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A Duke Energy Company

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July 29, 2004

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

ATTENTION: Document Control Desk

Subject: Duke Energy Corporation

McGuire Nuclear Station, Units 1 and 2
Docket Numbers 50-369 and 50-370

License Amendment Request for
Technical Specification 3.6.14, CONTAINMENT
SYSTEMS, Divider Barrier Integrity - Response to
Request for Additional Information

In a previous letter[1] to the NRC, Duke Energy Corporation (Duke) submitted a license amendment request (LAR) for the McGuire Nuclear Station Facility Operating Licenses and Technical Specifications (TS). This LAR proposed changes to TS 3.6.14 to allow a pressurizer hatch to be open for up to 6 hours, an increase from the present 1-hour allowance. In a letter[2] to Duke, the NRC sent a Request for Additional Information (RAI) on this LAR. Members of the NRC Staff discussed the pending RAI with Duke representatives in a telephone conference held on June 16, 2004. The attachments to this letter provide Duke's response to the July 2, 2004, NRC RAI. Attachment 1 contains a restatement of each of the NRC questions followed by the Duke response. Attachment 2 provides a report documenting an analysis which supports the June 3, 2003 LAR.

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[1] Letter, D. M. Jamil, Duke Energy Corporation, to the U. S. Nuclear Regulatory Commission, ATTENTION: Document Control Desk, SUBJECT: McGuire Nuclear Station. License Amendment Request for Technical Specification 3.6.14, Containment Systems, Divider Barrier Integrity, Dated June 3, 2003.

[2] Letter, J. J. Shea, U. S. Nuclear Regulatory Commission, to G. R. Peterson, Duke Energy Corporation, SUBJECT: McGuire Nuclear Station. License Amendment Request for Technical Specification 3.6.14, Containment Systems, Divider Barrier Integrity, Request for Additional Information, Dated July 2, 2004.

A001

Inquiries on this matter should be directed to J. S. Warren at (704) 875-5171.

Very truly yours,

Henry B Barron

Henry B. Barron

xc w/Attachments:

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Henry B. Barron, affirms that he is the person who subscribed his name to the foregoing statement, and that all the matters and facts set forth herein are true and correct to the best of his knowledge.

Henry B Barron

Henry B. Barron, Group Vice President, Nuclear Generation and Chief Nuclear Officer

Subscribed and sworn to me: July 29, 2004
Date

Betty Sharpe Gregory, Notary Public

My commission expires: 3/09/09
Date

BETTY SHARPE GREGORY
NOTARY
My Comm. Exp.
March 09, 2009
PUBLIC
MECKLENBURG COUNTY, N.C.

SEAL

bxc w/Attachments:

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NRIA File/ELL
McGuire Master File - Mail Code MG01DM

Attachment 1

Duke Energy Corporation
McGuire Nuclear Station, Units 1 and 2

Response to NRC Request for Additional Information on Containment Divider Barrier Integrity

Attachment 1 provides the Duke responses to the questions contained in the NRC's July 2, 2004 request for additional information. Some of the responses reference Attachment 2. Each NRC question is stated, followed by the Duke response.

Question 1:

Attachment 3 to the submittal, dated June 3, 2003, states the following:

A McGuire engineering calculation was performed to ensure that the drop of the largest pressurizer hatch plug on the pressurizer enclosure roof or operating floor, and a drop of the polar crane load block on to the operating floor would not damage any equipment, component, or systems necessary for safe shutdown. … Based on this calculation, the operating floor and the pressurizer enclosure roof can withstand a drop of the largest pressurizer enclosure hatch plug or the polar crane load block. Subsequently the heavy load drop analysis was revised to ensure the calculation enveloped the case of the largest pressurizer hatch plug dropping back into the hole.

a. Describe the assumptions and methodology used in the above revised calculation for the NRC staff's review.

b. Explain how the load drop analysis conforms to the NUREG-0612, Appendix A guidelines for analysis of postulated load drops. Specifically, address NUREG-0612, Appendix A, Section 1, Items 1, 3, 6, and 7.

c. NUREG-0612, Appendix A, Section 2, Item 1 recommends that the impact loads should include the load, the crane load block, and other lifting apparatus. However, your analysis involves dropping of the largest pressurizer hatch plug and the polar crane load block *separately* on structures. Explain how you determine consequences of a postulated load drop involving a drop of the load, the crane load block, and other lifting apparatus *together* on structures.

Response:

See the report provided as Attachment 2 in this submittal package. This report summarizes an analysis performed to support this LAR. The analysis is based on a calculation that was performed in accordance with the requirements for performing such analyses as described in NUREG-0612. The analysis does not assume a drop of the pressurizer hatch and the main hook load block since the pressurizer hatches are lifted with the auxiliary hook, not the main hook.

Question 2:

Explain how you satisfy the following of NUREG-0612: (1) general guidelines in Section 5.1.1 and (2) guidelines on minimizing the possibility of failing safe shutdown equipment as a result of a load drop in Section 5.1.5.

Response:

See the report provided as Attachment 2 in this submittal package and NRC letter dated March 12, 1985,[1] which transmits the Safety Evaluation Report regarding the control of heavy loads at McGuire.

Question 3:

You have stated it may be necessary to enter the pressurizer cavity to perform inspections and maintenance requiring the hatch to be opened longer than one hour during plant operation. Provide details on situations that would require the hatch to be opened for up to six hours as proposed in this amendment.

[1] Letter, T. M. Novak, U. S. Nuclear Regulatory Commission, to H. B. Tucker, Duke Power Company, SUBJECT: Control of Heavy Loads, Dated March 12, 1985.

Response:

Entries into the pressurizer enclosure are made during the applicability of TS 3.6.14. During startup and shutdown, entries are made to check for leaks. Planned entries into the pressurizer enclosure include the following situations:

1. Upon entering Mode 3 at the beginning of every refueling outage, an inspection of the packing leakoff lines on the PORVs and the PORV block valves is performed. While in the cavity, a general visual inspection for any type of leak or other problem is performed. This inspection must be performed in Mode 3 because it may not be possible to detect leakage when the unit is cooled down and depressurized.

2. An inspection similar to the one described above is performed during Mode 3 following every refueling outage. The PORVs and PORV block valves are inspected for packing leakage.

3. If any valve work (seat, bonnet, packing, or removal) was performed during the refueling outage on the PORVs, block valves, or safety valves, a functional test for external leakage must be performed at full temperature and pressure. The necessity to perform these activities usually occurs during Mode 2.

4. Surveillance is performed upon entering Mode 3 at the start of a refueling outage, or after a trip following a long run in order to check for boric acid leakages. Duke inspects all areas of containment, including the upper pressurizer enclosure, for signs of boric acid corrosion from leaks.

There are also several reasons why unplanned entries into the pressurizer enclosure would be made during Mode 1 operations. These include:

1. Suspected instrument tubing leak affecting pressurizer level indication.

2. Confirm pressurizer safety valve(s) leakage.

3. Confirm pressurizer PORV seat leakage.

4. Investigate pressurizer safety valve relief line high temperature.

Question 4:

Describe applicable regulations and requirements concerning the containment and pressurizer hatch and how the proposed change will not affect conformance with these requirements.

Response:

Duke's June 3, 2003, license amendment request (LAR) contained a supporting analysis that showed the containment acceptance criteria would continue to be met in a conservative manner following implementation of the proposed changes. Consequently, McGuire will remain in compliance with the applicable regulations and requirements. These are: 10CFR50, Appendix A, General Design Criterion (GDC) 16, "Containment Design," which requires that the reactor containment and associated systems provide an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment; GDC 38, "Containment Heat Removal," which requires that a system be provided to remove heat from the reactor containment; and GDC 50, "Containment Design Basis," which requires that the reactor containment structure be designed with conservatism to accommodate applicable design parameters (pressure, temperature, leakage rate).

PURPOSE:

This report documents an analysis which combines drop of the pressurizer hatch plug and the polar crane auxiliary hook to meet the requirements of NUREG-0612.

DISCUSSION:

This report considers failure of the auxiliary hook hoist cable. In this scenario, the hatch would fall back into the hole and then the auxiliary hook would be postulated to fall on the hatch. The polar crane procedure limits the lift height of the pressurizer hatch to 1' off the top of the pressurizer enclosure. It is conservative to assume that the rigging is long, and this allows the auxiliary hook to be in its highest position.

REFERENCES:

1. Design of Reinforced Concrete, Jack C. McCormac, Harper Collins College Publishers
2. Formulas for Stress and Strain, Raymond Roark and Warren Young, 5th Edition, McGraw Hill Book Company
3. Topical Report Evaluation BC-TOP-9 Rev 9, Design of Structures for Missile Impact, Bechtel Power Corporation, 1974
4. Impact Effects of Fragments Striking Structural Elements, By R.A. Williamson and R.R. Alvy, Holmes and Navier, Inc, November 1973
5. MC-1051-21 Reactor Building- Unit 2, Miscellaneous Steel, Sheet 2
6. MC-1051-100 Reactor Building, Unit 2, Pressurizer Hatch Covers, Elevation 817' + 6"
7. MC-1050-55 Reactor Building Unit 1- Plans and Sections at El 817+6 and 823+6 - Concrete
8. NUREG-0612 Control of Heavy Loads at Nuclear Power Plants
9. MP/1/A/7650/060 Operation of Polar Crane in Unit 1 Upper Containment
10. MP/2/A/7650/116 Operation of Polar Crane in Unit 2 Upper Containment
11. MP/0/A/7150/102 Pressurizer Hatch Plug Removal and Installaton
12. MCS 1109.00-1 Specification for Concrete Class 1 Structures
13. MCM 1125.01015-0001 Polar Crane Manual

ANALYSIS:

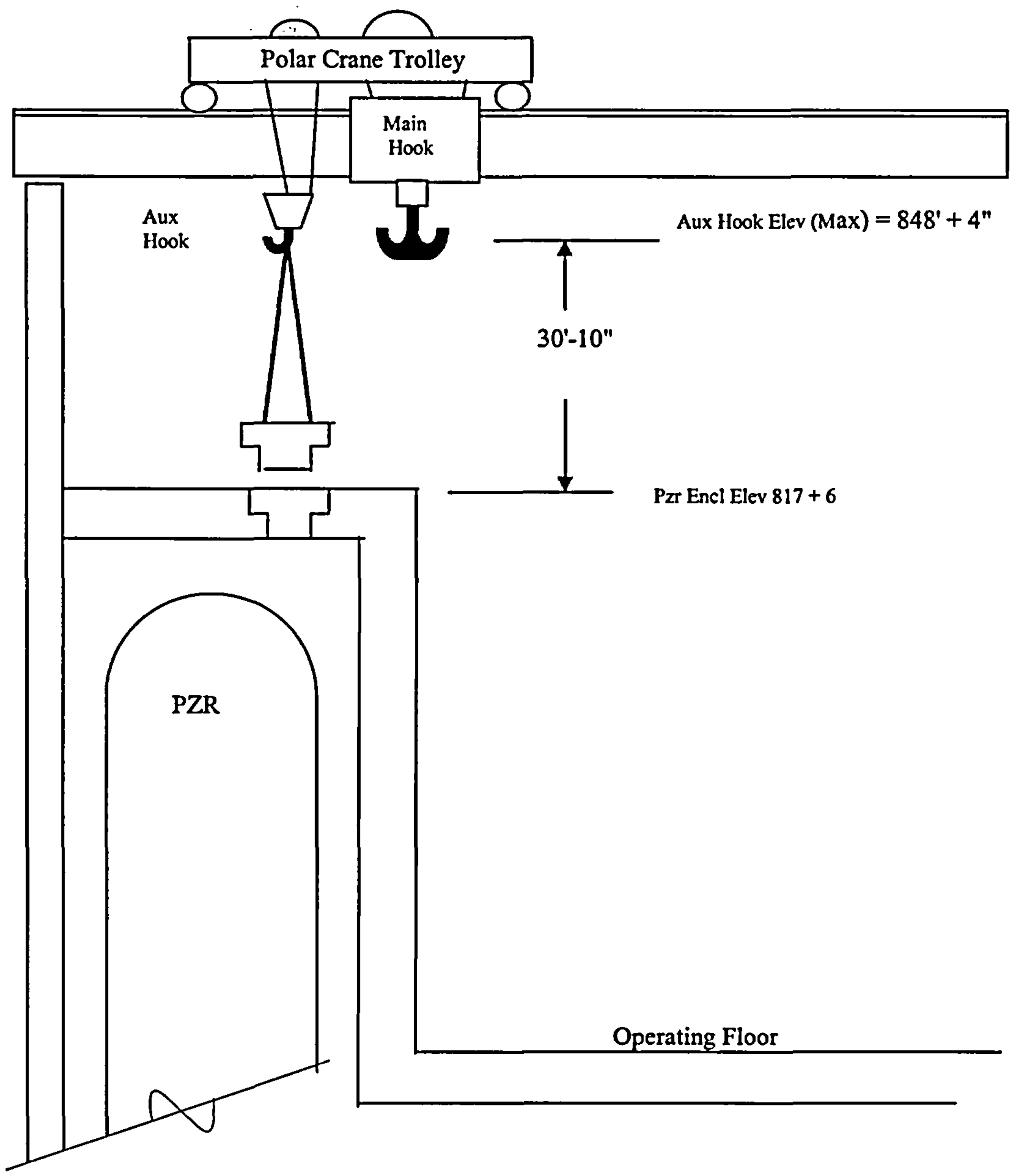
Assumptions:

1. It is assumed that the polar crane auxiliary hook is in the highest position prior to a postulated load drop. The auxiliary hook is at Elevation 848'-4".
2. It is assumed that the pressurizer hatch falls back into the hatch opening, and then the auxiliary hook falls on the center of the hatch. The impacts occur at different times. Note: The rigging is made up of slings, and there is not a below the hook lifting device that would make a rigid link between the pressurizer hatch.
3. The frontal impact area of the auxiliary hook is assumed to be 0.1 sq ft.
4. The pressurizer hatch plug falls back into the pressurizer hatch opening without yielding the rebar.

Given Data:

a. Concrete Strength = 5000 psi (C1 or C2, References 3.7 and 3.12)
b. Maximum Elevation of Polar Crane Auxiliary Hook = 848'-4" (Reference 13)
c. Elevation of top of pressurizer cavity = 817'-6"
d. Polar Crane Auxiliary Hoist Load Block Weight = 1000 lbs

Attachment 2



Drop Analysis:

Calculate Penetration Depth:

(1) Drop Height = 848'-4" - 817'-6" = 30.833 ft

(2) Time to drop 30.833 ft: $d = (1/2)at^2$

where:
d = drop distance = 30.833 ft
a = acceleration of gravity = 32.2 ft/sec²
t = time in seconds

t = SQRT(2d/a) = SQRT((2 X 30.833)/32.2) = 1.38 seconds

(3) Velocity at impact (ft/sec): V = (a)(t) = (32.2)(1.38) = 44.44 ft/sec

(4) Penetration of auxiliary hoist hook into hatch plug: $X = 12\ K_P\ A_P\ LOG_{10}\ (1 + V_S^2/215{,}000)$
(Equation from Reference 3)

Where:
X = Depth of penetration of missile penetration into concrete element of infinite thickness (inches)
K_P = Penetration coefficient for reinforced concrete (Figure 2-1, Reference 3) = 0.0023
A_P = (Missile Weight)/(Projected frontal area of missile) = 1000/0.1 = 10000 psf
V_S = Striking velocity of missile = 44.44 ft/sec (from above)
$X = 12\ (0.0023)(10000)\ LOG_{10}\ (1 + (44.44)^2/215{,}000) =$ 1.096 in.
$X_1 = [1 + e^{-4(t/x\ -2)}]X$ (Ref 3)

Where:
X1 = Depth of penetration of missile into a concrete element of finite thickness (inches)
$X_1 = [1 + e^{-4(t/x\ -2)}]X$
t = thickness of concrete element (inches) = 24"
$X_1 = [1 + e^{-4(24/1.096\ -2)}]1.096 = 1.096"$

Calculate Peak Impact Force:

$$\frac{Fi\ X}{2} = \frac{wv^2}{2g}$$

where:
Fi = Impact Force
w = weight of projectile
v = velocity of projectile
X = penetration depth

Therefore $Fi = (wv^2)/\ (gX) = (1000)(44.44^2)/(32.2*\ (1.096/12)) = 671{,}526$ lbs

<u>Calculate the peak stress in the center of the slab due to the impact load:</u>

From Table 26, Case 1C of Reference 2, $\sigma_b = \beta W/t^2$

Where:
σ_b = maximum bending stress at the center of the hatch
W = load on a small area in the center of the slab = 671,526 lbs
β = 1.82 for a/b =1 (square slab) and a1/a = 0.2 and b1/b = 0.0

Note: a1 and b1 are the assumed dimensions of the projected impact load

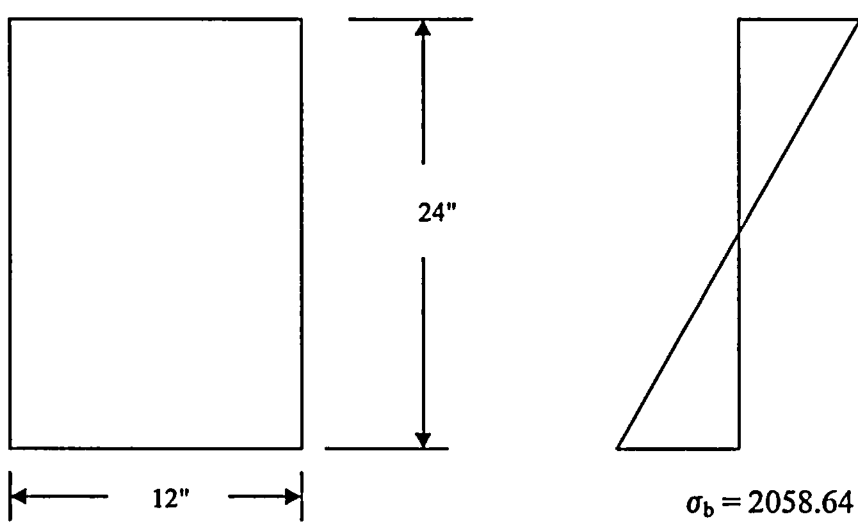
T = thickness of the hatch = 24"

Note: The hatch has two thicknesses, 24 inches in the center and 11 5/8" at the edges. Since the peak stress is in the center of the hatch, 24" will be used for the thickness of the slab.

$\sigma_b = (1.82)(671{,}526)/24^2 = 2122$ psi

<u>Convert the peak stress into a moment:</u>

Assume a beam, with a unit width of 12" with a depth of 24":



$\sigma_b = 2058.64$ psi

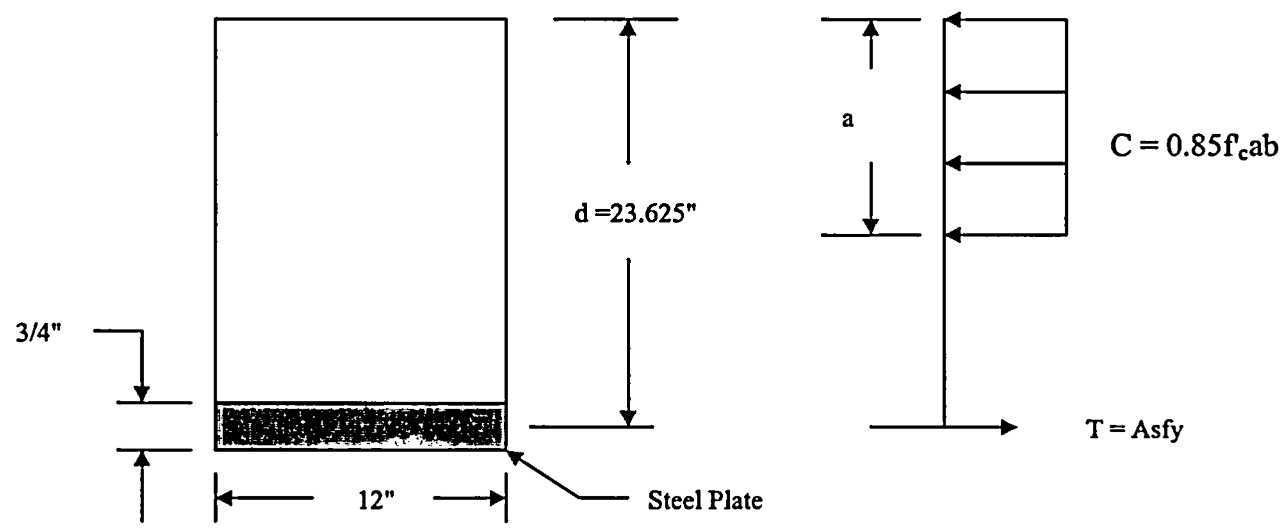
Moment of Inertia = I = $(1/12)12*24^3$ = 13824 in^4
Section Modulus = Sx = I/c = 13824/12 = 1152 in^3

σ_b = M/Sx
M= σ_b(Sx) = (2122) (1152) = 2,444,544 in-lbs

Attachment 2

Calculate the ultimate moment capacity at the center of the slab for the 12" unit width assuming beam action:

Conservatively neglect all the rebar and steel bars in the slab and assume that the 3/4" steel plate on the bottom of the slab carries all the tensile load:



$Mu = \phi A_s f_y d(1 - 0.59\rho f_y/f'c)$

Where:
Mu = Ultimate Moment Capacity
ϕ = 0.90
As = Area of Steel = (12)(0.75) = 9 in²
fy = yield stress of steel= 36 ksi
$\rho = \frac{As}{bd} = \frac{9}{(12)(23.625)} = 0.03175$
f'c = concrete compressive strength = 5 ksi
Mu = (0.9)(9)(36)(23.625)(1 - 0.59(0.03175)(36)/5) = 5959.896 in-kips = 5959896 in-lbs

The applied moment is 2,444,544 in-lbs and this is significantly less than the ultimate moment capacity of the section = 5959896 in-lbs. Therefore the moment in the center of the slab is considered acceptable.

Check the shear stress in the hatch to ensure the edges of the hatch do not shear off:

Assume that only the rebar and A36 rods described on Page 47 of this calculation carry the shear load.
(16) # 4 and (24) #7 Rebars
(12) A36 bars

Total area of the rebar = 17.572 in^2 and the area of the A36 steel = 9.425 in^2 for a total steel area of 27.0 in^2.

Using the Tresca maximum shear stress theory, shear yielding occurs at 50% of yield stress. Therefore limit all the bars to 1/2 the yield strength of the A36 bars = 18 ksi.

Assume 1/2 the total load is applied on one of the four ledges:
Applied shear = 671,526 lbs/2 = 335763 lbs
Shear resistance provided by A36 bars and rebar = (27 in^2)(18000 psi) = 486000 lbs
335763 lbs < 486000 lbs

Note: The above analysis is very conservative based upon the following:

- Nelson studs exist that were neglected
- Other rebar exist that was neglected
- The energy absorbing capacity of shearing the concrete was neglected
- The energy absorbing capacity of the steel frame was neglected

Check scabbing of the bottom of the pressurizer hatch:

The bottom of the pressurizer hatch has a 3/4" steel plate that will prevent the hatch from scabbing when the postulated load drop of the auxiliary hook falls on it. Therefore a scabbing check is not required.

CONCLUSION

The energy available from dropping the pressurizer hatch in combination with the polar crane auxiliary hook is insufficient to shear off the edge of the pressurizer hatch and will not overstress the center of the hatch due to bending. The pressurizer hatch can be lifted 1 foot above the enclosure and the auxiliary hook can be dropped from the highest position.