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June 6, 1988

Mr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Dresden Station Units 2 and 3
Quad Cities Station Units 1 and 2
"Response to Request for Additional Information Pertaining to the On-Going Flued Head Assessment (FHA) Program"
NRC Docket Nos. 50-237/249 and 50-254/265

Reference: Teleconference between CECo (I.M. Johnson, et.al.) and NRR (B. Siegel, et.al.) on May 12, 1988 Regarding Dresden and Quad Cities Flued Head Assessment Program

Dear Mr. Murley:

In response to the above referenced letter, concerns were raised by Mr. A. Lee (NRR). These concerns were originally raised by members of Brookhaven National Laboratories during a January 26-28, 1988 NRC Inspection of the Flued Head Anchor Assembly design. These concerns were most recently documented in an attachment to a Dresden Inspection Report (50-237/87030 and 50-249/87029) which is dated April 1, 1988.

This letter provides Commonwealth Edison's response to the items discussed in the attachment to the Dresden Inspection Report.

Please direct any questions you may have regarding this matter to this office.

Very truly yours,

Irene M. Johnson

I. M. Johnson
Nuclear Licensing Administrator

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Attachment

cc: T. Ross - NRR
B. Siegel - NRR
A.B. Davis - Regional Administrator
Dresden/Quad Cities - Resident Inspector

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This attachment responds to questions contained in "Evaluation Report on Flued Head Anchor Design, Dresden Units 2 and 3 and Quad Cities Units 1 and 2," prepared by Brookhaven National Laboratory (BNL), dated February 1988. CECo had verbally responded to these questions on May 12, 1988, during a telephone conversation with NRR and at this time committed to sending a written response. The report covers BNL's review and resulting comments on the following:

S&L Original Design Basis Calculations
S&L Recent (Jan. 1988) Calculations
Impell Calculations
As-Built Design

In conclusion, the BNL report recommends that CECo initiate a comprehensive program to demonstrate the adequacy of the flued head anchors.

CECo has initiated such a comprehensive program in February 1988. The scope of the program, loading combinations and acceptance criteria were described to the NRC Region III during a meeting on February 11, 1988, at the Region office. Attachment A provides this information. Since then, two monthly status reports for the assessment program have been submitted to the region staff. The scope of the program has recently been expanded to cover additional anchors for the following flued heads with bellows.

X-108A	D-2	X-123	D-3
X-109A	D-2	X-124	D-3
X-111A	D-2	X-138	D-3
X-130	D-2	X-109B	D-3
X-149A	D-2	X-147	D-3
X-149B	D-2	X-105A	D-3
X-113	D-2	X-105B	D-3
X-147	D-2	X-105C	D-3
X-105A	D-2	X-105D	D-3
X-105B	D-2	X-106	D-3
X-105C	D-2	X-107A	D-3
X-105D	D-2	X-107B	D-3
X-106	D-2	X-14	QC-1
X-107A	D-2	X-14	QC-2
X-107B	D-2		

The following presents the specific BNL comments and explains how they are addressed in the current assessment program.

S&L Original Design Basis Calculations - Pinned Truss

Comment #1: For the "Rock Bolts" the manufacturer recommends a tensile capacity equal to 50% of the ultimate load apparently in order to account for installation and other uncertainties, whereas the calculations used a capacity of 90% of the yield strength or sometimes even 90% of the ultimate strength. An investigation should be conducted to estimate a reliable design capacity of the Rock Bolts. Note that a safety factor of four is customarily recommended for such drill-in-concrete bolts.

Response: A reliable rock bolt design basis has been established and is described in Attachment A which was presented to the NRC Region III on February 11, 1988. The rock bolts are grouted bolts. The assessment basis satisfies the intent of ACI 349, Appendix B.

Comment #2: The allowable loads for expansion anchors could not be determined since neither the drawings nor the calculations provided adequate details of the expansion anchors, e.g., embedment length, type of anchor. The anchor bolts installed in the field should be documented and their allowable capacity should be verified.

Response: Field walkdowns have been performed to document the type of expansion anchors installed (shell or wedge type) and the configuration of the expansion anchored plate assemblies. The use of shell type expansion anchors has been found to be predominant. Embedment length of shell type anchors has conservatively been assumed to be the length of the shell. Embedment length for wedge type expansion anchors has been conservatively assumed to be 4.5 diameters. As described in Attachment A, expansion anchor allowable loads are consistent with those in the NRC IEB 79-02.

Comment #3: The anchor bolts were designed only for the tensile load. The base plates with shear lugs were used to transfer the shear loads although no calculations were available to demonstrate the adequacy of the embedment to transfer the shear to concrete. Usually the shear plate and the lugs are embedded in the cover of the concrete outside of the steel reinforcements. Test results seem to indicate looseness of concrete under high tension loads. Therefore, the shear transfer mechanism is questionable especially in the presence of tension and should be investigated. Note that the anchor bolts are typically weak in shear.

Response: As described in Attachment A, the rock anchors and shear lugs are assessed per the approach suggested in ACI 349, Appendix B. The rock anchors in assemblies with shear lugs are designed for pullout loads and the shear lugs are considered effective when they are located in a concrete compression zone developed between the embedment and the concrete and transverse to the direction of the shear force. The shear-friction approach is being utilized for rock anchors in assemblies without shear lugs.

Comment #4: There was no evidence presented during the audit that the calculations were checked. An error in inputting the structure geometry in the computer was observed for Dresden Unit 3, Penetration 111B. Therefore, CECo should demonstrate the general accuracy of the calculations.

Response: The calculations presented during the audit were the original 1969-1970 calculations. It was S&L's practice to check calculations in that time frame but documentation of such is not available. New calculations being performed under the scope of current assessment program supersede all corresponding original design calculations. These new calculations are being prepared, reviewed and approved in accordance with Sargent & Lundy's Quality Assurance Program.

Comment #5: The seismic and dead loads were not included in the design. It should be demonstrated that the penetration supports are capable of withstanding all the possible load combinations including seismic and dead loads.

Response: The dead, thermal and seismic loads are included in the current assessment program. The loading combinations are described in Attachment A. All anchors are assessed for loading combinations 1A, 1B and 2. Anchors for single pipe penetrations are assessed for loading combination 3a. Anchors which support multiple pipes are conservatively assessed for loading combination 3b. This combination assumes one broken pipe at a time. The SRSS method is used to combine the effects of pipe break loads with seismic loads.

Comment #6: The pipe rupture load should be assumed to act in either direction, i.e., positive or negative. For some load components, both directions were not considered in the analysis. It should be demonstrated that the final design load envelopes all possible load combinations including reversal of individual load components.

Response: The current assessment program incorporates appropriate pipe rupture load directions. Pipe rupture load cases have been postulated to include reversal of individual load components where applicable.

Comment #7: The base plates were designed for the compression load only. They should be verified for the tensile load as well.

Response: Assessment of base plates for tensile loads is incorporated in the current assessment program.

Comment #8: The STRUDL output shows spurious z-direction (i.e., lateral) deflection at center nodes of symmetrically loaded, symmetrical structures. This should be investigated.

Response: New calculations being performed under the scope of the current assessment program supersede all corresponding old calculations. Hence, a specific investigation of spurious z-direction deflection in an old calculation is not planned. Current procedures require the reviewer to assure that the computer program results are consistent with input parameters and within stated assumptions and limitations of the program.

Comment #9: The acceptance stress criteria (Fb) for the diaphragm and ring plates were different. This should be resolved and the appropriate allowable stress should be used for the design.

Response: The current acceptance criteria for structural steel, described in Attachment A, is the same.

Comment #10: For the ring plates, the allowable shear stress was assumed as 0.75Fy which apparently exceeds the yield strength in shear. The proper allowable stress should be used.

Response: For the current assessment program, allowable shear stress in ring plates is $0.95Fy/\sqrt{3}$.

Comment #11: The acceptance criterion for compression members specifies an allowable compressive stress equation which is identical to equation 1.5-1 in the AISC code except for the factor of safety. The AISC specifies a F.S. which varies from 1.67 to 1.92 for main members having KL/r values from 0 to 200 (see Attachment 1). The acceptance criteria has a constant F.S. of 1/0.9=1.11. Allowable stress values may be increased by 1.6 for analyses which include SSE and/or pipe rupture loads. The factor of safety per the AISC equation for these analyses are then reduced by 1/1.6 and very from 1.04 to 1.20. Using a constant F.S. of 1.1 for all KL/r values results in an acceptance criterion which is below AISC requirements particularly for compression members with high KL/r values. This inconsistency should be investigated and resolved since buckling of a primary compression member will result in gross structural failure of the flued head anchor truss.

Response: The allowable compressive stresses for compression members in the current assessment program are:

OBE combination: AISC allowable stress

SSE combination: AISC allowable stress x 1.6

Pipe break load combination: AISC allowable stress x 1.6

<u>S&L recent Calculations - Pinned Vs. Fixed Connections</u>

Comment: BNL's report refers to S&L analysis of one anchor (X-116A) prepared during January 1988 to investigate the influence of connection modeling on the load distribution and load carrying capability of this structure. The write-up concludes with: "Therefore, all concrete support connections possessing the capability of moment transfer should be addressed based on the assumption of a rigid frame. This comment is applicable for all penetrations."

Response: The current assessment program addresses this comment in that appropriate connection rigidity/flexibility is incorporated in the analysis.

Impell Calculations

Comment #1: Impell used the pipe break loads supplied by S&L. Impell stated that they reduced the moment based on the plastic moment capacity of the pipe section instead of the ultimate moment previously assumed by S&L. However, a load reduction up to a six-fold was observed (e.g., X-163 (sic), Load Case II) which could not be explained on the basis of the ultimate load alone. CECo should verify the true load and use it in the analysis.

Response: Anchor X-113 is included in the current assessment program. The current assessment program does not reduce original pipe break loads.

Comment #2: The shear load was neglected in the anchor design (e.g., calculation 0590-238-02, p44). The anchor should be designed for the shear load in addition to other loads.

Response: The current assessment program does not ignore shear load applicable to anchor X-113.

Comment #3: The analytical approach to determine the pull out capacity of Hilti expansion bolts is not reliable. The manufacturer's recommendations along with available test data should be used to determine the possible capacity reduction due to close spacing and closeness to the edge of concrete.

Response: The expansion anchors added by Impell as part of the RPR program for flued head anchor X-113 are being removed and replaced with grouted anchors as a result of the current assessment program. Capacity reduction due to close spacing and closeness to the edge of concrete has been considered where appropriate.

Comment #4: The Hilti bolts in one instance (Ref. Calculation 0590-238-02, p58) was observed to exceed the allowable load. This should be further investigated.

Response: See response to Comment #3 above.

Comment #5: The comments made above on the S&L calculations regarding the load combinations and design criteria are also applicable for the Impell calculations.

Response: The current assessment program includes assessment of all eight flued head anchors for the pipe break load combination 3a (Attachment A). For consistency, this work is being performed by S&L. Impell has already assessed these eight anchors for loading combinations 1 and 2 during the RPR program.

As-Built Design

Comment: Regarding the as-built configuration, CECo/S&L stated that several accessible penetration supports have Been inspected in the field. Most of them are very similar to the design drawings. However, some bracing members have been observed to be missing in the field. S&L is currently in the process of resolving the discrepancy. The results will be soon related to the NRC staff.

Response: The current assessment program includes a configuration walkdown of all the flued head anchors in the scope of the program and configurational deviations from the design drawings are incorporated in the assessment.

SCOPE OF FLUED HEAD ANCHOR REASSESSMENT

Concrete Expansion Anchor Review Scope

The following anchors are being assessed to verify that concrete expansion anchor factors of safety are in accordance with NRC I. E. Bulletin 79-02 for all FSAR load cases:

X-11	QC-1	X-11	QC-2
X-13A	QC-1	X-13A	QC-2
X-13B	QC-1	X-13B	QC-2
X-16B	QC-1	X-16A	QC-2
X-23	QC-1	X-23	QC-2
X-24	QC-1	X-24	QC-2
X-47	QC-1	X-47	QC-2

X-7A, X-7B, X-7C, X-7D, X-9A, X-9B, X-10, X-17, X-12 } Main Steam Frame - QC-1&2

X-8 Main Steam Drain - QC-1&2

Recirculation Pipe Replacement (RPR) Scope

The anchors listed below were previously analyzed and qualified for OBE and SSE load cases. In this assessment they are being analyzed for the pipe break load case only. (Load combination 3).

X-109A	ISO Condenser Return	D-3
X-111A	Shutdown Supply	D-3
X-111B	Shutdown Supply	D-3
X-149A	Core Spray	D-3
X-149B	Core Spray	D-3
X-113	Clean up Supply	D-3
X-116A	LPCI Pump Discharge	D-3
X-116B	LPCI Pump Discharge	D-3

Configuration Walkdown Scope

The anchors listed below have significant configurational variations as identified in the January 1988 configuration walkdown and could not be dispositioned using engineering judgement. Re-analysis is required for all FSAR load cases.

X-108A	D-3
X-128	D-3
X-115A	D-2
X-111B	D-2
X-116A	D-2
X-116B	D-2
X-123	D-2
X-124	D-2
X-144	D-2
X-36	QC-1
X-36	QC-2

Bellows Replacement Scope

The anchors listed below were analyzed and modified for OBE and SSE load cases in conjunction with the Bellows Replacement Program. Re-analysis is required for pipe break load case only. (Load combination 3).

X-16A	QC-1
X-16B	QC-2

LOADING COMBINATIONS

COMBINATION DESCRIPTION	NO	CONTRIBUTING LOADS AND LOAD FACTORS	TO BE USED FOR
OBE	IA	$1.0W + 1.0T + 1.0P + 1.0E_O + 1.0\ SRV$	Elastic Analysis - Anchor Frame Design
	1B	$1.4W + 1.7T + 1.7P + 1.9E_O + 1.7\ SRV$	Elastic Analysis - Rock Anchor & Through Bolt Assessment.
SSE	2	$1.0W + 1.0T + 1.0P + 1.0E_S + LOCA$	Elastic Analysis - All Components includ-ing Steel Embedments
PIPE BREAK	3a	$1.0W^* + 1.0T^* + 1.0P^* + 1.0R$	Elastic Analysis- All Components including Steel Embedments.
	3b	$1.0W^* + 1.0T^* + 1.0P^* + 1.0R + 1.0E_S + LOCA$	

NOTATION:

- W = Weight
- T = Pipe Thermal Reactions
- P = Reaction due to normal containment pressure (2 psig)
- E_O= Operating Basis Earthquake (OBE)
- E_S= Safe Shutdown Earthquake (SSE)
- SRV = Reaction due to SRV Torus excitation of piping
- LOCA = Reaction due to LOCA Torus excitation of piping
- R = Pipe break loads (Use process pipe M_p where moment given is $> M_p$)
- W^*= Weight (Unbroken End)
- T^*= Pipe Thermal Reaction (Unbroken End)
- P^*= Reaction due to containment pressurization accounting for timing with R.

ELEMENT		APPLICABLE CODE	STRESS LIMIT COEFFICIENT ON APPLICABLE CODE		
			LOAD CASE 1A & 1B (OBE)	LOAD CASE 2 (SSE)	LOAD CASE 3 (PIPE BREAK)
STRUCTURAL STEEL MEMBERS		AISC	1.0 (1A)	1.6 ≤ .95Fy	1.6 ≤ .95Fy (Plastic Modulus)
WELDS		AISC	1.0 (1A)	1.6 ≤ .48 Fu(B)	1.6 ≤ .48 Fu(B)
THROUGH-BOLTS		ACI 349 APP. B	1.0 (1B)	1.0	1.0
WILLIAMS ROCK ANCHORS	Pd > Tult	ACI 349 APP.B See Note b	1.0 (1B) (.9As Fy)	1.0 (.9As Fy)	1.0 (.9As Fy)
	Pd < Tult	ACI 349 APP. B See Note c	1.0 (1B) (.33 Pd)	1.0 (.33 Pd)	1.0 (.5 Pd)
EXPANSION ANCHORS	WEDGE	I. E. BULLETIN 79-02 See Note d	1.0 (1A) (Pult/4)	1.0 (Pult/4)	1.0 (Pult/4)
	SHELL	I. E. BULLETIN 79-02 See Note d	1.0 (1A) (Pult/5)	1.0 (Pult/5)	1.0 (Pult/5)
SHEAR LUGS		ACI 349 APP. B	1.0 (1B)	1.0	1.0
CONCRETE BEARING		ACI 349 APP. B	1.0 (1B)	1.0	1.0

Notes:

a. The concrete cone capacity for the individual anchors and/or anchor assemblies shall be calculated as follows:

Concrete cone capacity $P_d = 4 \times \phi \times \sqrt{f'_c} \times (A_p)$

where:

- A_p = Projected Concrete Cone Area
- ϕ = 0.85 - All embedments are located in a compression zone or in a tension zone where the tension stress at the surface of the concrete is less than $5 \phi \sqrt{f'_c}$.
- f'_c = Actual in-place concrete strength based upon concrete cylinder data.
- Effective embedment depth will be determined in accordance with Fig. B7-1 of ACI 349 Appendix B.
- The effective projected net area shall be reduced to account for overlapping cones from adjacent anchors and/or assemblies as well as the influence of the penetration sleeve which intersects the cone surface.
- The effect of the near-face reinforcing may be utilized to increase the capacity of the concrete cones.
- The shear lugs alone shall be assumed to transfer the applied shear in accordance with the requirements of Appendix B since they are located in a compression zone.

b. The design strength for an individual anchor, where the cone capacity exceeds the ultimate tensile capacity of the rock anchor, shall be established as:

T_{all} = 0.9 As fy

- (As fut) shall be taken as 75,000 lbs. for 1" diameter and 38,000 lbs for 3/4" diameter, Super High Tensile 'Spin-Lock" bolts in accordance with William's published data.

- (As fy) shall be taken as 60,000 lbs. for 1" diameter and 30,000 lbs for 3/4" diameter, Super High Tensile "Spin-Lock" bolts in accordance William's published design data.

c. For anchor assemblies in which the concrete cone capacity, Pd, is less than the ultimate strength of the concrete anchor, the design strength of the anchor shall not exceed:

.33 Pd for seismic load cases (1B and 2)
. 5 Pd for pipe break load case (3)

d. See the Project Structural Design Criteria for ultimate capacities for wedge and shell anchors (DC-SE-01-CE). The factor of safety is applied to the entire assembly rather than to individual anchors. Shear and tension are combined using an elliptical shear/tension interaction equation to the 5/3 power.

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U.S. NUCLEAR REGULATORY COMM.

WASHINGTON DC
20555

June 6, 1988

Enclosed is revised page DA 5-7 (Table DA 5-1, Emergency Action Levels) of the Dresden Station annex. To update your Dresden annex, please perform the following:

1. Remove and destroy page 5-7, February 1987, Revision 5.
   FROM GSEP Sta. Annex Manual
2. Insert new page 5-7, May 1988, Revision 5a.

Please sign, date and return this control sheet to:

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TABLE DA 5-1 (Cont)
DNPS EMERGENCY ACTION LEVELS

CONDITION	UNUSUAL EVENT	ALERT	SITE EMERGENCY	GENERAL EMERGENCY
6) Fire	Fire that cannot be extinguished within 10 minutes of arrival of the on-site Fire Brigade.			
7) Explosion causing damage.	One of the following: (1) Requiring off-site assistance. (2) Equipment described in the Technical Specifications is degraded such that a Limiting Condition for Operation requires a shutdown.	Equipment is degraded such that a Cold Shutdown*e* condition cannot be achieved or maintained.	Equipment is degraded such that neither a Cold Shutdown*e* condition nor a Hot Shutdown*e* condition can be achieved or maintained; and Safety Limits *e* may or will be exceeded.	
8) Earthquake has occurred or is being experienced.	Equipment described in the Technical Specifications is degraded such that a Limiting Condition for Operation requires a shutdown.	Equipment is degraded such that a Cold Shutdown*e* condition cannot be achieved or maintained.	Equipment is degraded such that neither a Cold Shutdown*e* condition nor a Hot Shutdown*e* condition can be achieved or maintained; and Safety Limits*e* may or will be exceeded.	

*e*Cold Shutdown, Hot Shutdown and Safety Limits are defined by the Technical Specifications.