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SUBJECT: Forwards addl info re control of heavy loads,single failure proof handling sys,per 810924 commitment.

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JUN 0 4 1982

Mr. A. Schwencer, Chief
Licensing Branch No. 2
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
NUREG 0612
CONTROL OF HEAVY LOADS
ER 100450 FILE 841-2, 841-11, 842-6
PLA-1110

Docket Nos. 50-387
50-388

References: 1) letter dated 12/22/80; Eisenhut to all Licensees of Operating Plants and Applicants for Operating Licenses and Holders of Construction Permits
2) letter dated 9/24/81; Curtis to Eisenhut (PLA-937 - 9 month response to Reference 1)

Dear Mr. Schwencer:

On 12/22/80, the NRC requested additional information on the control of heavy loads regarding single failure proof handling systems (Attachment 1 to Enclosure 3 of Reference 1). PP&L's response to this request (Reference 2) indicated that we would supply information on the subject of special lifting devices at a later date. This information is provided as Attachment A.

An analysis of the response of the reactor building overhead crane to seismic and hydrodynamic loads is discussed in Attachment B.

If you have any questions regarding this matter, please contact Mr. Thomas E. Gangloff at (215) 770-5486.

Very truly yours,

NW Curtis

N. W. Curtis
Vice President-Engineering & Construction-Nuclear

B001

TEG/mks

Attachments

ATTACHMENT A TO PLA-1110

EVALUATION OF GE SUPPLIED LIFTING DEVICES

Statement of Requirement:

Provide an evaluation of the lifting devices for each single-failure-proof handling system with respect to the guidelines of NUREG 0612, Section 5.1.6.

Statement of Response:

Lifting devices are classified as either (a) special lifting devices, or (b) lifting devices which are not specially designed. "Lifting devices which are not specially designed" is taken to mean lifting arrangements consisting principally of slings attaching the load to the hook of the hoist. "Special lifting devices" is taken to mean lifting devices involving more than simple slings.

(a) Special Lifting Devices
The loads in NUREG 0612, Table 3.1-1, (3) BWR-Reactor Building, for which special lifting devices have been provided are the reactor vessel head, the steam dryer, and the moisture separators. Each of these components and its lifting device is supplied by General Electric Co. General Electric Co. has prepared an evaluation of the lifting devices for these Heavy Loads for compliance with ANSI N14.6 1978 "Standard for Special Lifting Devices Weighing 10,000 lbs. or More for Nuclear Materials". This evaluation is contained in Attachment A1..

(b) Lifting Devices that are not Specially Designed

(1) The load in NUREG 0612, Table 3.1-1, (3) BWR-Reactor Building, for which a lifting device that is not specially designed has been provided is the vessel service platform. This component and its lifting device is supplied by General Electric. General Electric Company has prepared an evaluation of the lifting device for the vessel service platform for compliance with ANSI N14.6 - 1978. This evaluation is also contained in Attachment A1.

(2) In addition to the loads in NUREG 0612, Table 3.1-1, (3) BWR-Reactor Building, for which a lifting device, that is not specially designed has been provided for, are the reactor cavity shield plugs, pool gates, jib crane and new fuel two-bundle shipping containers. For these and any other loads which may be moved on the refueling floor, PP&L will provide slings that meet the requirements of ANSI B30.9 - 1971, in accordance with Paragraph 5.1.1(5) of NUREG 0612. In addition, slings used to lift critical loads will be provided with either dual load paths or doubled design safety factors except where components are not commercially available. These slings are now in the process of being purchased to the above requirements.

These slings will be covered under procedures MT-GM-014 "Rigging and Equipment Inspection Program" and/or MT-GM-013 "Crane and Dedicated Chain Fall Mechanical Inspection" for inspection, maintenance and documentation requirements. MT-GM-014 meets the requirements of ANSI B30.9 - 1971 and ANSI B30.10 - 1975; MT-GM-013 meets the additional requirements of ANSI B30.2 and OSHA Std. 1910.179.

ATTACHMENT A1

DESIGN OF LIFTING DEVICES SUPPLIED BY GENERAL ELECTRIC CO.

ANSI N14.6 - 1978, ANSI B30.9 - 1971, and NUREG-0612 were reviewed with reference to:

1) RPV Head Strongback
2) Dryer & Separator Sling
3) Service Platform Sling
4) Service Platform (interface lugs only)

The response to the affected sections or paragraphs is as follows:

1) RPV Head Strongback - 767E187P2, MPL #F19-E009.

In response to ANSI N14.6 - 1978:

3.1.1 & 3.1.2* No design specification as such exists. The design requirements are contained in design verification DV730E179, on drawing 767E187 (Head Strongback Assembly), and on drawing 131C9228 (Hook Pin). The quality requirements are covered by the general quality program under which the requirements are specified on the material request for ordering the hardware. In summary, the specific requirements of these paragraphs have been met and documentation can be traced when needed.

3.1.3 Design stress analyses are contained in GE Design Record File F13-00011, which is available for audit on request. The analyses contained in this Design Record File demonstrate what minimum safety factors have been provided. A summary of the design safety factors are contained in Attachment E to PP&L's 9 month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut; PLA-937).

3.1.4 Repair procedures applicable during manufacture of the equipment are covered by the general quality assurance program.

3.2.1 The load bearing members of this device have been designed to be capable of lifting 4.1 times the rated load (100 tons) without generating any stresses greater than the yield strength of the material. The material used for the Strongback structure is ASTM A36 with a minimum yield strength of 36,000 psi and a minimum ultimate tensil strength of

* Paragraph nos. correlate directly with the paragraph of the referenced ANSI Standard.

58,000 psi. Therefore, $\frac{58,000}{36,000} \times 4.1 = 6.6$, exceeding the requirement of capability to lift 5 times the rated load without exceeding the ultimate strength.

The Hook Pin material is ASTM A519, and similar safety factors in excess of requirements are provided.

3.2.2 In the opinion of the designer, the components will perform satisfactorily.

3.2.3 For the ASTM A36 material the yield point is well defined, and for the ASTM A519 material it is traceable back to the minimum ASTM A519 properties, which are derived in accordance with ASTM A370.

3.2.4 The specially designed Hook Pins which engage the Strongback to the Crane Hook meet the criteria of 3.2.1 to the extent as noted in reply to 3.2.1 above and can be handled manually.

3.2.5 No wire rope or chain is used in connection with this Strongback.

3.2.6 This equipment is used at ambient temperature and is not exposed to extreme temperature variations, therefore it is exempt from this requirement.

3.3.1, 3.3.2 Environmental conditions, material properties and decontamination requirements are taken into account by the designer.

3.3.3 No remote engagement devices.

3.3.4 Adjustable turnbuckles are provided to assure even load distribution.

3.3.5 All load carrying components that may become inadvertently disengaged are fitted with Cotter Pins or Lock Pins of a positive locking type.

3.3.6 No actuation mechanism is used.

3.3.7 This strongback is not used in any pools.

3.3.8 Nameplate requirements are in accordance with the owners recommendations. (See 5.1.5).

3.4 Minimizing decontamination was considered during the design and in the selection of materials and coatings for the lifting device.

3.5.1 Aluminum and stainless steel parts are not coated. Commercially procured items, such as turnbuckles and shackles are galvanized.

3.5.2 The nameplate is not coated.

3.5.3 Carbon steel surfaces are coated with a carbo zinc primer in accordance with GE spec. P50YP123. The final coating will be an approved epoxy based paint.

3.5.4 - 3.5.8 These requirements are met by GE spec. P50YP123.

3.5.9 For galvanized parts refer to reply 3.5.1.

3.5.10 The requirements for contact materials are complied with by standard GE procedures.

3.6 There are no lubricants used on this equipment.

4.0 FABRICATION. There is no design specification, as such, which covers fabrication. Fabrication requirements and specifications are contained on the drawing to which the equipment is fabricated. Nonconformances are reported and dispositioned per GE procedures. The furnished product is either in conformance with the drawing requirements, or the drawing is revised to agree with the as-built condition. Any drawing change is verified to assure the original design criteria is still being met. All precautionary measures concerning fabrication are controlled by GE practices and procedures.

5.1.1 As stated in section 3.1.1, there is no design specification for the Reactor Pressure Vessel Head strongback. However, design stress analyses are discussed in that section. A discussion of allowable stress levels and safety factors is included in Attachment E to PP&L 9 month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut; PLA-937).

5.1.2 Evidence of proof testing is included in Attachment E to PP&L's 9 month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut, PLA-737).

5.1.3 The RPV head strongback is only used to lift the RPV head. This lift has a specific written procedure which included an inspection of strongback and associated equipment prior to use. All load bearing components are examined for signs of wear, damage, cleanliness, and visible deformation.

5.1.4 Included in the operating procedures for the lift that employs the RPV strongback is an outline of the proper installation and use of the strongback.

5.1.5 The special lifting devices are provided with unique identification that ties them to written procedures. The procedures govern the use and documentation of the lifting devices.

5.1.5.1 None of the components of the RPV strongback will be used to lift anything other than the RPV head. Worn or damaged parts will be replaced with equal or better parts per established maintenance procedures.

5.1.5.2 Data such as load limits and environmental limitations are included in the operating procedures.

5.1.6 A complete history of normal use and routine inspection will not be kept for the RPV head strongback, however all abnormal incidents, maintenance, replacements, and retests will be recorded as part of existing quality control procedures.

5.1.7 Any special lifting device or component of a special lifting device that has been distorted, damaged, or otherwise made less able to perform its intended function will be removed from service until it can be repaired, replaced, or retested.

5.1.8 No special lifting device will be used by anyone other than the owner.

5.2 The Strongback was proof tested at 125 tons per spec. 21A8734 and all structural welds were magnetic particle inspected per spec. E5D-YP1, dry method, after proof test. The test load of 125 tons represents 125% of the 100 ton rated load.

6.0 This Strongback is designed to provide a minimum safety factor of 4.1 with respect to the material yield point, or a factor of 6.6 with respect to the ultimate tensil strength, for a "rated" load of 100 tons.

Although there are 2 Hook Pins, 4 Structural Arms, 4 Turnbuckles, and 4 Shackles to connect to the 4 Lift Eyes on the Pressure Vessel Head, this device does not completely qualify for the definition of having two separate distinct load paths, since all 4 Arms have one common center. However, the safety margin at the rated load is based on having one cross-arm support the rated load of 100 tons (e.g. either of the two cross-arms or associated shackles, turnbuckles, etc. may fail).

2) Dryer and Separator Sling - 767E438P3, MPL #F19-E008.

In response to ANSI N14.6 - 1978:

3.1.1 & 3.1.2 No design specification as such exists. The design requirements are contained in design verification DV731E964, on drawing 767E438, and on drawing 131C9228 (Hook Pin). The quality requirements are specified on the material request for ordering the hardware. In summary, the specific requirements of these paragraphs have been met, and documentation can be traced when needed.

3.1.3 Design stress analyses are contained in GE Design Record File F13-00009, which is available for audit on request. The analyses contained in this Design Record File demonstrate what minimum safety factors have been provided. A summary of the design safety factors is contained in Attachment E to PP&L's 9 month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut; PLA-937).

3.1.4 Repair procedures applicable during manufacture of the equipment are covered by the general quality assurance program.

3.2.1 The load bearing members of this lifting device have been designed for a minimum safety factor of 5 in reference to the ultimate tensil strength when lifting a load of 73.5 tons at a span of 224.75".

3.2.2 In the opinion of the designer, the components will perform satisfactorily.

3.2.3 For the ASTM A36 material, used for structural members, the yield point is well defined. The Hook Pin material is ASTM A519, which is traceable back to the minimum ASTM 519 properties, which are derived in accordance with ASTM A370. The Socket Pin material is AMS 6414 (AISI 4340), quenched and tempered to R_C 45-49. Per Marks' Standard Handbook 8th Edition, page 6-34 the tensil strength is 211,000 psi and the yield point is at 200,000 psi for a Brinell hardness of 426. Per ASTM a 370, Table 3A R_C 45-49 is equivalent to Brinell 421-468.

3.2.4 The specially designed Hook Pins which engage the Hook Box to the Crane Hook meet the criteria of 3.2.1 to the extent as noted in reply to 3.2.1 above and can be handled manually. The same applies to the Socket Pins, except they are actuated pneumatically to allow for remote control.

3.2.5 The Wire Rope Slings are in conformance with ANSI B30.9 1971, except when proof load testing the complete assembly, 140 tons were applied for a rated capacity of 73.5 tons. This amounts to 190.5% vs. the required 200%.

3.2.6	This equipment is used at ambient temperature and is not exposed to extreme temperature variations, therefore it is exempt from this requirement.
3.3.1, 3.3.2	Environmental conditions, material properties and decontamination requirements are taken into account by the designer.
3.3.3	The remote engagement support pins have guides to insure proper insertion. In addition the ends of the support pins extend out of the housing when latched, thus giving visual indication of proper engagement.
3.3.4	Adjustable turnbuckles are provided to assure even load distribution.
3.3.5	All load carrying components that may become inadvertently disengaged are fitted with Cotter Pins or Lock Pins of a positive locking type.
3.3.6	See 3.3.3 above.
3.3.7	The dryer/separator sling can be retrieved if unintentionally disengaged from the crane.
3.3.8	Nameplate requirements are in accordance with the owners recommendations. (See 5.1.5).
3.4	Minimizing decontamination was considered during design and in the selection of materials and coatings for the lifting device.
3.5.1	Aluminum and stainless steel parts are not coated. Sling components are galvanized. Socket Pins are nickel plated.
3.5.2	Nameplate is not coated.
3.5.3	Carbon steel surfaces are coated with a carbo zinc primer in accordance with GE spec. P50YP123. The final coating will be an approved epoxy based paint.
3.5.4 - 3.5.8	These requirements are met by GE spec. P50YP123.
3.5.9	For galvanized parts refer to reply 3.5.1.
3.5.10	The requirements for contact materials are complied with by standard GE procedures.
3.6	There are no exposed lubricants on this equipment.

4.0 FABRICATION. There is no design specification, as such, which covers fabrication. Fabrication requirements and specifications are contained on the drawing to which the equipment is fabricated. Nonconformances are reported and dispositioned per GE procedures. The finished product is either in conformance with the drawing requirements, or the drawing is revised to agree with the as-built condition. Any drawing change is verified to assure the original design criteria is still being met. All precautionary measures concerning fabrication are controlled by GE practices and procedures.

5.1.1 As stated in Section 3.1.1, there is no design specification for the Dryer/Separator sling, however, design stress analyses are discussed in that section. A discussion of allowable stress levels and calculated safety factors is included in Attachment E to PP&L's 9 month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut; PLA-937).

5.1.2 Evidence of proof testing is included in Attachment E to PP&L's 9 month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut; PLA-937).

5.1.3 The dryer/separator sling is only used to lift the dryer or the separator. Each of these lifts has a specific written procedure which includes an inspection of the sling and associated equipment before use. All load bearing components are examined for signs of wear, damage, cleanliness, and visible deformations. The hook block may be used with other slings to lift the reactor head insulation. The performance of these slings is verified by the rigging inspection program.

5.1.4 The operating procedures for the specific lifts that employ the dryer/separator sling, or the hook block when used with other slings to lift the head insulation, outline the proper installation and use of the special lifting devices.

5.1.5 The special lifting devices are provided unique identification that ties them to existing procedures and record keeping systems.

5.1.5.1 In the case of the dryer/separator strongback hook block which has multiple uses, the identification is attached directly to the hook block in addition to the main dryer/separator sling identification. No other components are exchanged between special lifting devices. Worn or damaged components will be replaced with similar equipment.

5.1.5.2 Proper methods, load limits, and environmental limitations such as minimum operating temperature are stated in the crane operating procedure or the specific subprocedure associated with the dryer or separator lifts.

5.1.6 A complete history of normal use and routine inspections will not be kept for the dryer / separator sling, however all abnormal events, maintenance, replacements, and tests will be recorded as a part of existing quality control procedures.

5.1.7 Any special lifting device or component of a special lifting device that has been distorted, damaged, or in any way made less able to perform its intended function will be removed from service until it can be repaired, replaced, or retested.

5.1.8 No special lifting device will be used by anyone other than the owner.

5.2 This Dryer and Separator Sling assembly was proof tested at 140 tons and all structural welds were magnetic particle inspected per GE spec. E5D-YP1, dry method, after proof test. The test load of 140 tons represents 190.5% of the 73.5 ton rated load. This exceeds the requirements of this paragraph, but does not quite meet the requirements of 3.2.5.

6.0 The Dryer and Separator Sling is designed to provide a minimum safety factor of 5 with respect to the ultimate material strength. No special features such as increased stress design factors or a dual-load-path are provided. Several parts of the lifting device exceed a safety factor of ten; however, to provide a safety factor of ten for the entire device or to provide completely redundant load paths would require a complete redesign of the dryer/separator sling strongback and a redesign of the dryer and separator lifting lugs.

In response to ANSI B30.9 - 1971:

The Wire Rope Slings of this lifting device are in conformance with all the requirements, except as mentioned in response to 3.2.5 of ANSI N14.6 - 1978 previously.

3) Service Platform Sling, 117C4530P2, Sub. to MPL #F21-E001

In response to ANSI N14.6 - 1978

3.1.1 & 3.1.2 No design specification as such exists. The design requirements are contained in the Design Record File DRF #F21-00001, and on purchased part drawing 117C4530. The quality requirements are covered by the general quality program under which the requirements are specified on the material request for ordering the hardware. In summary, the specific requirements of these paragraphs have been met, and documentation can be traced when needed.

3.1.3	Design stress analyses are contained in GE Design Record File F21-00001, which is available for audit on request. The analyses contained in this Design Record File demonstrate what minimum safety factors have been provided. A summary of the design safety factors are contained in Attachment E to PP&L's 9 month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut; PLA-937).
3.1.4	Repair procedures applicable during manufacture of the equipment are covered by the general quality assurance program.
3.2.1	The load bearing members of this device have been designed for a minimum safety factor of 5 in reference to the ultimate tensil strength. A safety factor with reference to the yield point is not applicable to Wire Rope Slings.
3.2.3	Not applicable to Wire Rope Slings.
3.2.4	Not applicable to this design.
3.2.5	The Wire Rope Sling (3-leg) is in conformance with ANSI B30.9 - 1971, except it was not proof load tested as optionally required per section 9.2.3.
3.2.6	This equipment is used at ambient temperature and is not exposed to extreme temperature variations, therefore it is exempt from this requirement.
3.3.1 - 3.3.4	Not applicable to this design.
3.3.5	Connecting Pins are tack welded to prevent inadvertent disengagement.
3.3.6	Not applicable to this design.
3.3.7	This sling is not used in pools.
3.3.8	The sling will be identified as to use and load capacity.
3.4	No special consideration was given for decontamination; the sling is not used in any pools or in any contaminated environment.
3.5.1 - 3.5.8	No paint or other coatings are used on this equipment.
3.5.9	No parts are galvanized or plated.
3.5.10	The requirements for contact materials are complied with by standard GE procedures.

3.6 There are no exposed lubricants on this equipment.

4.0 FABRICATION. There is no design specification, as such, which covers fabrication. The purchased part drawing 117C4530 specifies sizes, rating and how various standard catalog items are to be assembled for the required end product. It also specifies the supplier to be MACWHYTE a reputable manufacturer of lifting devices.

5.0 ACCEPTANCE TESTING, MAINTENANCE, AND ASSURANCE OF CONTINUED COMPLIANCE

A program of inspection, testing, maintenance and required documentation has been developed for all rigging and lifting equipment (including this sling). Procedure MT-GM-014 "Rigging and Inspection Program" will specify the requirements for inspection, testing and documentation for this sling. This procedure meets the requirements of ANSI B30.9-1971 and ANSI B30.10-1975. Periodic functional testing is used in lieu of proof load testing.

6.0 SPECIAL LIFTING DEVICES FOR CRITICAL LOADS.

The service platform is not a critical load.. See section 2.2.2, "Exclusion of Overhead Handling Systems on Refueling Floor" of PP&L's 9 month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut; PLA-937).

4) Lift Eyes On Service Platform, 731 E973, MPL #F13-E010

In response to ANSI N14.6 - 1978

3.1.1 & 3.1.2 No design specification as such exists, the design requirements are contained in the Design Record File DRF #F13-00006, and on purchase part drawing 731E973. The quality requirements are covered by the general quality program under which the requirements are specified on the material request for ordering the hardware. In summary, the specific requirements of these paragraphs have been met, and documentation can be traced when needed.

3.1.3 Design stress analyses are contained in GE Design Record File F13-00006, which is available for audit on request.

3.1.4 Repair procedures applicable during manufacture of the equipment are covered by the general quality assurance program.

3.2.1 This Lifting lug is designed for a minimum safety factor of 5 in reference to the ultimate tensil strength.

3.2.2 In the opinion of the designer, the components will perform satisfactorily.

3.2.3	For the ASTM A36 material used, the yield point is well defined at 36,000 psi. The ultimate tensil strength is 58,000 psi.
3.2.4 & 3.2.5	Not Applicable.
3.2.6	This equipment is used at ambient temperature and is not exposed to extreme temperature variations, therefore it is exempt from this requirement.
3.3.1, 3.3.2	Environmental conditions, material properties and decontamination requirements are taken into account by the designer.
3.3.3	No remote engagement devices.
3.3.4	Adjustable turnbuckles are provided to assure even load distribution.
3.3.5	Not Applicable.
3.3.6	No actuation mechanism is used.
3.3.7	Not Applicable.
3.3.8	Not Applicable.
3.4	Minimizing decontamination was considered during the design and in the selection of materials.
3.5.1	Not Applicable.
3.5.2	Not Applicable.
3.5.3	Carbon steel surfaces are coated with a carbo zinc primer in accordance with GE spec. P50YP123. The final coating will be an approved epoxy based paint.
3.5.4 - 3.5.8	These requirements are met by GE spec. P50YP123.
3.5.9	Not Applicable.
3.5.10	The requirements for contact materials are complied with by standard GE procedures.
3.6	There are no exposed lubricants on this part.
4.0	FABRICATION. There is no design specification, as such, which covers fabrication. Fabrication requirements and specifications are called for on the drawing to which the equipment is fabricated. Nonconformances are reported and dispositioned per standard GE procedures. The finished product is either in conformance with the drawing requirements, or the drawing is revised to agree

with the as-built condition. Any drawing change is verified to assure the original design criteria is still being met. All precautionary measures concerning fabrication are controlled by standard GE practices and procedures.

5.0 This lug is part of the Service Platform, which as a whole is not a lifting device. No proof test of this lug was performed. Periodic functional testing is used in lieu of proof load testing.

6.0 SPECIAL LIFTING DEVICES FOR CRITICAL LOADS
The service platform is not a critical load. See section 2.2.2, "Exclusion of Overhead Handling Systems on Refueling Floor" of our 9-month response to NUREG-0612 (letter dated 9/24/81; Curtis to Eisenhut; PLA-937).

<u>In response to ANSI B30.9 - 1971</u>:

The Wire Rope Slings of this lifting device are in conformance with all the requirements.

ATTACHMENT B TO PLA-1110

SEISMIC AND HYDRODYNAMIC EVALUATION
OF THE
REACTOR BUILDING OVERHEAD CRANE

Statement of Request:

With respect to the seismic analysis employed to demonstrate that the overhead handling system can retain the load during a seismic event equal to a safe shutdown earthquake, provide a description of the method of analysis, the assumptions used, and the mathematical model evaluated in the analysis. The description of assumptions should include the basis for selection of trolley and load position.

Statement of Response:

A dynamic-finite element analysis of the effect of seismic and hydrodynamic loads on the Reactor Building Cranes was performed by URS/John A. Blume and Associates, Engineers, San Francisco. Eight Mathematical models used for the analysis were developed from a model of the crane and the reactor building structure which supports it. The calculation considered interactions between the building and crane with the crane at different positions along the rails and with the trolley in different positions on the crane bridge. This was done with full load and no load conditions so as to ascertain the maximum conditions of dynamic response and maximum stress conditions imposed upon the crane structure for all operating conditions. Two positions of the crane were selected, one straddling the middle bent of the building and the second where the crane hook was centered between two of the building bents. The trolley was also positioned in two locations: the first in the center and the second at the end of the bridge nearest the most flexible side of the building. These four combinations each with full load and no load result in eight finite element models.

Combinations of seismic, hydrodynamic and operating loads with the proper damping ratio were considered. The hydrodynamic loads are those produced by the disturbance caused by the safety relief valve discharge (SRV) and the loss of coolant accident (LOCA) dynamics. It was determined that two cases of load combinations were governing and result in most severe conditions. These were: a) Dead load plus live load plus operating basis earthquake plus SRV at 2% damping ratio and, b) Dead load plus live load plus safe shutdown earthquake plus SRV plus LOCA at 5% damping ratio.

The finite element calculations were made on the largest crane in Unit 1. The only difference between the two cranes is that the crane girders supporting the trolley on the Unit 2 crane are separated by 16 feet while the girders on the Unit 1 crane are separated by 22 feet. This produces a lighter trolley on the Unit 2 crane but the difference in crane weight is less than 10%. Since the shift in frequencies is a function of the square root of the mass the frequency change is not significant. Since the smaller Unit 2 crane has the

same rating, and basically the same structure as the larger one the static stresses will be slightly lower, and since the vibration modes already correspond with the peak of the spectral acceleration curves, it is apparent the dynamic response of the smaller Unit 2 crane will produce lower stresses than the larger under the same conditions.

The computer code JAB/SAP-IV was used for the dynamic analysis to determine stresses and displacements. Hand calculations were used to determine some of the crane stresses. The stress levels for critical elements showed that the calculated stresses in all cases were less than allowable stresses for the materials. The calculations have shown that wheel uplift may occur but will be less than the height of the crane wheel flanges. It has been determined that the uplift will not result in the crane falling from the rails.

The URS/Blume detailed report of the analysis is in PP&L file number 148-01 and is identified as number M-22.