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NSP

NORTHERN STATES POWER COMPANY

MINNEAPOLIS, MINNESOTA 55401

November 22, 1976

Mr Victor Stello, Director
Division of Operating Reactors
U S Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr Stello:

MONTICELLO NUCLEAR GENERATING PLANT
Docket No. 50-263 License No. DPR-22

Design Report for Redundant Reactor
Building Crane

Attached are forty copies of a report describing a modification which will provide redundant lifting features on the Monticello Reactor Building Crane. The report is being submitted for your review to insure that the crane design will be acceptable for use in handling the spent fuel shipping cask.

Since it is anticipated that fabrication of the new trolley will begin in January 1977, your early attention to this matter is requested. Representatives from our Company will meet with members of your staff should you find it necessary.

Yours very truly,

L. O. Mayer

L O Mayer, PE
Manager of Nuclear Support Services

LOM/LLT/deb

cc: J G Keppler
G Charnoff
MPCA
Attn: J W Ferman

12042

Licensing Report NSC-LS&R-NOR-0151-17
November 11, 1976

REDUNDANT DESIGN FEATURE MODIFICATIONS AND SAFETY EVALUATION FOR THE REACTOR BUILDING CRANE SYSTEM AT THE MONTICELLO NUCLEAR GENERATING PLANT

Prepared for

NORTHERN STATES POWER COMPANY

by

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1.0 INTRODUCTION

This report contains a description of crane design modifications for the Monticello Nuclear Generating Plant which would provide for compliance with the regulatory position on the handling of heavy loads in spent fuel storage facilities, as stated in Regulatory Guide 1.13[1]. The modifications will provide a single-failure-proof crane which complies with Regulatory Guide 1.104[2] as applicable to an operating plant.

2.0 REACTOR BUILDING CRANE MODIFICATIONS

A description of the proposed design modifications, the design bases and interface requirements for the plant are provided below.

2.1 DESIGN BASES

A new replacement trolley will be provided for the 85 ton reactor building crane. The trolley will consist of a redundant main hoist system and a 5 ton conventional auxiliary hoist. The new trolley will be designed to be compatible with the existing bridge structure, bridge mounted control system and electrical motor-generator sets.

2.1.1 Design Criteria

In order to assure safe handling of critical loads at the nuclear power plant, the overhead crane system will be designed in accordance with the following general criterion:

> Redundant Crane Handling System
>
> The overhead crane system shall be designed such that a postulated single failure of any critical load handling member of the hoist drive, reeving, active crane components or control devices does not result in a load drop or the loss of capability of the handling system to perform its safety function. The system safety function shall be to prevent a critical load drop which may impair plant structures, vital equipment, spent fuel or safety related design features.

To accomplish this safety function, a dual load path for the reactor building overhead crane shall be provided. There shall be at least two component design features to perform vital load handling functions. This will include mechanical as well as safety limit switch control devices. Where limitations on space, performance, movement and weight preclude the installation of fully redundant trolley components (e.g., the main hook, hoist motor, load block, shafts or structures), the system shall be provided with non-redundant structural and mechanical safety devices (e.g., shock absorbers, safety lugs, etc.) or increased load safety factors to prevent a load drop from occurring.

2.1.2 Safety Design Bases

In accordance with Section C.5.b of Regulatory Guide 1.13[1], the existing crane will be upgraded to include single-failure-proof handling of heavy loads. The design developed will ensure that the provisions of 10CFR50, Appendix A[3], "General Design Criteria", are satisfied as applicable to crane handling system safety functions. Specific criteria applied include: Criterion 1, "Quality Standards and Records"; Criterion 5, "Sharing of Structures, Systems and Components"; and Criterion 61, "Fuel Storage and Handling and Radioactivity Control". In addition, the requirements of Regulatory Guide 1.104[2] have been incorporated into the design where practical. However, specific exceptions have been taken to these requirements due to limitations imposed by available space, extra weight, existing bridge and electrical equipment design, building arrangement, crane movement and hook approach dimensional restrictions.

Based upon the foregoing criteria and limitations, the reactor building crane modification shall meet the following safety design bases:

1. The new trolley shall be designed with redundant load train components to preclude a load drop in the event of a single failure of the main hoist machinery, reeving or other active components.

2. The new trolley design shall employ appropriate safety features, safety factors or protective devices required to ensure that the integrity of non-redundant components is maintained for all anticipated conditions of operation and environment.

3. The new trolley design shall be compatible with the existing bridge structural design, and the bridge mounted controls and electrical equipment without limiting the hoisting capacity or load handling capability of the crane.

4. The crane system shall retain its load and structural integrity for the Safe Shutdown Earthquake (SSE) specified in the Monticello FSAR[4]. Crane operation after the SSE is not required.

5. The new trolley shall be designed as seismic Class I equipment and shall withstand, in accordance with the existing bridge design, a maximum horizontal acceleration of 0.8g with a coincident maximum vertical acceleration of 0.08g applied at the bridge rails.

6. Bridge and trolley equipment shall be adequately restrained to prevent derailment, load displacement, loss of load control and travel during the seismic loading imposed by Item 5.

7. The crane system shall ensure safe handling of all critical loads including spent fuel shipping casks, fuel storage equipment and components required for plant operation and refueling.

8. Redundant brakes shall be available for emergency lowering to control speed and dissipate heat following any single brake failure.

9. A load equalizing and transfer feature shall be provided between the redundant load trains such that for a postulated rope failure, the intact reeving system shall remain balanced without excessive motion or impact loading.

10. Redundant means of main hoist upper travel limit controls shall be provided to prevent damage due to excessive upper travel.

11. The new trolley shall withstand the design operating environment specified for the reactor building including long periods of idleness at high humidity.

12. The crane system shall be subjected to pre-operational performance tests, load tests and functional tests as specified in the applicable Codes and Standards governing overhead crane systems.

13. The existing program for periodic testing, inspection, surveillance and maintenance for the reactor building crane shall be applied to the new trolley to ensure continued safe operation during its service life.

14. A Quality Assurance Program, established in accordance with the applicable requirements of 10CFR50 Appendix B shall be followed.

2.1.3 Applicable Codes and Standards

The following codes and standards are applicable to the crane modification throughout all phases of design, fabrication, installation and testing. These provisions are in accordance with design and procurement specifications and 10CFR50.55a.

AGMA - American Gear Manufacturers Association, for defining and calculating the gear durability and strength horsepower requirements.

AFBMA - Anti-Friction Bearing Manufacturers Association, for bearing load limits and expected bearing life calculations.

AISE - Association of Iron and Steel Engineers, for basic outline of mechanical components such as drum grooving, drive systems, electrical horsepower calculations, and reeving efficiency calculations.

ASCE - American Society of Civil Engineers, rules for designing the structure, bolting, and connections, which are not fully covered in C.M.A.A. #70.

ASTM - American Society for Testing Materials, for specifying the grades of material and material testing procedures.

AISI - American Iron and Steel Institute, for specifying general materials such as shafting and forgings.

AWS - American Welding Society, AWS D14.1 or D2.0 used for welding procedures.

CMAA - Crane Manufacturers Association of America, Specification No. 70, for basic parameters and structural, mechanical, and electrical features.

NEMA - National Electrical Manufacturers Association, used to specify electrical equipment such as controls and panels.

SSPC - Steel Structures Painting Council, for cleaning and painting specifications.

ANSI - American National Standards Institute, the B30.2.0 safety code[5] for electric overhead bridge cranes which is also part of OSHA.

NFPA - National Fire Protection Association, Code No. 70-1975, for electric safety which is also part of OSHA.

NEC - National Electrical Code, for specifying the wiring, insulation, and fastenings.

IEEE - Institute of Electrical and Electronic Engineers, for industrial controls and recommended practices.

OSHA - Occupational Safety and Health Administration, 29CFR1926.179[6], Federal Register, Vol. 36, No. 105; and 29CFR1926.550, Construction Standards and Interpretations, for safety requirements for walkways, guard rails, switchgear, clearances checkout and testing procedures for maintenance and operation.

ASME - American Society of Mechanical Engineers, defines nondestructive testing, supplements ASTM and AWS and assists in design of machinery components.

AISC - American Institute of Steel Construction, specification for rails and structural methods; covers the details referenced in C.M.A.A Specification #70.

SAE - Society of Automotive Engineers, for shafting and machinery fittings not contained in AISI and AISC.

2.2 LOAD HANDLING REQUIREMENTS

During plant operation, the most critical lift involving heavy loads with the reactor building crane is the spent fuel shipping cask. Other load handling requirements are as follows:

(1) Reactor building shield blocks and plugs:
156,000 lbs, 20 lifts per year

(2) Reactor vessel head:
140,000 lbs, 2 lifts per year

(3) Drywell vessel head:
92,000 lbs, 2 lifts per year

(4) Reactor steam separator:
87,000 lbs, 2 lifts per year

(5) Reactor steam dryer:
51,000 lbs, 2 lifts per year

It is anticipated that the General Electric IF-300 and the Nuclear Fuel Services NFS-4 (Nuclear Assurance, NAC-1) spent fuel shipping casks will be used to transport spent fuel from the facility.

A complete description of the two casks to be handled is provided in Section 3.4 and Reference 7 for the IF-300 cask and Reference 8 for the NFS-4 (NAC-1) cask.

2.3 MODIFICATION DESCRIPTION

The Reactor Building Crane is an indoor, electric powered traveling bridge crane, with a single trolley cab or pendant controlled 85 ton main hoist. The crane was originally constructed by the Crane Manufacturing and Service Corporation to the requirements for a Class A crane established by the Electrical Overhead Crane Institute Specification 61[9], and Bechtel Design Specification 5828-M-3[10]. A complete description of the existing crane design, operation and testing is provided in Reference 11. Figure 2-1 shows the existing reactor building arrangement and crane dimensional envelope.

The existing bridge and bridge mounted equipment will be retained and a replacement trolley with a redundant main hoist and conventional auxiliary hoist will be provided. The replacement trolley will be furnished by Ederer, Incorporated, a qualified crane manufacturer with previous nuclear and QA experience.

2.3.1 Existing Equipment

The entire crane will be evaluated for the additional weight, load requirements and operating conditions imposed by the new trolley design. The existing equipment to be retained are as follows:

Crane Bridge and Drive

The bridge of the crane consists of two welded box section girders rigidly attached to the bridge trucks. The bridge drive consists of two 7.5 h.p. direct current motors each coupled to a drive wheel axle through a gear reducer. The drive systems are located on opposite sides of the box girders. The drive motors receive electrical power from their own motor-generator set. The bridge drive has regenerative braking similar to that described for the existing main hoist in Reference 11.

The bridge parking brake is a solenoid operated disc and shoe brake which is set and released as described for the existing main hoist mechanical brakes. The parking brake is designed to hold 150% of the rated full load drive motor torque and sets automatically on loss of power to the brake or drive motor. The truck wheels are double flanged machine steel. The end truck has safety lugs to limit the drop of the truck in the event of a wheel or axle failure. The bridge has two end-of-travel limit switches which, when activated, de-energize the drive motors and brake solenoids. The bridge has four polyurethane bumpers and runway stops to prevent over-travel of the bridge.

The bridge will be altered only as required to interface with the new trolley and the additional control safety features. The existing General Electric Maxspeed control system is to be adapted and utilized.

Crane Control System

The existing bridge and new trolley will be controlled using the present General Electric Company Maxspeed crane drive system. The Maxspeed crane drive system is a D-C adjustable-voltage drive operating from an A-C power source. The basic drive consists of a D-C shunt wound motor, a motor-generator set operating on A-C power and supplying adjustable D-C voltage power to the D-C motor, an A-C/D-C control panel, a start-stop pushbutton for the MG set, and a cab master switch or pendant station for controlling direction of motion and speed.

The Maxspeed Drive is a speed control drive providing programmed speed versus load characteristics and smooth acceleration and deceleration regardless of how rapidly the operator manipulates the controller. The Maxspeed Drive 'number' refers to the programmed speed characteristic selected for the drive unit and is the percent of full load hoist speed at which the drive will operate in the hoisting direction at no-load. The bridge and trolley drive units are Maxspeed 100 Drives which employ regulated speed control using a shunt wound D-C motor. The no-load speed is nearly the same as full-load speed with generator voltage being regulated. The main hoist drive unit is a Maxspeed 320 drive which provides a speed-load characteristic curve allowing no-load speed to increase.

The complete operating control system, including emergency controls, are located in the main cab on the bridge. Remote controls, or pendant controls, have the same control functions as the controls in the cab. To stop from a fast speed, the Maxspeed drive decelerates the motor by regenerative braking before the mechanical brake is set. This saves wear on the brake and lessens the strain on the machinery. These controls also provide smooth acceleration and regenerative lowering during emergencies.

A mainline circuit breaker is provided in the cab. An emergency stop pushbutton is provided in the cab and on the pendant for disruption of all power to drives. A "dead man" switch is also provided in the cab which automatically cuts off all motions if the operator leaves the control station.

Control of crane motions will be from either the operator's cab or from the pendant. Controls are so arranged that both hoists cannot be operated simultaneously and pendant controls cannot be used simultaneously with cab controls.

2.3.2 New Equipment

A new reactor building 85/5 ton trolley will be designed, fabricated, tested and delivered by Ederer, Incorporated and will employ redundant design features not provided by the existing trolley. The new trolley will weigh approximately 128,000 lbs and will provide dual main hoist components to meet the single failure criterion and the design bases stated in Section 2.1.2. A main hoist double drum arrangement will be used with a unique quad-support reeving concept. The new trolley arrangement is shown in Figure 2-2. This arrangement was specifically selected to best meet the space, clearance and safety requirements without restricting the lifting capability or travel envelope with the new trolley design.

2.3.2.1 Trolley Design

The new trolley arrangement is shown in Figure 2-2. The technical specifications for the new trolley and a comparison with the existing design are presented in Table 2-1. The revised specifications are indicated by an entry in the New column.

The trolley frame will be of an all welded structural steel design with machined pads for motors, bearings, and gear cases. The main hoist drums will be machined grooved right and left for each rope section. The trolley wheels will be rolled steel, double flanged, rim toughened, 24" diameter, machined true to diameter and fitted with rotating axles and anti-friction bearings. The trolley will be equipped with spring bumpers and track clearers. In the construction of the new trolley, safety, simplicity, and accessibility are provided. The trolley will be shop assembled, tested with its own controls, painted, and then will be knocked down sufficiently for shipping.

2.3.2.2 Trolley Machinery

Figure 2-2 provides an illustration and identification of the safety related and critical items of the new trolley. Inspection and testing activities for the components are discussed in Section 2.4. Certification and quality assurance for these items is discussed in Section 4.1. The critical machinery components provided as identified by numerical call-outs in Figure 2-2 include:

1. Main Hook
2. Load Block Trunnion
3. Hook Nut
4. Hook Thrust Bearing
5. Block Structure
6. Sheave Pins
7. Sheave Bearings
8. Sheaves
9. Wire Rope
10. Wire Rope Drums
11. Drum Shaft
12. Drum Shaft Bearings
13. Drum Gears
14. Drum Pinion
15. Pinion Bearings
16. Pinion Shaft
17. Gear Case
18. Gear Case Bearings
19. Gear Case Shafting
20. Gears.
21. Gear Case Seals
22. Hoist Line Shaft Couplings
23. Hoist Line Shafting
24. Hoist Line Shaft Bearing
25. Hoist Brake
26. Hoist Motors
27. Drum Retention Structure
28. Machinery Pads and Supports
29. Trolley Truck Structure
30. Trolley Load Girt
31. Rotary Limit Switch
32. Power Limit Switch
33. Trolley Travel Limit Switch
34. Sheave Retainers
35. Equalizer Assembly
36. Trolley Wheels
37. Trolley Wheel Bearing
38. Trolley Wheel Shaft
39. Trolley Drive Assembly
40. Load Sensing System
41. Trolley Drop Lug

TABLE 2-1

REACTOR BUILDING CRANE MODIFICATION
TECHNICAL SPECIFICATIONS

PARAMETER		EXISTING	NEW
CAPACITY:	(at rated load)		
	Main Hook (Ton)	85	85
	Auxiliary Hook (Ton)	5	5
	Crane Classification	A1	A1
BRIDGE:			
	Runway Length	130'-6"	
	Bridge Height (r/r)	4'-8"	
	Bridge Span	98'-9"	
	Girder Gage	13'-6"	
	Bridge Weight	180,000 lbs	
	Wheel Size	8 - 27" O.D.	
	Design Speed	50 fpm	
	Drive Motors	2 - 7.5 hp	
	M-G Set Rating	20 hp/13KW	
	Controller	Maxspeed 100	
TROLLEY:			
	Runway Length	101'-0.5"	100'-10.5"
	Trolley Height	6'-2"	6'-2"
	Runway Rail Size	100 lbs	
	Wheel Gage	13'-6"	13'-6"
	Trolley Weight (net)	62,000 lbs	128,000 lbs
	Trolley Weight (w. load)	232,000 lbs	298,000 lbs
	No. Wheels - Size	4 - 24" O.D.	4 - 24"O.D.
	Design Speed	10 fpm	25 fpm
	Drive Motor	2 hp (1150 rpm)	2 hp (1150 rpm)
	M-G Set Rating	3 hp/1.5 KW	
	Controller	Maxspeed 100	
	Travel Accuracy	--	0.25"
	Load Proof Test	125%	125%
MAIN HOIST:			
	Type	Conventional	Redundant
	Hook N-S Travel	87'-4"	86'-11.5"
	Hook E-W Travel	108'-6"	108'-6"
	Hook Lift	117'-2"	117'-2"
	Hook Eye Clearance Above Operating Floor	23'-6.25"	23'-6.25"
	Hook Palm Clearance Above Operating Floor	24'-0"	24'-0"

TABLE 2-1 (Continued)

MAIN HOIST: (Continued)

Drum Size (P.D.)	52.25"	46.0"
Full Load Hook Speed, Max.	5 fpm	5 fpm
No Load Hook Speed, Max.	16 fpm	16 fpm
Drive Motor	40 hp (850 rpm)	40 hp (850 rpm)
M-G Set Rating	50 hp/33Kw	
Controller	Maxspeed 320	
Travel Accuracy	--	.0625"
No. Drums	1	2
Control Braking	Regenerative	Regenerative
Hook Type	Sister	Sister
Hook Design Load	340,000 lb	510,000 lb
Hook Test Load	340,000 lb	340,000 lb

MAIN HOIST REEVING SYSTEM:

Rope Type	6 x 37 IPS-FC	6 x 37 IWRC
No. Parts Rope	12	4 x 6
Rope Diameter	1.125"	.875"
Max. Rope Speed	30/96 fpm	30/96 fpm
Exterior Fleet Angle	3.5°	3.5°
Interior Fleet Angle	-	1.5°
No. Reverse Bends	-	0
Max. Vertical Travel for Rope Failure	-	3"

MAIN HOIST SAFETY FEATURES:

No. Ropes	1	4
Hook Safety Factor	6	10
No. Load Cell Devices	-	2
Equalizer Type	-	Cylinder
Holding Brake Type	Spring Set	Spring Set
No. Holding Brakes	2	3
Brake Capacity, ea.	150%	125%
No. Upper Travel Limit Switches	2	3
No. Lower Travel Limit Switches	1	2

AUXILIARY HOIST:

Type	Conventional	Conventional
Material	Stainless Steel	Stainless Steel
Hook Lift	117'-2"	117'-2"
Design Speed	20 fpm	20 fpm
Rope Size	.875"	.5625"
No. Parts Rope	1	4
Drum Size	30"	18"
No. Brakes	2	2
Hook Design Load	20,000 lb	20,000 lb
Hook Test Load	20,000 lb	20,000 lb
Drive Motor	7.5 hp (850 rpm)	7.5 hp (850 rpm)

The foregoing components will meet the minimum requirements for design, materials, manufacture and assembly prescribed by CMAA Specification No. 70 as applicable to Class A-1 (standby service) cranes.

2.3.2.3 Redundant Main Hoist

The main hoist is designed to provide a dual load path through the hoisting machinery and reeving system. The hoisting machinery along with the reeving system is designed to withstand single failures. Non-redundant components are provided for items that cannot be dual because of space or operating restrictions. These items include the trolley structure, main hook, drive motor and portions of the load block structure. Non-redundant components can be readily analyzed, tested or protected by use of safety features or increased load safety factors.

The redundant main hoist design parameters are provided in Table 2-1. The main hoist system consists of the following components as illustrated in Figure 2-2.

MOTOR

The main hoist motor is a shunt wound, D-C motor, rated at 40 hp and 850 rpm. The hoist motor provides a separate series winding for use during dynamic braking.

The hoist motor is controlled by a General Electric Maxspeed 320 crane drive unit. The drive unit varies motor field and armature currents to control the speed and torque of the motor along a constant horsepower characteristic. Consequently, the speed of the hoist motor is a function of the weight of the load being lifted. At full load the hoist motor rated speed is 850 rpm which is equivalent to a hook speed of 5 fpm. Power for the hoist motor is supplied by an A-C driven motor-generator set installed on the crane bridge. The generator is a shunt wound DC machine.

HOLDING BRAKES

Three main hoist holding brakes are provided which permit mechanical braking by solenoid release, spring operated, shoe brakes. Two brakes are located on the outboard side of the gear cases with the third brake located between the gear cases on the drive motor shaft. The brakes are spring loaded and automatically set whenever electrical power is removed. The brakes are released (armature energized) simultaneously with the energization of the main hoist motor. Each brake is designed to hold 125% rated full load hoist motor torque at base speed.

Emergency braking action is affected by immediate application of all three mechanical holding brakes when the hoist motor voltage decreases to 70 volts, when upper or lower hoist travel limit switches are activated, or upon loss of power to the main hoist motor.

GEAR REDUCERS

Two parallel shaft, inline, AGMA rated, modified addendum, through-hardened, spur gear, speed reducers are provided on both sides of the main hoist drums. All gears will be alloy steel with machine cut teeth. All pinions will be forged steel with machine cut teeth. All gear cases and gear couplings will have splash lubrication.

BEARINGS

Bearings will be anti-friction type designed for minimum bearing life as required for the service specified (B-10 life of 3,000 hours minimum). Bearings will be lubricated by Alemite pressure fittings.

DUAL HOISTING DRUMS

The hoisting drums are constructed of all fabricated steel. Each drum is machine threaded with cable grooves and fitted with drum gears to provide an interconnection between the redundant drive trains. The length of the drum is designed so that two complete wraps of cable remain on the drum when the hook is in its lowest position and so that no overlapping occurs with the hook in its highest position. Two 46 inch diameter drums are employed to provide a dual load path and to accommodate the tight space restrictions imposed by the existing reactor building arrangement.

REDUNDANT REEVING

The reeving consists of 24 parts of rope, 7/8 inch diameter, MacWhyte 7-Flex, 6 x 37 EIPS-IWRC. The rope is sized for a static load safety factor of at least 5 based upon breaking strength. The rope is furnished in 4 sections, 2 sections for each drum as shown in Figure 2-2. Each rope section is clamped to its respective drum and is spooled to the drum grooves prior to being conventionally reeved to one side of the load block and to its independent set of upper block sheaves. The opposite end of each rope section is attached to an independent equalizer system dedicated to each drum and one side of the load block. This dual reeving system provides a quad-support system for the load block using the four independent rope sections.

EQUALIZER SYSTEMS

Each system consists of several deflector sheaves journaled to the trolley structure and an equalizing assembly. The rope ends are secured to a double acting hydraulic cylinder which provides for load equalization. The system allows a hydraulic piston to float freely during normal operation. During a rope failure, the system acts as a shock absorber through the use of a velocity actuated mechanical device.

LOAD BLOCK

The load block is a steel constructed assembly with 4 sets of sheaves to carry the load. Anti-friction sheave bearings are provided with lubricated Alemite pressure fittings. Retaining plates are provided to capture the sheaves within the load block. The block has an anti-friction thrust bearing to support the sister hook.

2.4 INSPECTION AND TESTING

Inspection and testing activities for the new trolley shall be conducted in accordance with the Quality Assurance Program and established vendor and purchaser procedures.

Materials and components which are part of the redundant load path (see Section 3.1.1) or ensure safe control of critical loads shall be certified and tested by the methods indicated in Table 2-2. The trolley components subject to these requirements are identified in Section 2.3.2.2.

2.5 CONTROL AND ELECTRICAL CHANGES

The existing control system described in Section 2.3.1 will be retained and modified as required to comply with new trolley requirements. The entire control system will be reviewed to ensure that no single failure will result in a loss of load or ability to maintain the load in a safe position.

Electrical changes necessary to comply with the foregoing requirements include:

1. Additional trolley conductors for the increased number of main hoist brakes.

2. Additional trolley conductors for power type head and load block limit switches.

3. Overspeed control for the main hoist drive motor and train.

4. Overload and load equalization controls for the redundant hoist system.

TABLE 2-2

COMPONENT INSPECTION, TESTING AND CERTIFICATION REQUIREMENTS

TROLLEY COMPONENT (per Figure 2-2)

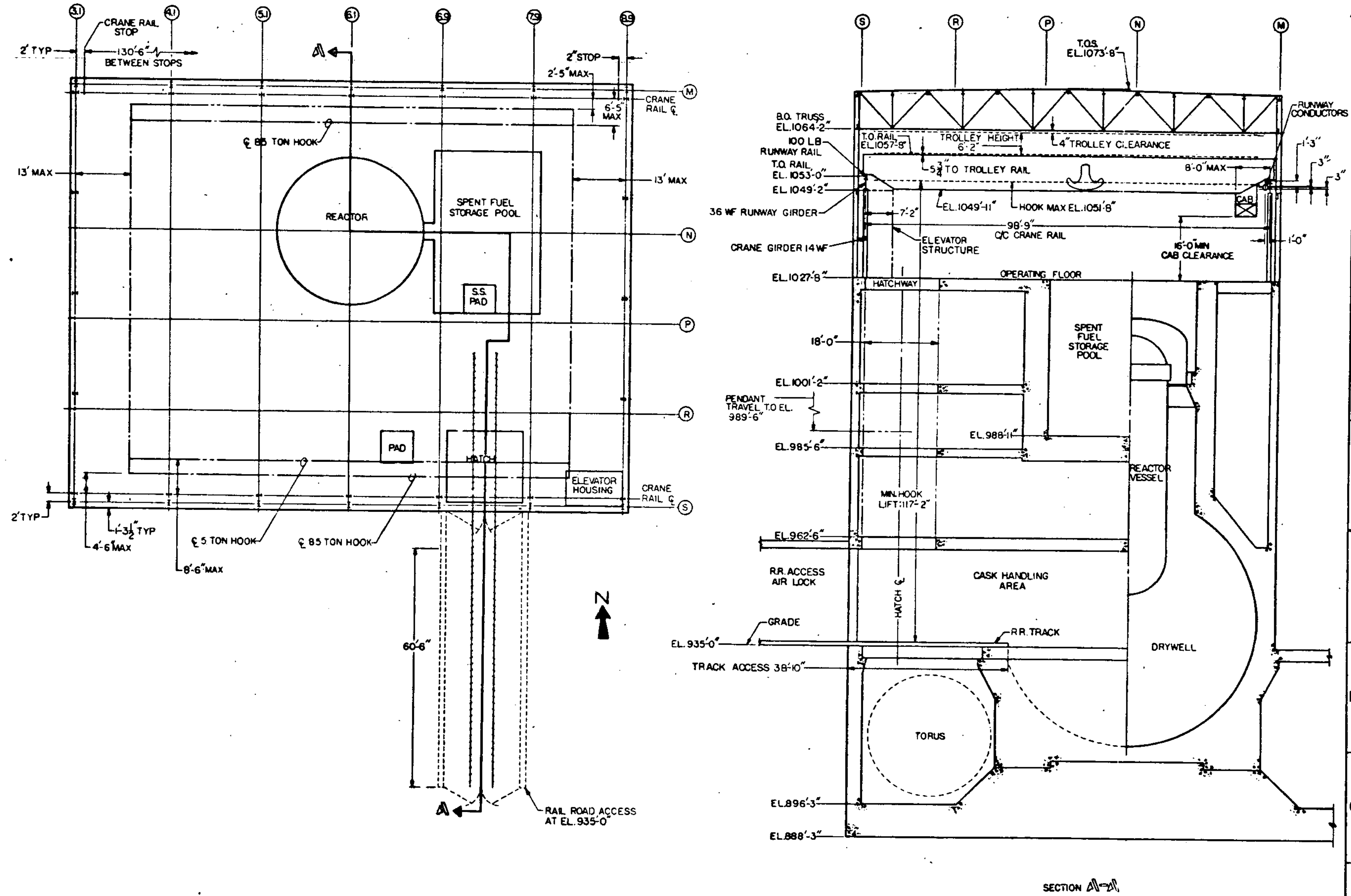
ACTIVITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Certification of material chemical properties.	X	X	X		X	X		X		X	X		X	X		X	X		X	X	
2. Certification of material physical properties.	X	X	X		X	X		X		X	X		X	X		X	X		X	X	
3. Certification of material nil ductility transition temperature.	X	X	X		X	X															
4. Ultrasonic test of material.	X	X	X		X																
5. 200% overload test.	X	X	X																		
6. Magnetic particle inspection and dimensional check after overload test.	X	X																			
7. Visual weld inspection.					X												X				
8. Weld size gauge inspection.					X												X				
9. Critical weld magnetic particle inspection.					X																
10. Shop functional test.				X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
11. Field functional test.				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12. Field full load test.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
13. Field overload test.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14. Certification of compliance or certified data sheet.	X	X					X		X			X			X			X			X
15. Inspection for conformance to detail drawings.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16. Sample pulled to failure.									X												

TABLE 2-2 (Continued)

COMPONENT INSPECTION, TESTING AND CERTIFICATION REQUIREMENTS

TROLLEY COMPONENT (per Figure 2-2)

ACTIVITY	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	
1. Certification of material chemical properties.		X					X	X	X				X		X		X			X	
2. Certification of material physical properties.		X					X	X	X				X		X		X			X	
3. Certification of material nil ductility transition temperature.									X												
4. Ultrasonic test of material.									X												
5. 200% overload test.																					
6. Magnetic particle inspection and dimensional check after overload test.																					
7. Visual weld inspection.																					
8. Weld size gauge inspection.																					
9. Critical weld magnetic particle inspection.									X												
10. Shop functional test.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
11. Field functional test.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
12. Field full load test.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
13. Field overload test.	X	X	X	X	X	X	X	X	X				X	X	X	X	X		X	X	
14. Certification of compliance or certified data sheet.	X		X	X	X					X	X	X		X	X	X			X		
15. Inspection for conformance to detail drawings.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
16. Sample pulled to failure.																					



MONTICELLO REACTOR BUILDING

FIGURE 2-1

Nuclear Services Corporation

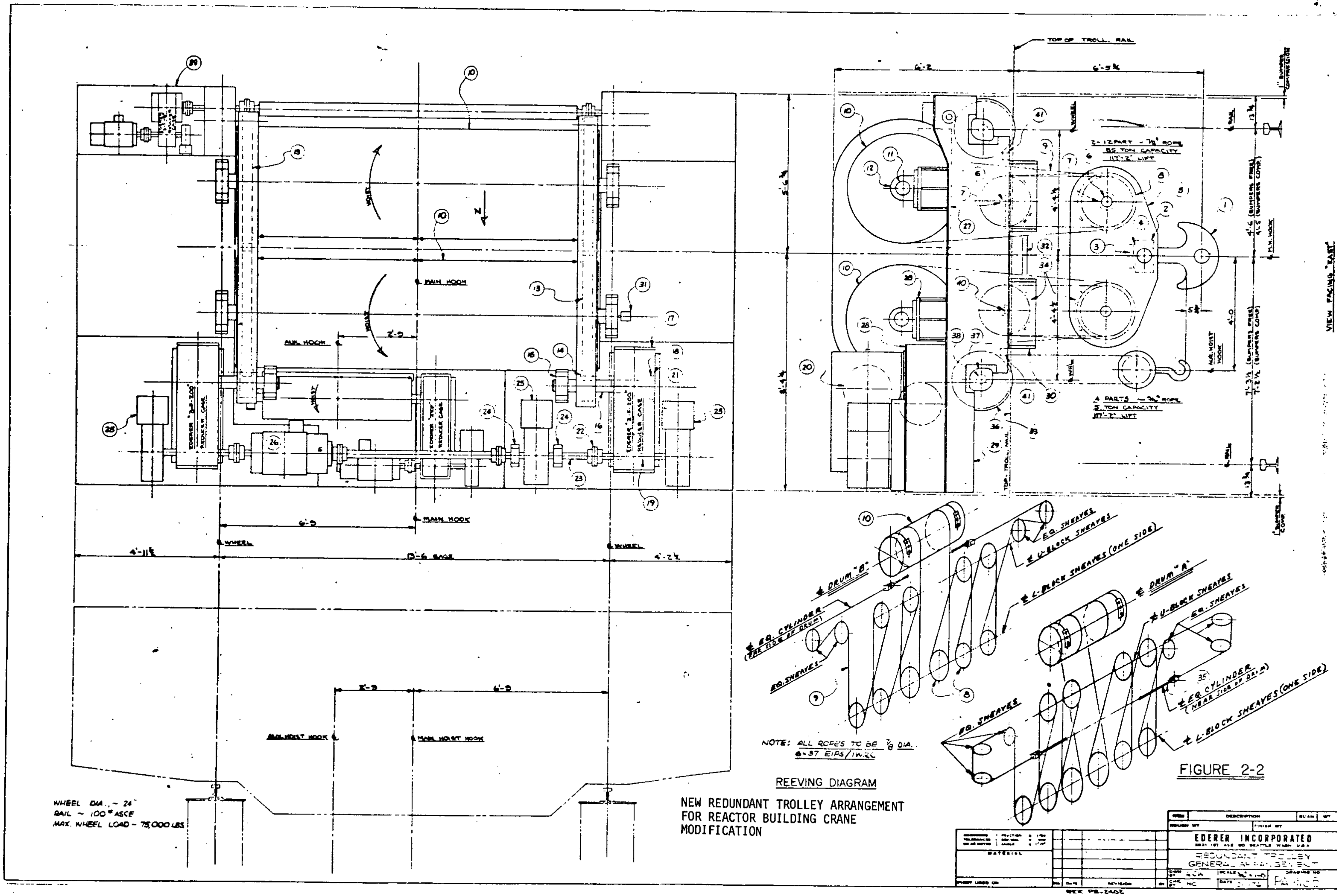
DRAWN M'Dermott 4-3-75

TITLE REACTOR BLDG CRANE -- MONTICELLO NUCLEAR GENERATING PLANT OUTLINE DIMENSIONS

SCALE 1/8" = 1'-0"

DWG NO. SK1000266

SHEET 1 of 1



NEW REDUNDANT TROLLEY ARRANGEMENT
FOR REACTOR BUILDING CRANE
MODIFICATION

FIGURE 2-2

3.0 SAFETY EVALUATION

An evaluation of the redundancy and design safety features provided with the modified crane trolley has been completed. The critical load handling components of the main hoist have been examined for their vulnerability to a single failure. Those passive components which are not redundant are protected through the use of safety features or increased design safety margins. An evaluation of the main hoist failure modes and their effects is presented. The design is also evaluated against Regulatory Guide 1.104[2].

3.1 SAFETY FEATURES AND REDUNDANCY

The new trolley and main hoist machinery is designed to ensure safe handling of critical loads handled in the plant. In the event of a crane component failure or malfunction, continued operation is not essential but the loss of a critical load due to a single failure will be precluded by design or safety margin.

In accordance with the safety design bases of Section 2.1.2, all critical load bearing components of the main hoist will have a minimum safety factor of 5:1 based upon ultimate strength. In addition, wherever feasible, dual element protection is provided or a means is provided to capture a failed component in order to prevent an uncontrolled descent of the load.

3.1.1 Redundant Load Path

Each component in the main hoist load path has been evaluated to ensure that the redundancy requirement has been met for active components and that a conservative design is employed for any non-redundant components. The results of this evaluation for the components identified in Figure 2-2 are as follows:

ITEM 1 - MAIN HOIST HOOK

Due to hook lift height restrictions imposed by the reactor building arrangement, the redundant main hoist is not provided with a dual sister hook. With the additional space occupied by the redundant reeving and blocks, the upper travel of hook will provide the necessary clearance above the operating floor only with a single hook arrangement. Since the hook is not subjected to crane cyclic loading, and since it is easily analyzed, can be readily overload-tested and can be provided with an increased load safety factor, redundancy is not necessary for this passive component. The hook will be designed with a factor of safety of 10:1 which significantly lowers the maximum working stress below the established endurance limit of the material. Furthermore, traceability of material, design, workmanship and NDE provisions ensure that expected properties and integrity will be maintained.

ITEMS 2-4 - HOOK TRUNNION ASSEMBLY

The load block trunnion, hook nut and hook thrust bearing will be designed, manufactured and tested to the same standards as the hook. The safety factor employed will exceed 10:1.

ITEM 5 - BLOCK STRUCTURES

The load block and the upper sheave nest support structures are a passive load path component and will be manufactured from tested and certified material per the controls described in Section 2.4. A 10:1 factor of safety ensures that the stress levels will be well below the endurance limit of the materials.

ITEMS 6 and 7 - SHEAVE PINS AND BEARINGS

The upper and lower block sheave pins and sheave bearings are designed in a conservative manner consistent with other redundant components. Redundancy is not feasible; however, failure protection is provided by sheave retainer plates incorporated into the block structures. The sheave retainers, Item 34, would act to capture the block components in the event of a failure. The failure of a sheave bearing would not effect crane operation or result in a loss of load.

ITEM 8 - RUNNING SHEAVES

Four independent sets of running sheaves are provided to satisfy redundancy requirements. The failure of any one sheave would not prevent crane operation or result in a loss of load. Operations without one set of sheaves would be possible in an emergency with the redundant reeving system.

ITEM 9 - WIRE ROPES

The reeving system consists of 4 independent wire ropes, each secured to a drum and equalizing system. The rope system is designed with a minimum factor of safety of 5:1 under rated load, and failure is considered to be extremely unlikely. The reeving diagram in Figure 2-2 shows that in the event of the failure of one rope, the load will be retained in a safe, stable position held by 18 of the original 24 parts of rope.

ITEM 10 - HOISTING DRUMS

Dual hoisting drums are provided. A failure of either drum would require a passive failure but would not result in a loss of load. A review of the drum geometry shows that the depth to length ratio falls short of the requirement for a beam in bending. Furthermore, the wire rope keeps the drum in compression. Thus, the possibility of a crack, and its propagation, resulting in a failure are minimal. These considerations virtually eliminate the possibility of a drum failure.

Additional safety protection is provided, in any event, by a drum retention structure, Item 27. This structure provides backup support for failure of the drum shaft, bearings or machinery supports.

ITEMS 13-21 - GEAR REDUCTION TRAINS

Two redundant gear reduction assemblies are provided. A failure of either assembly would not result in loss of control of the load or render the system inoperative. Any obstructions resulting from the failure may have to be removed, but upon removal, the system would be capable of full lowering and hoisting.

Both gear trains are mechanically connected to one another via the main hoist motor shafting (Item 23), the drum gears (Item 13) and the drum structure (Item 10). Thus, each gear train is designed to backup the other and to accommodate the total load in the event of a failure. An additional safety factor is included since both gear trains are designed for the duty cycle and projected life of the crane. This safety feature is based upon the assumption that the entire crane load is carried by only one gear train.

ITEMS 22, 23 and 26 - HOIST LINE

The main hoist line consists of the shafting, shaft couplings and hoist motor. The cross shafting may be subject to a postulated single failure without resulting in a loss of load. This is assured due to the existence of a redundant cross-shaft assembly and drive train.

Mechanical failure of the hoist motor would not result in the uncontrolled lowering of the load; however, normal operations would be interrupted until the problem is corrected. A hoist motor failure without regenerative braking has been anticipated. A mechanical switch, Item 31, sensing overspeed operation is arranged to interrupt power to the hoist motor and set the hoist brakes.

ITEM 25 - MAIN HOIST BRAKES

Three redundant main hoist brakes are provided to stop the hoisting operation in the event of component failures. The brakes are spring loaded and solenoid operated when the hoist motor fails, when load imbalance is detected, when limit switch controls are activated, or upon operator actuation. In the event of a single brake failure, redundant braking capability for load control or emergency lowering is not lost.

ITEM 35 - EQUALIZER SYSTEM

The equalizer assemblies, Item 35, are based on a design which has been developed jointly by Ederer, Incorporated and the Tennessee Valley Authority for a redundant nuclear crane. The system has been analyzed extensively and proven to be adequate in every respect. Each wire rope terminates on one end of a double acting hydraulic system which allows reeving equalization to compensate for normal rope stretch and weight distribution. Hydraulic fluid is allowed to pass from one side of the cylinder to the other at lower velocities with small pressure differential during normal operation. In the event of a component failure, the sudden transfer of loads causes a significant increase in velocity across the hydraulic circuit. A velocity actuated valve then creates a large pressure drop across the cylinder, making the cylinders act as dashpots, to reduce shock. Abnormal displacement of the hydraulic cylinders will be sensed by proximity switches which deactivate the hoisting system and set the holding brakes. Repair of the system would then be initiated as required.

ITEMS 36-38 - TROLLEY WHEEL ASSEMBLIES

The trolley wheel assemblies consist of the wheels, shafts and bearings. The trolley structure transmits the load from the main hoist machinery to these components in a passive manner. Failure of the wheel assemblies will not prohibit hoist operation or result in a loss of load. Trolley drop lugs, Item 41, are provided to catch the trolley for such a postulated failure. The hoist load would be held in a safe condition until repairs can be made.

3.1.2 Safety Features

Section 3.1.1 discusses the main hoist and trolley design features and the provisions made for redundancy and single failure protection. Several design items were also described in Section 2.3.2 which are not considered load path components but serve as backup safety features or control devices to prevent a load drop from occurring. These design features include:

Main Hoist Brakes - Item 25
Drum Retention Structure - Item 27
Drum Rotation Limit Switches - Item 31
Hoist Overspeed Switch - Item 31
Block Position Limit Switches - Item 32
Sheave Retainers - Item 34
Equalizer Velocity Device - Item 35
Overload Sensing System - Item 40
Trolley Drop Lugs - Item 41

The above safety features complement or aid the main hoist load path components and drive system in preventing a load drop. Three main hoist brakes provide protection against a single brake failure.

The drum retention structures provide passive protection against a drum or drum support failure. The main hoist load block sheaves and upper sheave nest will be captured by the use of sheave retainers (Item 34 in Figure 2-2). These passive components preclude a loss of load due to sheave, sheave pin or bearing failure. The trolley structure is designed with passive drop lugs at each wheel to prevent the trolley from dropping in the event of a wheel or wheel assembly failure.

The dual load equalizing system is designed to absorb shock load due to a reeving failure through the use of a mechanical velocity limiter device described in

Section 3.1.1. In conjunction with this feature, two overload sensing devices will be located on each half of the redundant reeving system. These load cells will trip the main hoist motor and set the holding brakes upon reaching 125 percent of design rated load.

Redundant means of preventing excessive load block upper travel are provided by the use of rotary and power type main hoist limit switches. These devices will trip the main hoist motor and set the holding brakes. In addition, a main hoist overspeed switch will be installed with the existing controls to trip the drive motor and set the holding brakes.

3.2 CRANE SAFETY MARGINS

An evaluation of the design factors of safety to be employed with the trolley and critical mechanical components has been conducted to determine the actual safety margins involved with handling of the design rated load and the spent fuel shipping casks discussed in Section 3.4. For comparison, the crane safety factors at the design rated load (85 tons), for handling the General Electric Company IF-300 spent fuel shipping cask (70 tons) and the NFS-4 (NAC-1) shipping cask (25 tons) have been calculated. The results are reported in Table 3-1.

The results of this evaluation show that all factors of safety for the load path components are greater than a factor of 6 when handling the IF-300 cask and greater than 17 when handling the NFS-4 cask. Thus, even though the main load path of the new trolley is redundant, significant safety margin exists for handling either the design rated load or the spent fuel shipping casks.

Minimum design safety margins for the new trolley are specified by Table 3-1. Design safety margins are based on ultimate strength of the materials used. Load combinations for normal operation are dead load (including the new trolley), plus rated load (85 tons), plus 15% vertical impact and 5% coincident lateral load.

For seismic loading on the trolley, the load conditions are dead load, plus rated load, plus coincident horizontal and vertical earthquake forces.

REACTOR BUILDING CRANE MODIFICATION

MINIMUM FACTORS OF SAFETY

CASK HANDLING

ITEM[1]	MAIN HOIST COMPONENT	REDUNDANT COMPONENTS	DESIGN RATED LOAD (85T)	WITH IF-300 (70T)	WITH NFS-4 (25T)
1.	Main Hook	(2)	10	12.1	34
2.	Load Block Trunnion	(2)	10	12.1	34
3.	Hook Nut	(2)	10	12.1	34
5.	Block Structure	(2)	10	12.1	34
6-8	Sheave Components	X	5	6.1	17
9	Wire Rope, each	X	5	6.1	17
10	Wire Rope Drums	X	5	6.1	17
11-12	Drum Shafts, Bearings	X	5	6.1	17
13	Drum Gears	X	5	6.1	17
14-21	Gear Reducer Assemblies	X	5	6.1	17
22-24	Hoist Line Components	X	5	6.1	17
27	Drum Retention Structure	(2,3)	2	2.4	6.8
28-30	Trolley Structure	(2)	5	6.1	17
34	Sheave Retainers	(2,3)	2	6.1	6.8
35	Equalizer Assembly	(3)	5	6.1	17
36-39	Trolley Wheel Assembly	(2)	5	6.1	17
41	Trolley Drop Lugs	(2,3)	2	2.4	6.8

NOTES: (1) Item Nos. referenced to Figure 2-2

(2) Passive Structural component

(3) Component is primarily a safety feature

3.3 COMPLIANCE WITH REGULATORY GUIDELINES

Section 2.1.2 presents the safety design bases for reactor building crane modifications at Monticello. The intent of applicable regulatory guidelines has been followed during modification planning, procurement and design. Specific technical guidance established by Regulatory Guide 1.104[2] has been incorporated into the design where feasible and practical. However, due to many restrictions and limitations imposed by an operating plant with an existing functional crane, several exceptions to the regulatory requirements are necessary. Exceptions taken to Regulatory Guide 1.104 are based upon the Reference 12 response by Northern States Power Company to the Nuclear Regulatory Commission. Exceptions specific to the subject crane modification are provided in comments below. These comments are to clarify the position taken on the guideline as applicable to the Monticello Generating Plant and the new trolley design furnished by Ederer, Incorporated. Other comments on this guideline have been developed; however, unless addressed, compliance with the requirements of the regulatory guide is anticipated.

COMMENTS ON REGULATORY GUIDE 1.104[2]

Regulatory Position C.1.b(2), C.1.b(3)

The requirements of Section C.1.b(2) and the alternative "cold proof" test is not applicable to the new trolley. The reactor building crane is located indoors in a heated environment with a minimum ambient temperature of 70°F. This is equal to or above the NDTT +60°F requirement for most structural steels. Since the crane is only operated in this controlled environment, the consideration of brittle failure and the toughness tests are not necessary.

C.1.c

The requirement to reclassify the crane as Seismic Category I is not considered practical for a licensed operating plant. To reclassify cranes previously licensed as Seismic Class II would require extensive modifications to the bridge trackway and a new bridge. It is considered sufficient to analyze the new trolley in a manner consistent with the design codes and loading conditions applicable at the time of the original installation.

C.2.b

Dual or ancillary systems will be provided as feasible. Systems which cannot be provided with a dual or fully redundant load path features because of space limitations, operating requirements or existing design restrictions will be protected by additional factors of safety, quality assurance, and nondestructive testing as appropriate to the design constraints imposed.

C.3.a

The main hook, as proposed, is not redundant because of facility imposed height restrictions. Appropriate increases in safety factor and quality assurance have been considered.

C.3.c

The maximum full load hoisting speed as proposed for this design is 5 fpm or less. However, the no load hoisting speed may be increased as dictated by the existing crane control system.

C.3.e

The hoisting line speed when lifting the rated load is less than 50 fpm. However, the no load hoisting speed may be increased in excess of this value. Lead line velocity is not considered a safety characteristic.

C.3.g

A 200% static load test will not be conducted. A survey of crane manufacturers has shown that crane suppliers do not have the capability for testing an assembly the size of a complete trolley. Therefore, this test can only be accomplished at the plant after installation. This is contradictory to both the requirements of ANSI B.30.2.0[5] and of the requirements of Section C.4.d of the Regulatory Guide which requires only a 125 percent test after installation. A test of this nature could reduce the fatigue life of the entire crane and the procedure for NDE of crane components after completion of the test would require a complete breakdown, re-examination, verification and re-assembly of the trolley.

C.3.j

Protection against forces generated by load "hangup" is provided by the load sensing cut out switch located in the reeving system. Protection against forces which could be imposed on the trolley due to "two blocking" is provided by redundant hoist limit switches actuated by the load block. Actuation of a hoist limit switch will stop the hoist motor and set the mechanical brakes. With proper selection and location of limit switches, "two blocking" would be precluded.

C.3.m

Procedures for manual brake operation during emergency lowering can limit speed to less than 3.5 feet per minute. Additional brake capacity is provided in this case to ensure that a controlled lowering of load can be maintained by plant personnel with allowance for any single brake failure.

C.3.p

The 110% horsepower limitation for the trolley motor is not compatible with established drive motor requirements. The trolley motor is selected to obtain a reasonable rate of acceleration, rather than being based on the steady state running horsepower. Pages ED-19 and 20 of AISE Standard No. 6, tentative May 1, 1969 shows that at 15 lbs. per ton and the slowest acceleration rate of 0.38 ft/sec^2, the multiplying factor to determine a minimum one hour motor rating is .00076; whereas the steady state running horsepower is determined by a factor of .000455. Thus, the minimum one hour motor rating for this particular combination is 1.67 times the full load running horsepower and 57% above the proposed limit stated in the regulatory guide.

C.4.b

The hoisting machinery and reeving will not be subjected to "two block" or "load hangup" tests at the facility. Either test would be in direct violation of ANSI B30.10. Further, the trolley manufacturer considers "two blocking" as a destructive test requiring replacement or complete NDE of all components subjected to forces generated by this test.

3.4 PROVISIONS FOR SPENT FUEL CASK HANDLING

A review of anticipated spent fuel cask handling activities and operations to take place at the Monticello site has been conducted. Detailed procedures and instructions are used when fuel shipping operations are initiated with the IF-300 or NFS-4 (NAC-1) spent fuel casks. The activities described in this section will provide a general summary of the fuel cask handling operations to be conducted at the site.

3.4.1 Description of IF-300 Shipping Cask

Spent fuel will be shipped from the Monticello plant site in the General Electric Company IF-300 irradiated fuel shipping cask[7]. The cask has a capacity of 18 BWR fuel assemblies and weighs, when fully loaded, approximately 70 tons. The overall dimensions of the cask are 64 inches in diameter and 208 inches in length, typical of the fuel cask shown in Figure 3-1. In transit, the cask is carried on a skid frame with enclosed integral cooling and temperature monitoring systems. The skid is 37.5 feet in length and 8 feet in width. The combined weight of the cask and skid is 87.5 ton, requiring shipment by rail flatcar.

A fuel basket is provided in the fuel cavity such that with the cask in the vertical position, fuel assemblies may be inserted and removed from stainless steel square tubes in the fuel basket.

The shipping cask is comprised of two concentric stainless steel cylindrical shells and a corrugated jacket. The inner shell, which surrounds the fuel cavity, is filled with water and serves as a coolant pressure vessel. Both the temperature and pressure of the fuel cavity are monitored; a pressure relief valve permits gas venting in small amounts to relieve any cavity overpressure, and temperature is controlled via a thermocouple contained in a well on the external surface of the shell. The cask cavity is provided with two nuclear service valves which provide access to the coolant for filling, draining, venting and sampling. Each valve has a quick disconnect fitting to which a pressure gauge may be connected. These valves are secured in transit.

Surrounding the inner shell of the cask is a 4 inch thick layer of depleted uranium which provides shielding from gamma radiation. The shield assembly is shrink-fitted to the inner shell to improve heat transfer. The outer stainless steel shell is 1.5 inches thick and serves as a puncture barrier. This shell is shrink-fitted to the uranium shield. An outer water gap for neutron shielding and an exterior steel jacket around the cask fuel zone is also provided.

The cask head consists of an outer shell and flange of cast stainless steel with a 3 inch core of depleted uranium. The head is fitted to the cask body using 32 sleeve nuts and studs. Guide pins are used for head alignment during cask closure and sealing.

The external surface of the cask is finned for impact protection and heat transfer. There are 2 large circumferential fins on both ends of the cask and 32 radially mounted fins on the bottom head. In addition to impact protection, the four large circumferential fins are also used as lifting rings during movement of the cask. The cask is designed to withstand, without excessive radiation release, a 30 foot drop onto an unyielding surface, a subsequent 40 inch drop onto a 6 inch diameter pin, followed by 30 minutes in a 1475°F fire, prior to an 8 hours immersion in 3 feet of water.

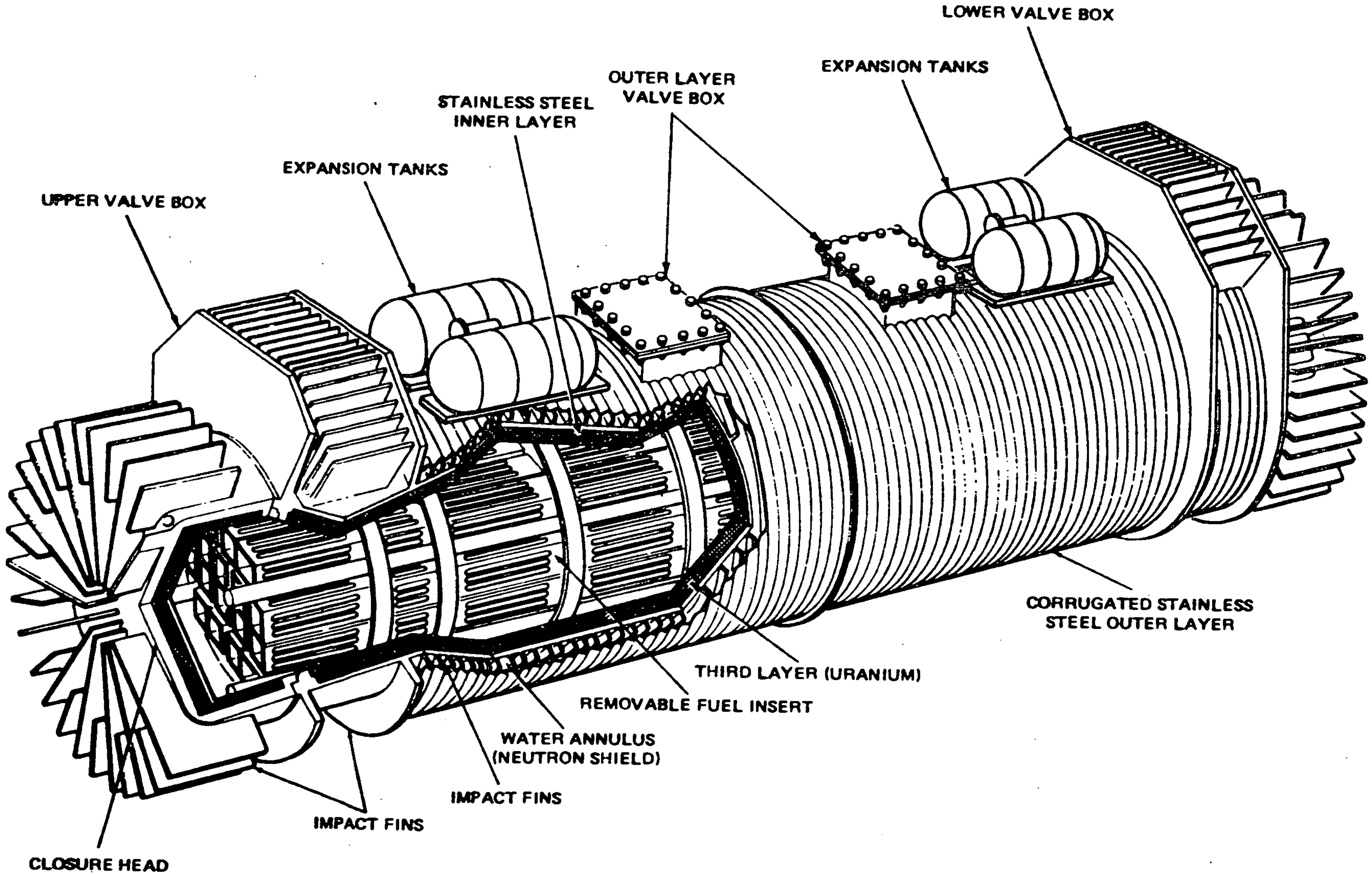
While on the skid, the cask is supported in a horizontal position by a saddle just below the closure flange and a pivot cradle at the base. Hardened steel pins are inserted through the saddle ears and lifting rings for restraint. The cradle pivots on two trunnions resting on pedestals. The cradle is counterbalanced to remain steady after removal of the cask. The cradle trunnions are mounted slightly off-center to cause the cask to tip toward the saddle during loading.

The spent fuel shipping cask lifting yoke is a steel structure which consists of two yoke legs, two cross members, and a retractable six inch diameter heat treated pin for insertion in the main hook shackle hole. The two yoke legs engage the cask lifting trunnions, the six inch diameter pin is inserted through the two yoke leg crossmembers and the main hook shackle hole.

A redundant lifting yoke is available for handling the IF-300 cask. This yoke design employs a primary and secondary yoke system. The primary system is pinned to the hook shackle hole while the secondary system employs a mechanical operated, power screw assembly lifting structure which supports the cask from below via yoke arms attached to two separate and redundant lifting pins which engage above the sister hook palms. This redundant yoke system is employed to provide a redundant load path for spent fuel cask handling.

3.4.2 Description of the NFS-4 (NAC-1) Shipping Cask

Reference 8 presents a complete description of the NFS-4 (NAC-1) spent fuel shipping cask.



IF-300 SPENT FUEL SHIPPING CASK

FIGURE 3-1

4.0 DESIGN AND ADMINISTRATIVE CONTROLS

Modifications to the crane shall be covered by the applicable requirements of 10CFR50 Appendix B, "Quality Assurance Requirements for Nuclear Power Plants". Quality Assurance (QA) program documents, procedures, and controls will be applied throughout design, procurement, fabrication, testing and installation. A program for shop and field testing as well as performance testing and check-out will be implemented. An operational program of periodic surveillance and maintenance will also be followed during the crane service life.

4.1 QUALITY ASSURANCE

Northern States Power Company has implemented a program for control of quality during the design modification. Vendors, subcontractors and consultants shall adhere to the requirements of 10CFR50 Appendix B as applicable to nuclear power plant crane systems. The design, materials, fabrication, testing and installation of the new trolley shall be governed by the design bases of Section 2.1 and the codes and standards prescribed in Section 2.1.3. These measures are in accordance with ANSI N45.2-1971, "Quality Assurance Program Requirements for Nuclear Power Plants" and the appropriate procurement specification requirements.

Section 2.4 discusses the inspection and testing activities to be conducted which ensure that certified components will be used in the new trolley. These activities will be carried out, checked and audited, as required, to assure: (1) traceability of critical material and components; (2) documentation of all phases of design, manufacturing, testing and installation; and (3) compliance with the design requirements specified.

4.2 FUNCTIONAL AND LOAD TESTING

The new trolley and portions of the existing bridge equipment will be subjected to tests at the manufacturer shop or tests at the site following trolley installation. Tests to be conducted are described below.

Shop Functional Test

The completed trolley assembly will be supplied with power and control through a shop motor generator system. The load blocks will not be reeved during the shop test.

Shop testing will include running tests of all motors, shafting, and gearing in accordance with the ANSI B30.2.0-1967 code[5]. All noted deficiencies will be corrected prior to shipment. Correct operation and circuitry of the load block limit switches will be determined. All drives will be operated at maximum speed. An audio check and sign off will be conducted to assure that the noise level is within normal limits. Noise level is used as a parameter in determining proper gear cutting, alignment, and support. A vibration check and sign off will also be conducted to further assure proper assembly. A manufacturers routine test report will be obtained for each motor.

Field No Load Test

Prior to initial crane usage, the crane will be subject to a complete no-load run-through testing program consisting of, but not limited to, the items listed below:

1. Operate the bridge, trolley, and hoist throughout the entire range of their travel. Clearance requirements will be reviewed during this testing sequence and corrected, if necessary.

2. Operate all brakes to assure that they are properly adjusted.

3. Check upper, lower, and backup hoist limit switches, re-adjust if necessary and repeat the operation to verify proper switch response.

4. Check for proper contact of trolley and runway current collectors and conductors throughout the entire length of travel.

5. Check for proper engagement of bridge and trolley with the stops at the ends of the girder.

6. With the hook at its extreme lower limit of travel, check to see that at least two full turns of rope remain on drum.

7. With the hook at the extreme upper limit of travel, check to see that there is no overlapping of rope on the drums.

8. Accurately measure the no load speeds for all crane motions at each control point.

9. Check all travel limit switches for proper response.

Field Pre-Operational Load Test

The test items listed under the field no load test will be repeated with the exception of the following items with an initial lift of 10-15 tons on the main hoist.

Crane clearances would not be checked.
Crane stop engagement would not be checked.
Wrapping of rope on the drums would not be checked.
Limit switch settings would not be checked.

Field Overload Test

A 125% static overload test shall be conducted on the main hoist. A test load of approximately 212,000 lbs will be required. This test will be performed with the main hoist load block positioned near grade elevation. While lifting the load some 3 to 4 feet above the floor, visual inspection of all crane parts and checking will be conducted to verify that no undue strain is being experienced while the load is suspended. No crane movements, other than the required vertical lift, will be performed during this test.

Field Full Load Performance Test

A performance test of the entire crane system shall be conducted at the rated load of the main and auxiliary hoists. Items to be verified during this test include:

1. Hoist speeds.
2. Upper, lower, trolley and bridge travel limit switches.
3. Trolley and bridge brakes.
4. Check operation of the hoist, trolley, and bridge throughout the entire travel envelope and vertical lift.
5. Hoist brakes to ascertain that the crane can stop and hold the load.
6. Pendant control of hoists to verify crane movements and emergency controls required for critical load operations.

4.3. PERIODIC TESTING, SURVEILLANCE AND MAINTENANCE

A periodic test program including surveillance, inspection and maintenance requirements will be established based upon the crane manufacturers recommendations. This program will be in accordance with existing Monticello Nuclear Generating Plant procedures as discussed in Reference 8, Section 4.3. Inspection and testing will be carried out on a periodic basis as defined by ANSI B30.2.0[5] and OSHA requirements[6]. Crane system checkout, prior to critical lift operations, will be conducted as described in Reference 8, Section 6.2.

5.0 SCHEDULE FOR MODIFICATIONS

It is anticipated that the entire modification will be completed and the redundant trolley will be in service by August, 1977. In order to achieve this accelerated schedule, the crane manufacturer has provided the following revised work plan:

Procurement Initiated		September 6, 1976
Preliminary Design and Layout	4 weeks	
Prepare Licensing Report	3 weeks	
Design and Engineering	16 weeks	
Trolley Fabrication and Assembly	10 weeks	
Delivery Date		May 1, 1977
Installation and Testing	8 weeks	
Crane Operation		July 1, 1977

The foregoing schedule is based upon anticipated crane vendor progress and estimates of installation and replacement time for the existing trolley. All crane modifications, testing and restoration must be complete prior a scheduled fall 1977 refueling outage.

6.0 REFERENCES

1. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis", Revision 1, December, 1975.

2. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.104, "Overhead Crane Handling Systems for Nuclear Power Plants", February, 1976.

3. Title 10, Code of Federal Regulations, Chapter 1 - Nuclear Regulatory Commission (NRC), Part 50, Appendix A - General Design Criteria for Nuclear Power Plants.

4. Northern States Power Company, Monticello Nuclear Generating Plant - Final Safety Analysis Report (FSAR), Part XII, Section 2.1.4, "Criteria for Design".

5. American National Standards Institute (ANSI). "Overhead and Gantry Cranes," USA Standard B30.2.0-1967, by ASME, 1430 Broadway, New York, N. Y., 10018

6. Title 29, Code of Federal Regulations, Chapter XVIII - Occupational Safety and Health Administration (OSHA), Part 1910, Section 1910.179 - Overhead and Gantry Cranes.

7. General Electric Company, "IF-300 Irradiated Fuel Shipping Cask", Technical Description report NEDO-10864, July, 1972.

8. L. O. Mayer, letter to Victor Stello, Director, Division of Operating Reactors, U. S. Nuclear Regulatory Commission, from Northern States Power Company, Manager of Nuclear Support Services; Re: License DPR-22, Docket No. 50-263; "Offsite Shipment of Spent Fuel", January 22, 1976.

9. Electric Overhead Crane Institute, "Specification No. 61 for Electric Overhead Traveling Cranes," One Thomas Circle, N.W., Washington D.C. (superseded by CMAA Specification No. 70).

10. Bechtel Corporation, "Specification No. 5828-M-3 for Reactor Building Bridge Crane for the Monticello Nuclear Generating Plant," San Francisco, Revision 2, March 29, 1968.

11. L. O. Mayer, letter to K. R. Goller, Assistant Director for Operating Reactors, U. S. Atomic Energy Commission, from Northern States Power Company, Director of Nuclear Support Services; Re: License No. DPR-22, October 1, 1974.

12. A. V. Dienhart, letter to G. A. Arlotto, Director, Division of Engineering Standards, Nuclear Regulatory Commission, from the Vice President of Engineering, Northern States Power Company, April 12, 1976.