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REPORT

EVALUATION OF SELECTED SPECIAL LIFTING DEVICES FOR COMPLIANCE WITH NUREG-0612.

MONTICELLO NUCLEAR GENERATING STATION

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REVISION CONTROL SHEET

SUBJECT: Report: Evaluation of Selected Special Lifting Devices for Compliance with NUREG-0612

REPORT NUMBER: NSP-77-007

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1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) has established design procedures and safety margins which assure the safe handling of heavy loads at operating Nuclear Power Plants. The establishment of these design procedures and safety margins as reported in NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants", has required that licensees evaluate their operating procedures and design margins for compliance with these regulatory guidelines.

Northern States Power (NSP) has requested that NUTECH assist them in evaluating their level of compliance with the guidelines specified in NUREG-0612 for two (2) special lifting devices: the Drywell/Reactor Vessel Head Strongback, and the Dryer/Steam Separator Sling. This report summarizes the results of NUTECH's evaluation for these special lifting devices.

2.0 DESCRIPTION OF SPECIAL LIFTING DEVICES

2.1 The Drywell/Reactor Vessel Head Strongback and Dryer/ Steam Separator Sling are used for the installation and removal of the Drywell/Reactor Vessel Head and Dryer/ Steam Separator, respectively, during maintenance and repair operations.

2.2 The Drywell/Reactor Vessel Head Strongback consists of two 17 foot long 24 inch deep built-up one inch thick plate girders which intersect at an angle of 90 degrees at their midspans. The flange widths are nominally 7 inches and gradually increase in size in the proximity of the plate girder intersection. Slot-fitted and welded into the girder intersection is a fabricated hook box. Two lifting lugs are attached to the underside of each of the four girder ends. The four outer lifting lugs provide attachment points for the lifting of the Drywell Head while the four inner lifting lugs provide attachment points for the lifting of the Reactor Vessel Head. The Drywell and Reactor Heads are attached to the Strongback through use of anchor shackle and turnbuckle assemblies.

2.3 The Dryer/Steam Separator Sling consists of two W5X16 rolled beams intersecting at their midspans and supported by four wire ropes. One end of each of the wire ropes attaches to a lifting lug welded to each of the beam ends, while the other end of each of the wire ropes attaches to a common hook box located 19 feet above the rolled beam. The wire ropes are attached to the lifting lugs and hook box by means of spelter sockets, tapered sleeves, wire rope thimbles, and turnbuckles. A bell housing and locking pin device is provided at each end of the rolled beam to facilitate attachment of the Dryer/Steam Separator to the lifting sling.

3.0 EVALUATION CRITERIA

The Drywell/Reactor Vessel Head Strongback and Dryer/Steam Separator Sling assembly have been evaluated to determine compliance with the criteria established in NUREG-0612 and ANSI N14.6-1978. Since the original stress analysis was not available, detailed stress analysis was performed for the two special lifting devices. The ANSI Standard specifies that the devices shall be capable of lifting three (3) times the actual load without exceeding the minimum yield strength, and five (5) times the actual load without exceeding the ultimate strength. Since both of these devices are dual load path devices, the additional factor of two (2) delineated in Section 5.1.6.1a of NUREG-0612 need not be applied to the factors recommended in the ANSI Standard.

In accordance with NUREG-0612, the "actual loads" were assumed to be the "service load" increased by a factor of 15% (as recommended in CMAA Specification #70-1975) to account for dynamic effects. The effects of the device weights themselves were found to be negligible when compared to the actual loads and were neglected in the analysis.

The ultimate component load was calculated by ratioing up the yield component load by a factor of (Fult/Fy). The shear yield strength is based on a maximum stress of $(Fy/\sqrt{3})$.

4.0 EVALUATION RESULTS

4.1 Drywell/Reactor Vessel Head Strongback

Design margins for the Drywell/Reactor Vessel Head Strongback were found to exceed the minimum acceptable ANSI factors of safety in all areas as shown below:

ITEM	ANSI Yield F.S.	ANSI Ultimate F.S.
Minimum Requirement	3.00	5.00
Drywell/Reactor Vessel Head Lug (Shear Pull-out)	7.02	11.31
Plate Girder Flange Bending due to Drywell Head	4.49	7.23
Plate Girder Flange Bending due to Reactor Vessel Head	9.95	16.02
Plate Girder Shear Stress in Fillet Weld Near Drywell Head Lug	3.81	6.14
Hook Box Plates (Shear Pull-out)	7.76	12.50
Hook Box Plates (Bearing)	8.34	13.44
Hook Box Pins (Shear)	11.00	15.72
Hook Box Pins (Bending)	9.26	13.22
Plate Girder Flange Bending Near Hook Box due to Drywell Head	4.10	6.61

ITEM	ANSI Yield F.S.	ANSI Ultimate F.S.
Plate Girder Flange Bending Near Hook Box due to Vessel Head	5.47	8.81
Plate Girder Web to Hook Box Weld	17.68	28.49
Hook Box Corner Welds	17.68	28.49
Anchor Shackles	9.34	25.48
Turnbuckles (Drywell Head)	5.22	13.04
Turnbuckles (Reactor Vessel Head)	5.79	14.48

4.2 Dryer/Separator Sling

Design margins for the Dryer/Steam Separator Sling were found to exceed the minimum ANSI factors of safety in all areas as shown below:

ITEM	ANSI Yield F.S.	ANSI Ultimate F.S.
Minimum Requirement	3.00	5.00
Socket Pin (Bending)	5.93	6.50(3)
Socket Pin (Shearing)	37.85	41.49
Socket Pin (Bearing)	7.59	8.32
Bell Housing (Pull-out Shear)	26.11	42.07
Bell Housing Connection to W5X16	9.27	14.94

ITEM	ANSI Yield F.S.	ANSI Ultimate F.S.
Lifting Lugs (Pull-out Shear)	9.90	15.96
Lifting Lugs (Plate Shear)	43.76	70.51
Lifting Lugs (Combined Bending & Tension)	8.45	13.62
W5X16 (Axial Compression)	---	8.89
2½ x 24" Turnbuckle	6.32	15.81
1½" Wire Rope Thimble	---	8.73 (2)
1½" Tapered Sleeve	---	8.73 (2)
1½" Dia. 6-19 Wire Rope	---	8.73 (1,2)
1½" Open Spelter Socket	---	8.73 (2)
Hook Box Cross Plates (Pull-out Shear)	10.09	16.26
Hook Box Cross Plates (Plate Shear)	19.71	31.77
Hook Box Cross Plates (Combined Tension & Bending)	13.06	21.05
Hook Box/Cross Plates Connection	6.81	10.98
Hook Box (Tension)	15.18	24.45
Hook Box (Bending)	3.55	5.72
Hook Box (Pull-out Shear)	8.40	13.54
Hook Box Pin (Shear)	15.06	21.51
Hook Box Pin (Bending)	12.59	17.99
Hook Box Pin (Bearing)	11.38	16.26

(1) G.E. Drawing No. 730E497 calls for 1½ inch diameter, 6-19 wire rope, non-lubricated, corrosion resistant steel by J.A. Roebling Corporation or equivalent. Since it was not possible to obtain original strength data for this rope from Roebling, Federal Specification RRW-410-C was referenced. This Specification states the minimum breaking strength of 1½ inch, 6-19, fiber core galvanized wire rope as 82.8 tons.

(2) The wire rope thimbles, tapered sleeves, and open spelter sockets are rated 100 percent efficient by the manufacturer.

(3) Since the ratio of the socket pin's yield stress to ultimate stress exceeds .8, a fracture toughness analysis was performed in accordance with ANSI N14.6-1978, Section 3.2.1.1. The results of this analysis show a factor of safety against brittle fracture of greater than 2.0.

5.0 CONCLUSIONS AND RECOMMENDATIONS

All components of the Dryer and Steam Separator and Reactor Vessel Head Lifting Device meet the applicable requirements for design stated in paragraph 3.2 of ANSI N14.6-1978. Since a fracture toughness analysis was required for the Dryer and Steam Separator Lifting Device Socket Pins, it is recommended here that the magnetic particle method of nondestructive testing be used as the method to verify continuing compliance for these pins prior to use of this lifting device (See Sections 6.2.1 and 7.0 of NUTECH Specification, "Design Specification for the Dryer and Steam Separator Sling Lifting Device").