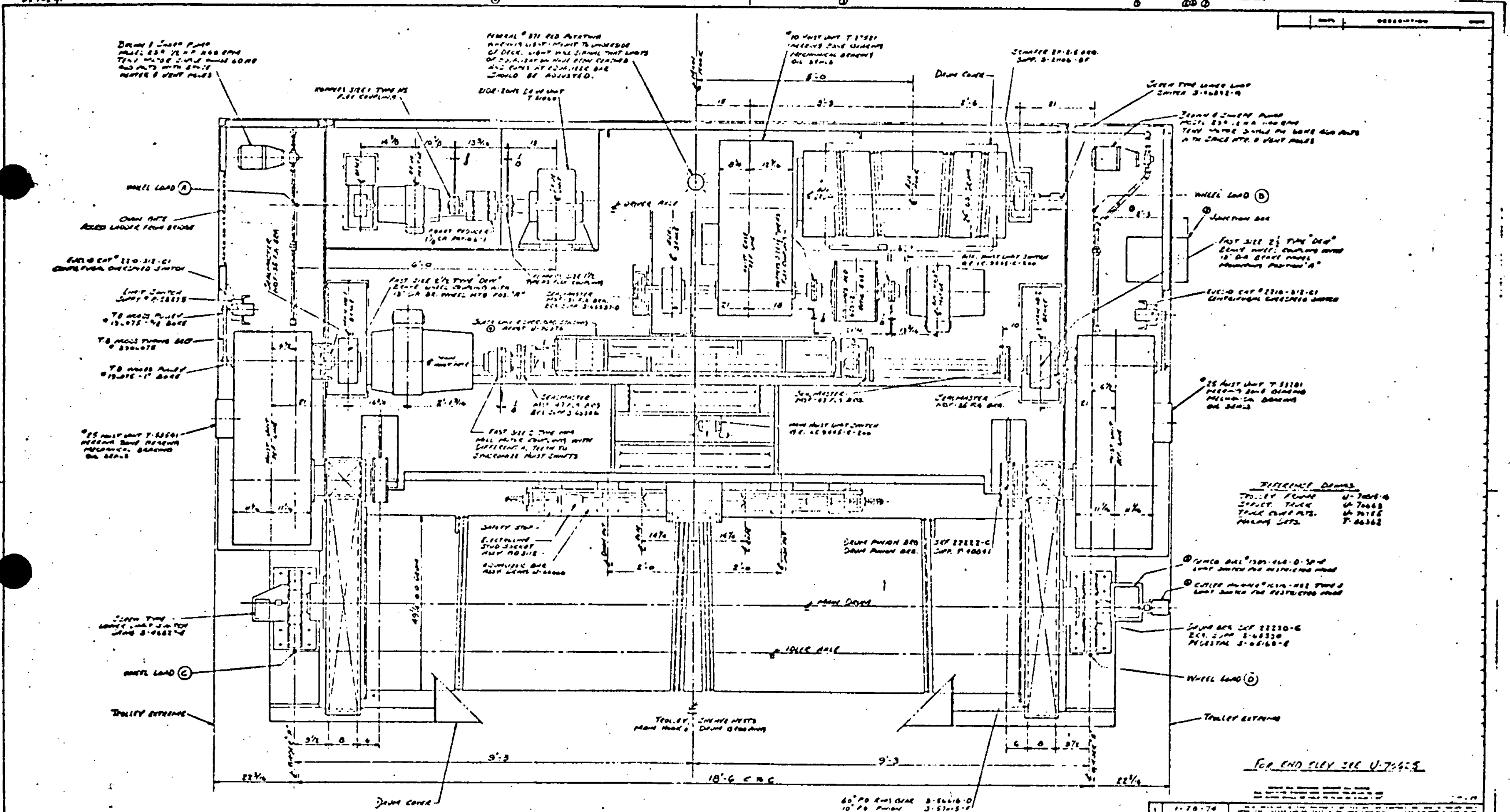
WHITING CORPORATION

TITLE END ELEVATION & CONTROL LAYOUT

T-56114

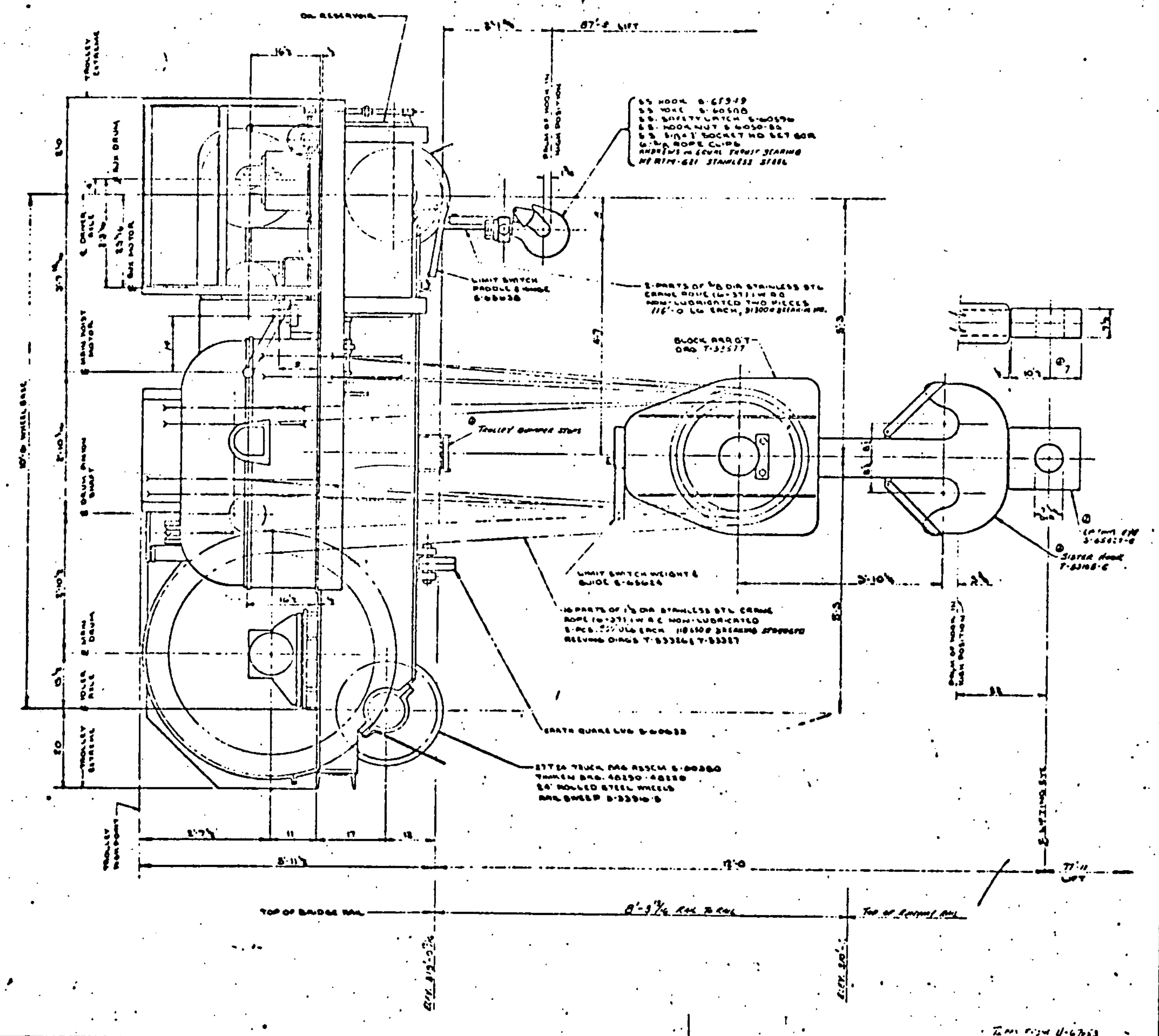


175# RAIL WITH ADJUSTABLE RAIL CLIPS
GALVANIZED GRATING
LADDER
℄ GIRD. 'B'
℄ GIRD. 'A'
WESTINGHOUSE MOTOR 284TA 15 HP 1200 RPM
ACCESS LADDER TO TROLLEY
LIMIT SWITCH TO INDICATE TROLLEY HAS APPROACHED WITHIN 9' OF SPRING BUMPER
SPRING BUMPER FOR TROLLEY
TROLLEY
RES
BRIDGE
AUX. HOIST
RES.
MAIN HOIST
RECEPTACLE
VENTILATED ENCLOSURE
GALVANIZED GRATING
TOOL BOX
JUNCTION BOX ON TROLLEY
LOW POINT OF ROOF
37'-0" SPAN
HIGH POINT OF TROLLEY
HIGH POINT OF ELECT. EQUIPMENT
JUNCTION BOX ON BRIDGE
BLDG. CLEARANCE LINE
TOP OF RWY RAIL
LOW POINT OF CRANE EXCEPT CAB
7/8 DIA HOLE
℄ HOOK
LOW POINT OF CAB
CRANE DATA
WHITING CORPORATION
U-70455



WHITING CORPORATION

U-70624



MAIN HOIST REDUNDANCY

REDUNDANCY OF ROPE IS PROVIDED THROUGH THE USE OF TWO HOIST ROPES. EACH ROPE WILL BE ANCHORED TO THE DRUM AND THE EQUALIZER BAR ASSEMBLY AND WILL BE REEVED THROUGH LOWER AND UPPER SHEAVE ASSEMBLIES SO THAT ITS EIGHT PARTS PROVIDE TWO PARTS IN EACH QUADRANT OF THE LOAD BLOCK ABOUT THE VERTICAL AXIS OF THE HOOK.

WITH BOTH ROPES EFFECTIVE, THE LOAD IS SHARED EQUALLY BY ALL SIXTEEN PARTS OF ROPE. IF ONE ROPE LOSES ITS EFFECTIVENESS, THE LOAD WILL BE SUPPORTED BY THE EIGHT PARTS OF THE REMAINING ROPE.

REDUNDANCY OF MACHINERY COMPONENTS IS PROVIDED BY TWO COMPLETE GEAR TRAINS BETWEEN THE HOIST MOTOR AND THE DRUM ASSEMBLY, EACH CAPABLE OF HANDLING THE RATED LOAD WITH THE CALCULATED STATIC STRESS IN THE MATERIAL NOT TO EXCEED [illegible] OF THE MINIMUM ULTIMATE STRENGTH OF THE MATERIAL.

IN CASE OF A FAILURE IN THE ABOVE MENTIONED SYSTEMS, THE HOIST WILL REMAIN SUFFICIENTLY OPERABLE TO PERMIT POSITIONING OF THE LOAD UNDER NORMAL POWER OPERATION OR BY MANUAL OPERATION OF THE HOIST BRAKES FOR GRAVITY LOWERING.

FURTHER PROTECTION IS PROVIDED BY LUGS TO CATCH THE DRUM HUBS IN CASE OF SHAFT FAILURE, RETAINERS FOR ALL SHEAVES ON TROLLEY AND IN BLOCK TO SUSTAIN LOAD IN CASE OF PIN OR SWIVEL FAILURE.

THE FAILURE OF ANY OF THESE PARTS WILL NOT ALLOW FURTHER OPERATION OF THE HOIST, BUT WILL SUSTAIN THE LOAD.

THE BLOCK ASSEMBLY CONTAINS TWO LOAD CARRYING DEVICES, A LIFTING EYE AND A SISTER HOOK. A FAILURE OF EITHER THE LIFTING EYE OR SISTER HOOK WILL RESULT IN A TRANSFER OF LOAD TO THE SISTER HOOK OR LIFTING EYE RESPECTIVELY.

THE ATTACHMENTS OF THE LOAD TO THE LIFTING EYE & THE SISTER HOOK MUST BE SUCH THAT A FAILURE OF ONE ATTACHMENT WILL NOT PERMIT LOAD TO FREE FALL MORE THAN [illegible].

FOR PLAN VIEW SEE U-70624

WHITING CORPORATION

GEN'L ARR'G'T CR'N
THREE MOTOR TROLLEY
— END ELEVATION —

U-70625