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SUBJECT: Forwards response to NRC 870623 request for addl info re proposed single-failure-proof mod to auxiliary bldg crane at plant, consisting of responses to NRC questions & MP Alexich 870410 ltr.

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July 20, 1987
AEP:NRC:0514V

Donald C. Cook Nuclear Plant Unit Nos. 1 and 2
Docket Nos. 50-315 and 50-316
License Nos. DPR-58 and DPR-74
SINGLE-FAILURE-PROOF MODIFICATIONS TO AUXILIARY
BUILDING CRANE: REQUEST FOR ADDITIONAL INFORMATION

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Attn: T. E. Murley

Dear Dr. Murley:

This letter is in response to a verbal request from your staff for additional information regarding the proposed single-failure-proof modification to the auxiliary building crane at the Donald C. Cook Nuclear Plant. The attachments to this letter transmit additional information as discussed with your staff members on June 23, 1987.

This document has been prepared following Corporate procedures which incorporate a reasonable set of controls to insure its accuracy and completeness prior to signature by the undersigned.

Very truly yours,

M. P. Alexich
Vice President

cm

Attachments

cc: John E. Dolan
W. G. Smith, Jr. - Bridgman
R. C. Callen
G. Bruchmann
G. Charnoff
NRC Resident Inspector - Bridgman
A. B. Davis

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Attachment 1 to AEP:NRC:0514V

Responses to NRC Questions on the

Single-Failure-Proof Modifications to the Auxiliary Building Crane

At the Donald C. Cook Nuclear Plant

The following clarifications are provided by Indiana & Michigan Electric Company on the single-failure-proof modifications to the auxiliary building crane at the Donald C. Cook Nuclear Plant. The "NRC questions" below are our understanding of what was asked by members of the NRC staff during the teleconference on June 23, 1987. The section numbers noted here correspond to the section numbers noted in Attachment 1 to our letter AEP:NRC:0514T, dated April 10, 1987, a copy of which is enclosed with this letter.

(1) NRC Question

Section 2.2: Will you mark the MCL (maximum critical load) and DRL (design-rated load) on the crane as required by Section 2.2 of NUREG-0554?

Response

Both maximum critical load and design-rated load will be identified on both sides of the crane.

(2) NRC Question

Section 2.3: Address the applicability of the first paragraph of Section 2.3 of NUREG-0554, regarding hazardous environmental variables for the design of the crane.

Response

We do not believe this section to be applicable, since the auxiliary building crane will be used only in the mild environment of the auxiliary building. The ranges of temperature, pressure, and humidity anticipated for crane usage are as follows:

Temperature: Ambient temperature inside the auxiliary building with seasonal variations between winter and summer.

Pressure: Ambient pressure except during refueling outage activities, when slightly negative pressure ($\geq$ 1/8 inch w.g.) will be maintained as required by Technical Specification 4.9.12.d.4.

Humidity: This could range from a minimum of 0% to 100%.

(3) NRC Question

Section 2.7: Explain the sentence in Section 2.7, "The fatigue stress level of materials is typically beyond normal design stress allowables."

Response

The allowable stress range for fatigue design is higher than the normal design allowables of Crane Manufacturers Association of America (CMAA) Specification No. 70-1975. As a result, a

fatigue analysis will not be performed, since it is not a governing factor in design of the crane. Copies of the pertinent pages of the CMAA specification are enclosed in Attachment 2.

(4) NRC Question

Section 4.1: The last sentence of the first paragraph of NUREG-0554, Section 4.1, states that protection against excessive wire rope wear and fatigue damage can be ensured through scheduled inspection and maintenance. Include a statement concerning maintenance and inspection of wire rope in your letter.

Response

Plant procedures require, as part of the preventive maintenance program, periodic inspection of the wire ropes of the auxiliary building crane for excessive wire rope wear and damage.

(5) NRC Question

Section 4.1: The last sentence of the first paragraph of NUREG-0554, Section 4.1 states that the maximum load (including static and inertia forces) on each individual wire rope in the dual reeving system with the MCL attached should not exceed 10% of the manufacturer-published breaking strength. Address this issue in your letter.

Response

The maximum load (including static and inertia forces) on each individual wire rope in the dual reeving system with the MCL attached will not exceed 10% of the manufacturer's published breaking strength.

(6) NRC Question

Section 4.4: The first sentence of Section 4.1 of NUREG-0554 states that the maximum hoisting speed for the critical load should be limited to that given in the "slow" column of Figure 70-6 of CMAA Specification #70. Did you commit to this CMAA specification?

Response

Yes. The maximum hoist speed for the MCL (approximately 4.5 FPM) is less than the suggested operating speed in the "slow" column of Figure 70-6 of the CMAA specification, a copy of which is enclosed in Attachment 2.

(7) NRC Question

Section 4.6: Clarify your action in response to the NUREG-0554, Section 4.6 requirement that lifting devices and hooks should be designed or selected to support a load of three times the load (static and dynamic) being handled without permanent deformation.

Response

The lifting beams and other devices attached to the crane hook block will be designed to have factors of safety based on guidelines noted in NUREG-0612 and NUREG-0554. Each device will be able to support a load of three times the load (static and dynamic) being handled without permanent deformation as recommended in Section 4.6 of NUREG-0554.

(8) NRC Question

Section 8.1: Clarify the 125% load test versus proof-testing to verify the ability of components or subsystems to perform.

Response

Proof-testing of a subcomponent is an independent verification of the subcomponent's ability to perform. The main hook block and eye bolt of the hook block assembly will be tested at 200% of the design-rated load (DRL). Before and after this test, the hook and eye bolt will be subject to nondestructive examinations. The wire rope supplier will test a section of wire rope by subjecting it to an overload condition until breaking occurs. No other components of the crane shall be proof-tested. Upon successful completion of the above proof tests, the overhead crane will be tested at 125% of the DRL. This test will ensure the ability of the crane and its subcomponents to perform their intended function.

(9) NRC Question

Section 8.2: Provide clarification concerning the load test that will take place on the modified crane.

Response

The overhead crane will be tested after installation by means of a no-load test and a 125% capacity load test. The no-load test consists of operating each crane motion to its extreme travel limit without a load on the hook. During the no-load test, the crane bridge shall travel the entire length of the runway, the top-running trolley shall traverse the crane bridge, and the hook block shall be operated through its complete vertical travel limits. Upon successful completion of the no-load test,

the 125% capacity DRL test will be conducted. Each crane motion shall be engaged with the 125% DRL test load suspended from the hook. However, due to the physical restrictions of the plant, each motion will not be operated to its full travel limit during the 125% DRL load test.

(10) NRC Question

Section 8.3: Why did you take an exception to the load hangup test? Provide some documentation showing the adverse effects this type of test could have on the crane.

Response

Load-anchor testing is not recommended by the crane manufacturer (Whiting Corporation). Since Whiting customers have followed the recommendation, there is no available information on past load-anchor tests. The overload-sensing device will be preset and tested using a load higher than the preset load. The last sentence of Section 8.3 of NUREG-0554 states: "The crane manufacturer may suggest additional or substitute test procedures that will ensure the proper functioning of protective overload devices." Based on that provision, and per crane manufacturers' recommendations, we are planning to perform the overload testing.

(11) NRC Question

Section 9.0: Clarify your commitment to Section 9 of NUREG-0554. In particular, the preventive maintenance program should include such items as servicing, repair and replacement requirements, visual examinations, inspections, checking, measurements, problem diagnosis, nondestructive examinations, crane performance testing, and special instructions. State your commitment to the above requirements in the letter.

Response

The operating manual supplied by the crane manufacturer will comply with Section 9.0 in its entirety, including details on preventive maintenance program items noted in the first paragraph of Section 9.0 of NUREG-0554. The existing plant procedures on the preventive maintenance program will be revised to address the above-noted items.

(12) NRC Question

Item 4: Clarify your response to refer to the guidelines of NUREG-0612, Section 5.1.6, on design of interfacing lift points.

Response

The non-redundant or non-dual lift-point system will be designed to have a design factor of safety of ten times the maximum combined concurrent static and dynamic load in accordance with NUREG-0612, Section 5:1.6 Item 3(b).

ATTACHMENT NO. 2

TO

AEP:NRC:0514V

3.3.3 DESIGN LIMITATIONS

3.3.3.1 Welded Box Girders.

Welded box girders shall be fabricated of structural steel with continuous longitudinal welds running the full length of the girder. All welds shall be ample to develop the beam section for the maximum shear and bending.

3.3.3.1.1 Proportions

l/h should not exceed 25
l/b should not exceed 60
b/c should not exceed 60

The h/t ratio of the web plate, when provided with transverse stiffeners or diaphragms as specified in Section 3.3.3.1.5 is limited by the use of longitudinal stiffeners, as follows:

The h/t ratio of the web shall not exceed:

$$\frac{h}{t} = C(k+1)\sqrt{\frac{17.6}{f_c}}$$ nor shall it exceed M

Where: The coefficients C and M are as tabulated below:

Longitudinal stiffeners	C	M
None	81	188*
One	162	376
Two	243	564

* For other values of M at reduced stress levels, see the following table.

Max h/t for 16.3 ksi compression stress - 188*
Max h/t for 12.0 ksi compression stress - 220
Max h/t for 10.0 or less compression stress - 240

Where:

- l = Span in inches
- b = Distance between web plates in inches
- c = Thickness of top cover plate in inches
- f_c = Maximum compressive stress (k.s.i.)
- f_t = Maximum tensile stress (k.s.i.)
- h = Depth of web in inches
- k = f_t/f_c
- t = Thickness of web in inches

3.3.3.1.2 Longitudinal Stiffeners

3.3.3.1.2.1 When one longitudinal stiffener is used it shall be placed so that its centerline is 0.4 times the distance from the inner surface of the compression flange plate to the neutral axis. It shall have a moment of inertia no less than:

$$I_o = 1.2\left[0.4 + 0.6\,\frac{a}{h} + 0.9\left(\frac{a}{h}\right)^2 + 8\left(\frac{A_s a}{h^2 t}\right)\right] ht^3 \ \text{in.}^4$$

If f_c is greater than f_t, a distance equal to twice the distance from the inner surface of the compression flange to the neutral axis shall be substituted in place of "h" in equation for I_o.

3.3.3.1.2.2 When two longitudinal stiffeners are used they shall be placed so that their centerlines are 0.25 and 0.55 times the distance, respectively, from the inner surface of the compression flange plate to the neutral axis. They shall each have a moment of inertia no less than:

$$I_o = 1.2 \left[0.3 + 0.4 \frac{a}{h} + 1.3\left(\frac{a}{h}\right)^2 + 14\left(\frac{A_s a}{h^2 t}\right) \right] ht^3 \cdot \text{in.}^4$$

If f_c is greater than f_t, a distance equal to twice the distance from the inner surface of the compression flange to the neutral axis shall be substituted in place of "h" in equation for I_o.

Where:

a = The longitudinal distance between full depth diaphragms or transverse stiffeners in inches.

A_s = Area of one longitudinal stiffener in square inches.

3.1.2.3 The moment of inertia of longitudinal stiffeners welded to one side of a plate shall be calculated about the interface of the plate adjacent to the stiffener.

For elements of the stiffeners supported along one edge, the maximum width to thickness ratio shall not be greater than 12, and for elements supported along both edges, the maximum width to thickness ratio shall not be greater than 38. If the ratio of 12 is exceeded for the element of the stiffener supported along one edge, but a portion of the stiffener element conforms to the maximum width-thickness ratio and meets the stress requirements with the excess considered as removed, the member will be acceptable.

3.3.3.1.3 Basic Allowable Stresses

Tension = 17.6 ksi

Compression = 17.6 ksi when the ratio of b/c is equal to or less than 38.

When the ratio of b/c exceeds 38, the allowable compressive stress shall be computed from the following formula:

$$fc = 17.6 \sqrt{\left(\frac{38}{b/c}\right)^3}$$

b/c = 40:	fc =	16.3 ksi	b/c = 52:	fc =	11.0 ksi
b/c = 44:	fc =	14.1 ksi	b/c = 56:	fc =	9.8 ksi
b/c = 48:	fc =	12.4 ksi	b/c = 60:	fc =	8.9 ksi

Shear = 13.2 ksi

Bearing = 26.4 ksi on plates in contact

Allowable Stress Range - Repeated Loads:

Members and fasteners subject to repeated load shall be designed so that the maximum stress does not exceed that shown above, nor shall the stress range (maximum stress minus minimum stress) exceed allowable values for various categories as listed in table 3.3.3.1.3-1. The minimum stress is considered as negative if it is opposite in sign to the maximum stress. The categories are described in Section 3.10 with sketches included. The allowable stress range is to be based on the condition most nearly approximated by the description and sketch.

TABLE 3.3.3.1.3–1

Category	Allowable Stress Range, F_{sr} – ksi			
	Crane Service Classification			
	A and B	C and D	E	F
	Number of Loading Cycles			
	20,000 to 100,000	100,000 to 500,000	500,000 to 2,000,000	Over 2,000,000
A	40	32	24	Steel Mill Service A.I.S.E. Spec.
B	33	25	17	
C	28	21	14	
D	24	17	10	
E	17	12	7	
F	17	14	11	
G	15	12	9	

3.3.3.1.4 Stiffened Plates in Compression:

When one, two or three longitudinal stiffeners are added to a plate under uniform compression, dividing it into segments having equal unsupported widths, full edge support will be provided by the longitudinal stiffeners, and the provisions of Section 3.3.3.1.3 may be applied to the design of the plate material when stiffeners meet minimum requirements as follows:

3.3.3.1.4.1 For one longitudinal stiffener at the center of the compression plate, where b/2 is the unsupported half width between web and stiffener, the moment of inertia of the stiffener shall be no less than:

$$I_o = \left[0.6\,\frac{a}{b} + 0.2\left(\frac{a}{b}\right)^2 + 3.0\left(\frac{A_s a}{b^2 t}\right)\right] bt^3 \quad \text{in.}^4$$

FIG. 70-6

SUGGESTED OPERATING SPEEDS

FEET PER MINUTE

Capacity in Tons	HOIST			TROLLEY			BRIDGE		
	Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
3	20	35	70	125	150	200	200	300	400
5	20	35	70	125	150	200	200	300	400
7½	20	35	70	125	150	200	200	300	400
10	20	30	60	125	150	200	200	300	400
15	15	30	50	125	150	200	200	300	400
20	15	25	40	125	150	200	200	300	400
2[illegible]	15	25	30	100	150	175	200	300	400
30	15	25	30	100	125	175	150	250	350
35	10	15	25	100	125	150	150	250	350
40	8	15	25	100	125	150	150	250	350
50	5	10	20	75	125	150	100	200	300
60	5	10	20	75	100	150	100	200	300
75	5	10	18	50	100	125	75	150	200
100	5	8	12	50	100	125	50	100	150
150	5	8	12	30	50	100	50	75	100

NOTE: [F]OR FLOOR CONTROLLED CRANES, IT IS RECOMMENDED THAT [T]ROLLEY AND BRIDGE SPEEDS NOT EXCEED THOSE GIVEN IN [TH]E "SLOW" COLUMNS.

ATTACHMENT NO. 3

TO

AEP:NRC:0514V