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Acting Director
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CNRO-2004-00070

November 19, 2004

U. S. Nuclear Regulatory Commission
Attn.: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Response to NRC Request for Additional Information Pertaining to Request for Alternative ANO2-R&R-002, Rev. 1

Arkansas Nuclear One, Unit 2
Docket No. 50-368
License No. NPF-6

REFERENCES:

1. Entergy Operations, Inc. letter CNRO-2004-00016 to the NRC dated March 11, 2004
2. Entergy Operations, Inc. letter CNRO-2002-00018 to the NRC dated April 4, 2002

Dear Sir or Madam:

In Reference 1, Entergy Operations, Inc. (Entergy) requested NRC authorization to use the new design of the mechanical nozzle seal assembly (MNSA-2) in permanent applications at Arkansas Nuclear One, Unit 2 (ANO-2). Entergy plans to use the MNSA-2 on various pressurizer nozzle locations as documented in Request for Alternative ANO2-R&R-002, Rev. 1.

In various e-mails to Entergy, the NRC staff has requested additional information pertaining to this request. These requests for additional information (RAIs) involve three sets of comments and questions regarding supporting calculations and inspection information. Entergy will respond to each set of questions separately.

Enclosed in this letter are our responses to the set of RAIs pertaining to supporting Calculation CN-CI-02-6. Rev. 0. This calculation was provided to the NRC as Attachment A of Westinghouse Design Report DAR-CI-02-2, *Addendum to CENC-1224 Analytical Report for Arkansas Nuclear One Unit 2 Pressurizer* via Reference 2.

A047

This letter contains no commitments.

Should you have any questions regarding this letter, please contact Guy Davant at (601) 368-5756.

Very truly yours,

FGB/GHD/ghd

Enclosure: Response to NRC Request for Additional Information Pertaining to Request for Alternative ANO2-R&R-002, Rev. 1

cc: Mr. W. A. Eaton (ECH)
Mr. J. S. Forbes (ANO)

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ENCLOSURE

CNRO-2004-00070

REQUEST FOR ADDITIONAL INFORMATION REGARDING REQUEST FOR ALTERNATIVE ANO2-R&R-002, Rev. 1

ARKANSAS NUCLEAR ONE - UNIT 2

**REQUEST FOR ADDITIONAL INFORMATION REGARDING
REQUEST FOR ALTERNATIVE ANO2-R&R-002, Rev. 1**

CALCULATION CN-CI-02-6, REV 0, "Analysis of ANO-2 Pressurizer Heater Sleeve MNSA-2 Designs" dated March 21, 2002[1]

1.0 Section 3.1.4, "Sealing Pressure," (page 9) states that the radial pressure against the pressurizer (PZR) bore and the heater sleeve is at least 80% of the axial pressure. Please indicate where this determination is demonstrated in Reference 6 of the calculation.

Response:

The Grafoil Literature Sheet, documented in Union Carbide Corporation's Engineering Design Manual, Vol. 1 *(Reference 6 of CN-CI-02-6) and provided in Attachment 1, shows the Increase in radial load transfer with applied axial load. As evidenced from the graph, a transfer coefficient of 80% results in an applied load of 3,500 psi.*

2.0 Section 6.3.1.1.2, "Maximum Relative Displacement," (page 21) shows the calculated maximum relative thermal growth for the inboard and outboard heater sleeves, and for the long and short threaded rods. These values are quoted from the spreadsheet in Appendix B-2, page 65, subtitled "Entergy MNSA-2 Designs, Relative Thermal Growth Evaluations to Determine the Changes in Preload (MNSA-2 to Vessel)." However, none of the values on page 21 correspond to the values in this spreadsheet. Section 6.1, "MNSA-2 Description," (page 13) states that the ANO-2 heater sleeves evaluated in this calculation are identified as nozzle number 9 and are designated as MNSA-2 Type 4. The spreadsheet in Appendix B-2, page 65, does not identify a Type 4 MNSA-2, nor does it refer to inner and outer nozzles. In addition, the length of the heater sleeve compression collar in Section 6.2.7 is listed as 4.45 inches. None of the MNSA-2 types compression collars listed in the spreadsheet has this length. It appears that this spreadsheet does not reflect the MNSA-2 Type 4. Provide the pertinent spreadsheet calculation for the MNSA-2 Type-4 relative thermal growth, verifying the maximum relative displacement values stated on page 21.

Response:

The spreadsheet originally provided in Appendix B-2 of CN-CI-02-6 is incorrect, and applies to instrument nozzles rather than to the heater sleeves. A corrected spreadsheet is provided in Attachment 2. Its results are consistent with those in Section 6.3.1.1.2. Please note that Westinghouse conservatively used a compression collar length of 4.7 inches, which is the sum of the compression collar and the Grafoil seal. Using 4.7 inches yielded a more conservative value for thermal growth of the threaded rods.

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[1] Entergy submitted supporting Calculation CN-CI-02-6 to the NRC staff as Attachment A of Westinghouse Design Report DAR-CI-02-02 via letter CNRO-2002-00018 dated April 4, 2002.

3.0 Section 6.3.1.3, "Preload and Maximum Operating Load," (page 21) states that each Belleville stack will be compressed 0.0318 inch, which corresponds to a preload of 2,040 lbs per threaded rod, rounded off to 2,100 lbs. These values appear to correspond to the loading curve on Appendix B-2, page 69. On page 29, the Belleville washer stiffness is determined from the curve shown on Appendix B-2, page 68. The deflection determined from this curve, corresponding to 2,100 lbs, is 0.0214 inch. Likewise, the stiffness calculated from this curve is 30,998 lbs/in, which does not correspond to the slope of the loading curve on page 69, shown as 69135 lbs/in.

A. Indicate which of the curves on pages 68 and 69 are applicable to the MNSA-2 design for ANO-2.

B. The curves on pages 68 and 69 refer to Reference 11 in the calculation, titled Westinghouse LTR-ME-02-15, "MNSA-2 Belleville Washer Data." Provide this reference, which should have the basis for these curves.

Response:

The Belleville washer data shown in pages 68 and 69 are based on tests performed by the manufacturer. The curve on page 68 was available during the initial stages of the MNSA design, based on testing of prototype washer packages, and was used in the design stages to determine the increase in preload due to thermal growth differences. It is noted that the preload value of 3,034 lbs (for 48 mils compression) is reasonably consistent with corresponding loads obtained from the loading curve portion for the Reference 11 tests (page 69). This second test series was performed on washers from the actual production series and was designed to provide the load hysteresis information that is apparent from these curves. The preload value of 2,040 lbs per rod for 17-ft-lbf installation torque is derived from the loading portion of the lower graph on page 69.

For the Belleville washer stiffness calculation, the data from page 68 was used. It was considered to be a "lower bound" of the loading and unloading curves shown on page 69. This choice was justified since it results in higher impact forces.

A copy of Westinghouse document LTR-ME-02-15 (Reference 11) is provided in Attachment 3.

4.0 In Section 6.3.2.2.1, "Component Stiffness System," the stiffness equation shown on page 30 for the combined stiffness of the threaded rods and washers appears to be based on a configuration that considers the rods and the washers in series. (This model implies that the rods and the washers will both be in tension.) However, the equation for the relative displacement shown in Section 6.3.1.1.2, "Maximum Relative Displacement," (page 20) appears to be based on a configuration in which the washers are in series with the collar and the flanges, and in parallel with the threaded rods. Please explain this apparent discrepancy in the two models, and provide the maximum threaded rod load on page 33 to reflect the configuration on page 20.

Response:

The NRC's statements are correct. However, there are two different models in use. Section 6.3.1.1.2 determines the relative displacements due to thermal growth differences between components. Section 6.3.2.2.1 deals with determining impact forces using stiffness properties.

With respect to Section 6.3.1.1.2, the spreadsheet provided in response to Comment 2.0 (see Attachment 2) gives additional information. The purpose is to determine the change (increase) in the Belleville washer compression due to heatup. This increase is based on the change between growth in the collar plus flanges plus washers minus the growth in the vessel shell plus free threaded rod length. As seen in the spreadsheet and the table below, the free "threaded rod" length varies based on location and "short" or "long" threaded rod designation.

Free Length Values of ANO-2 Heater Sleeve Threaded Rods

Description	*Long Rod*	*Short Rod*
Inner Heater Sleeve	*6.85 inches*	*5.7 (5.66) inches*
Outer Heater Sleeve	*7.08 inches*	*5.08 inches*

Also, see spreadsheet on page 72 of CN-CI-02-6 for actual computations.

With respect to Section 6.3.2.2.1, there are two (2) sets of forces that act in parallel. The forces comprising each set act in series. The first set is comprised of the Grafoil seal, compression collar, and upper flange. The second set is comprised of the threaded rods and the Belleville washers. The maximum load is computed as the sum of the preload plus the impact force multiplied by the stiffness of the rod/washer divided by the sum of the stiffness values due to rod/washer and flange/collar/Grafoil.

5.0 The maximum preload value is shown in Section 6.3.1.1.3, "Preload and Maximum Normal Operating Load," (page 21) as 12,200 lbs. This value does not correspond to the value of 16,600 lbs shown on page 45 of CN-CI-02-12, or 15,600 lbs shown on page 223 of CN-CI-02-12, Appendix C. Provide the basis for these three different preload values, justification why three different values were used, and which is the correct design value.

Response:

12,200 lbs is correct, actual value for the maximum preload. 16,600 lbs was an assumed conservative value used in the analysis. Since 16,600 lbs is conservative, the analysis is bounding for the actual conditions. The analysis was not revised to remove the conservatism. 15,600 lbs is a typographical error and should be 16,600 lbs.

6.0 In Section 6.3.2.2.1, "Component Stiffness System," (page 32) the cross-sectional area of the compression collar is listed as 0.757 square inch, based on an inner diameter (ID) of 1.325 inches. Section 6.2.7, "Compression Collar Dimensions", (page 19) lists the cross-sectional area as 1.082 square inches, based on an ID of 1.158 inches. Explain this discrepancy, and state which is the correct ID. If 1.082 is the correct value, then provide the revised compression collar stiffness and provide the maximum threaded rod load on page 33 to reflect this revised stiffness.

Response:

Both area values are correct. One area is for the seal region (seal pressure), while the other is for the shank region (collar stiffness calculation). The dimensions given are provided in Reference 9.13 of CN-CI-02-6.

Seal: *OD = 1.649", ID = 1.158"*

Shank: *OD = 1.649", ID = 1.325"*

7.0 Section 6.3.3.2.8, "Stress Due to Initial Compression," (page 42) lists 5,040 lbs as the installation preload per threaded rod.

A. Provide the basis for this preload value.

Response:

The initial compression load of 5,040 lbs is higher than the maximum preload value of 3,050 lbs. The preload value was chosen to assure initial "compacting" of the seal and then to return to lower preloads for operating conditions. The initial preloads were used prior to hydrostatic testing of various seal designs; this process demonstrated excellent seal performances.

B. The stress in the compression collar exceeds the allowable value of S_m at room temperature. Verify that the stress in the compression collar does not exceed 2/3 of the critical buckling stress for short columns, and provide justification for using 0.9 S_y as the limiting stress.

Response:

A value of 0.9 S_y was used to ensure the stresses remain within the elastic limit and do not affect the components. The minimum yield stress for the compression collar is 30 ksi at room temperature. The compressive stress is 26.63 ksi, which is below 0.9 S_y (27 ksi). Since this is a one time occurrence, and not a steady state or operating condition, this stress condition was deemed acceptable, as stated.

Assuming conservatively a compression collar length of 4.45 inches, a uniform outside diameter (OD) of 1.649 inches, a uniform ID of 1.325 inches, pinned/pinned end conditions, then the buckling load is determined as:

$F_K = \pi^2 E I / s^2$

with $E = 28.3 \times 10^6\ lb/in^2$

$I = \pi/64\ (OD^4 - ID^4) = 0.2117\ in^4$, *and*

$S = 4.45\ in$

$F_K = 2{,}985{,}363\ lbs \ggg 4 \times 5{,}040 = 20{,}160\ lbs$

C. Provide justification why this loading condition was not included in the counterbore and tapped hole fatigue analyses.

Response:

Fatigue degradation is driven by cyclic loading. Although the initial compression load is high, it is only a one-time load that does not recur while the component is in service under normal operating loads. One-time loads such as this are typically not considered in the Code fatigue analysis."

8.0 In Section 6.3.3.4, "Compression Collar," (page 44) the compressive stress is based on the cross-sectional area of 0.757 square inch. Verify that this is the correct area for the heater sleeve MNSA-2 Compression Collar. (See Question 6.0, above.)

Response:

See the response to Question 6.0.

ATTACHMENT 1

GRAFOIL SEAL TRANSFER COEFFICIENT

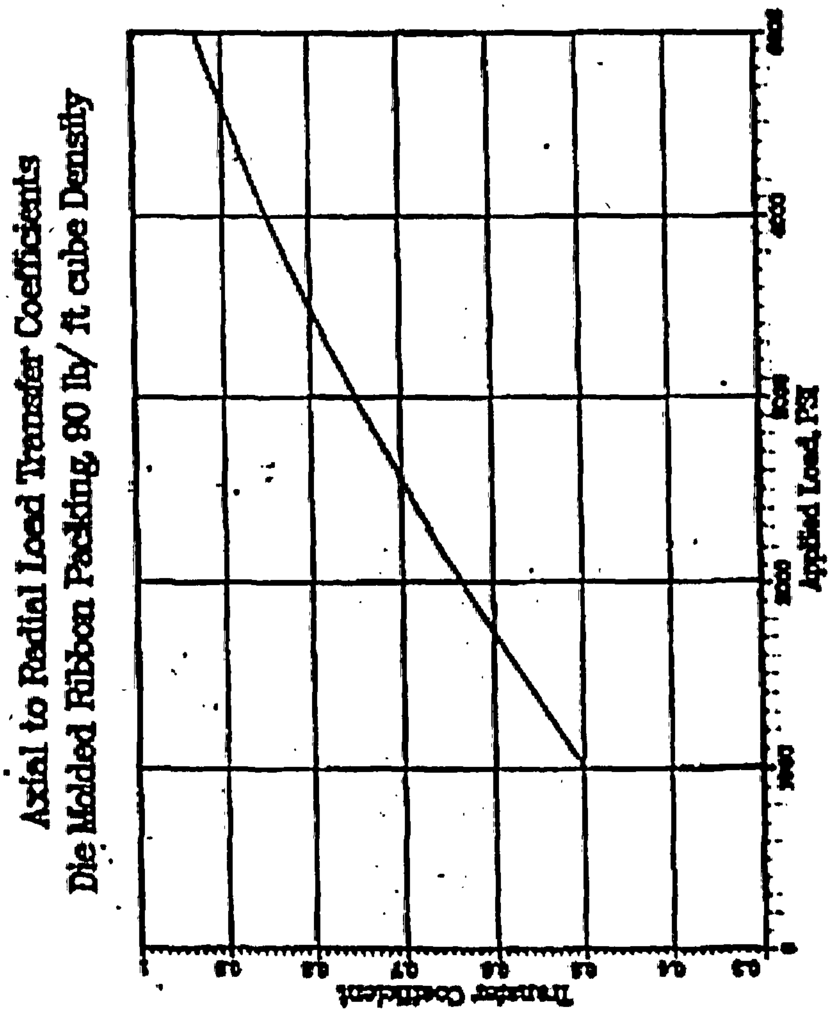
Westinghouse Proprietary Class 2
WESTINGHOUSE ELECTRIC COMPANY LLC

Calculation Note Number	Revision	Page
CN-CI-04-6	0	30

Appendix B2: Grafoil Seal Transfer Coefficient

TECHNICAL INFORMATION

UNION CARBIDE
UNION CARBIDE CORPORATION
ELECTRONICS DIVISION
SPECIALTY PRODUCTS GROUP
P.O. Box 94637, Cleveland, OH 44101



ATTACHMENT 2

THREADED ROD THERMAL GROWTH CALCULATIONS USING CLASSICAL APPROACH (CORRECTED SHEET)

Entergy MNSA-2 Designs, Relative Thermal Growth Evaluations to Determine the Changes in Preload (MNSA-2 to Vessel)

			Sleeve Dimensions			Compression Collar Height Dimensions			Effective	Effective	Long Bolt Length Dimensions			Short Bolt Length Dimensions		
			Collar/Bore	Nozzle OD/		Total	Inside	Outside	Height of	Height of	Total Free	Above		Total Free	Above	
			Dia.	Sleeve OD	Seal Area	Height	Vessel	Vessel	HD Plates	Spring Pack	Length	Reference		Length	Reference	
MNSA-2	Plant	Location	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]	[in]		[in]	[in]	
Type 4	ANO-2	Inner HS	1.656	1.156	1.104	4.700	1.070	3.630	1.125	1.375	6.85	0.35		5.70	1.50	
Type 4	ANO-2	Outer HS	1.656	1.156	1.104	4.700	1.600	3.100	1.125	1.375	7.39	-0.19		4.40	2.80	
Type 4	ANO-2	Mid HS	1.656	1.156	1.104	4.700	1.334	3.366	1.125	1.375	7.08	0.12		5.08	2.13	

Note, some dimensions as measured from Prints.

			Compression Collar Temperature			Long Bolt Temperature			Short Bolt Temperature			Springpack	Growth	Growth	Growth	Maximum	Relative
			Inside	Average	Assumed	Inside	Average	Assumed	Inside	Average	Assumed	Holddown	Collar, HD	Long	Short	Relative	Growth
			Vessel	Outside	Value	Vessel	Outside	Value	Vessel	Outside	Value	Plate	Plates, Spr.	Bolts	Bolts	Growth	Short
MNSA-2	Plant	Location	[Deg. F]	[Deg. F]	[Deg. F]	[Deg. F]	[Deg. F]	[Deg. F]	[Deg. F]	[Deg. F]	[Deg. F]	[Deg. F]	[mils]	[mils]	[mils]	[mils]	Rods
Type 4	ANO-2	Inner HS	653	507	507	653	331	331	653	358	358	350	26.7	16.8	20.5	9.8	6.2
Type 4	ANO-2	Outer HS	653	524	524	653	321	321	653	397	397	350	28.0	15.1	24.3	12.9	3.7
Type 4	ANO-2	Mid HS	653	515	515	653	327	327	653	376	376	350	27.3	16.1	22.4	11.2	4.9

Reference Temperature 70

A. **Growth of Compression Collar above Reference Plane** — Height inside Vessel x (Tv - Tamb) x Alfa (Collar/653) + Height outside Vessel x (Tavg - Tamb) x Alfa (Collar

B. **Growth of Holddown Plates based on Temperature of 350 Deg. F.** — Effective Height HD Plates x (Tplates - Tamb) x Alfa (Plates/Tplates)

C. **Growth of Bolts above Reference** — Vessel Height above Reference * (Tv -Tamb) x Alfa (Bolts/653) + Bolt Length x (Tavg - Tamb) x Alfa (Bolt/Ta

D. **Growth of Spring Pack based on Temperature of 350 Deg. F.** — Spring Pack Height * (Tsprings - Tamb) x Alfa (Springs/350)

Relative Change in Spring Compr. (A+ B + D) - C