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ComEd

ESK-96-072

May 15, 1996

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

Subject: Quad Cities Nuclear Power Station, Units 1 & 2
Commonwealth Edison (ComEd) Response to NRC Request for Additional Information, Regarding Unit 2 Corner Room Steel Operability Evaluation

NRC Docket Nos. 50-254, and 50-265

References:

(A) April 1, 1996 letter ESK-96-041 from E. S. Kraft, Jr. of ComEd to the USNRC Document Control Desk.

(B) AISI, "The Variation of Product Analysis and Tensile Properties, Carbon Steel Plates and Wide Flange Shapes", September 1974.

(C) April 5, 1996 letter ESK-96-052 from E. S. Kraft, Jr. of ComEd to the USNRC Document Control Desk.

(D) August 1995 Quad Cities Units 1 and 2 Corner Room Structural Steel operability evaluation, including calculation No. QDC-0020-S-0055.

(E) April 9, 1996 letter ESK-96-054 from E. S. Kraft, Jr. of ComEd to the USNRC Document Control Desk.

(F) ComEd Calculation 9200-EO-S, Pages 89.72 - 89.99.

During our May 7, 1996 meeting you requested a formal submittal of the recent material test results for the Quad Cities Corner Room Structural Steel along with further justification for the 10% overstress factor used in performing the operability evaluation (Reference A). Response 1, provides a more detailed and case specific justification of the use of the 10% overstress factor, through the implementation of a quantitative demonstration of this same criteria to the previously

A001

selected beams and connections. The result of this revised evaluation shows that all of the beam and connection interaction coefficients are less than 1.0 using the material defined minimum yield strength of 36,000 psi. Response 2, provides an explanation of the structural steel material testing that was performed. Included in this explanation is a summary description of the purpose for the testing, the type and extent of the testing and the test results.

In addition, during a telephone communication on May 14, 1996 between ComEd and Geoffrey Grant of the USNRC Region III staff a request was made concerning the schedule for restoring the Unit 2 Corner Room Steel to conformance. This is covered in Response 3 below.
Response 4 provides an explanation of the loads used as input to the operability assessment.

Response 1) 10% Overstress Factor

The Quad Cities corner room steel operability evaluation that was previously submitted (References A, C, D and E) utilized a 10% overstress factor (i.e. Interaction Coefficient (IC) of less than or equal to 1.10) which was based on conservatisms that exist in the analysis methods, load definition and material properties. In Reference A, we provided a qualitative basis for this 10 % overstress criteria, and in this response we are including a quantitative demonstration of the implementation of this same criteria. The referenced justification included several different sources of conservatism, and in this evaluation we have incorporated two of these factors into the calculations for the previously selected critical beams and connections: 1) the use of reduced live loads and 2) the full structural strength based on Fy without a 5% reduction in the allowable yield stress. The use of the full ASTM yield stress without a 5% reduction is consistent with the Standard Review Plan and the Quad Cities UFSAR. The revised calculations (Reference F) as summarized in Table 1 below, demonstrate that by eliminating some of the identified conservatisms that the interaction coefficients (ICs) for the beams and connections are less than 1.0.

Table 1 Summary of Interaction Coefficients

Beam No. or Critical Connection Component	Location	Previous IC (Conservative Inputs)	Revised IC (Incorporating Noted Conservatisms)
B1	Unit 1, SE Room	0.88	0.88
B2	Unit 1, SE Room	0.58	0.58
B4	Unit 1, SE Room	1.08	0.998
B8	Unit 1, SE Room	1.079	0.99
B2L Angle Leg Bending	Unit 1, SE Room	0.57	0.57
B2R Beam Web Bending	Unit 1, SE Room	0.51	0.51
B8L Beam Web Bending	Unit 2, SE Room	1.04	0.99
B8R Angle Leg Bending	Unit 2, SE Room	1.09	0.56
B10R Beam Web Bending	Unit 2, SE Room	1.09	0.997

Provided below is a brief summary of the revised calculations for each of the beams and connections listed in Table 1 above. A summary of the methodology used to reduce the interaction coefficients to less than or equal to one is also provided. Where the live load reductions have been used, compensatory measures are being performed to ensure that the analysis inputs remain consistent with the actual configuration and load definition.

Beams B1, B2 and connections B2L and B2R

These beams and connections did not require new or revised calculations as the interaction coefficients for these beams were already below 1.0 using the full live load and with a 5 % reduction in the allowable yield stress.

Beam B4

A reduced floor and gallery live load of 20 psf was used to calculate beam bending moment. The full plastic capacity of the beam, without the 5% reduction was used to calculate the revised interaction coefficient of 0.998.

Beam B8

A reduced floor and gallery live load of 10 psf was used to calculate beam bending moment. The full plastic capacity of the beam, without the 5% reduction was used to calculate the revised interaction coefficient of 0.99.

B8 Left Connection

The previously determined IC was based on the limiting beam web capacity. The previous flexural capacity was based on the 5% reduction in the allowable yield stress. The revised beam web flexural capacity was recalculated using the full yield strength of 1.0 Fy resulting in a connection IC of 0.99. The full original design basis live load was not reduced in this calculation.

B8 Right Connection

The capacity of the outstanding leg of the connection was calculated based on a more refined procedure and the full plastic capacity of the angle leg was used in bending. The revised connection calculation resulted in an IC of 0.56. The full original design basis live load was not reduced in this calculation.

B10 Right Connection

A reduced floor and gallery live load of 10 psf was used to calculate the loads at this connection and the full plastic capacity of the connection components was used, resulting in an IC of 0.997.

Response 2) Structural Steel Material Test Results

A. Purpose

As noted in our recent meeting we have taken a total of six samples from the in-place structural steel and have performed tests to determine the yield and ultimate tensile strength of the steel. The first five samples were removed from the Unit 2 in-place steel in late March of 1996 as a means of confirming that actual material properties met industry experience (i.e. average yield stress more than 10% over minimum yield). Verification of the material properties by testing was initiated in parallel with the effort to locate the original. Certified Material Test Reports (CMTRs). The objective was to confirm that the in-place steel was ASTM-A36 with yield and tensile strength properties that were consistent with industry experience (Reference B). The sixth sample was removed from a specific member of Unit 1 to determine if the actual material yield strength exceeded the minimum for ASTM A-36 material with the intent of using the actual yield strength to avoid adding a modification and thus reducing radiation exposure to the workers. It should be noted that this option was not implemented, as an alternate analytical solution which demonstrated full qualification of the beam was obtained using the material minimum yield strength.

B. Type and Extent of Testing

As described in the preceding sections, a total of six samples were removed and tested to determine the physical material properties (tensile strength, yield strength, percent elongation and percent reduction in area). The samples were removed and tested using established industry methodology with the one exception that five of the six samples were taken from the beam flanges rather than the webs. The material strength data provided in Reference B indicates that the yield strength of web samples tend to be slightly higher than the samples removed from the flanges. Therefore, this exception will result in slightly more conservative results (i.e., lower material strength properties for analysis) and thus is acceptable. The five Unit 2 samples were removed from the flanges rather than the webs due to access limitations. The difficulty and additional time in a radiation area needed to obtain samples from the webs would not have been consistent with the overall philosophy to keep worker exposure as low as reasonable achievable, and therefore the samples were taken from the more accessible flange locations.

C. Test Results

The material test results are summarized in Table 2 below as well as in the material test reports (Attachments 1 and 2). The test results indicate that the physical material properties are within the ASTM defined limits and are representative of ASTM A-36 material. The average yield strength of all six samples is 40,780 psi which is 13% greater than the ASTM minimum yield strength. Since the industry experience is for a mean yield strength to be at least 10% above the ASTM defined minimum, these results are consistent with ASTM acceptance criteria and

general expectations. Note that all of the samples were above the rated minimum yield strength for this steel and that the 13% above the minimum is considered average performance.

Table 2 Material Test Results - Summary

Sample No.	Sample Location	Tensile Strength Fu (psi)	Yield Strength Fy (psi)
C1	Unit 2, B-5, NE Room	63,100	41,700
C2	Unit 2, B-9, NE Room	63,100	36,300
C3	Unit 2, B-3, NE Room	69,800	42,600
C4	Unit 2, B-4, SE Room	69,800	44,300
C5	Unit 2, B-6, SE Room	63,300	39,800
B1	Unit 1, B-1, NE Room	63,700	40,000
Sample Average		65,470	40,780
ASTM Limits		58,000-80,000	36,000

Response 3) Installation of Unit 2 repairs

The best information regarding engineering design activities indicates completion of design change package preparation not later than August 30, 1996. At that point, the construction interval is currently believed to be approximately 10-12 weeks. Our intention is to take advantage of every opportunity to address this non-conformance. This means performing activities on line consistent with the risk associated with the interaction between the work activities and the equipment located in the room. In addition, any forced or planned outage before Q2R14 (next refueling outage for Unit 2) would be used to install all or part of the repair as the specific outage would permit. Finally, we will use Q2R14 to restore any or all of the Corner Room Steel design to conformance prior to return to service from that refueling outage.

Response 4) Governing Seismic Load Combinations

The Quad Cities Corner Room Steel operability evaluation (References A, C, D and E) is based on the most critical resultant forces, moments and shears from the UFSAR defined load combinations in conjunction with the allowable stress limits as defined in Reference D which is based on ensuring the steel meets functional goals. The critical load combinations from the UFSAR (Section 3.8.4.1.3) are as follows:

D + R + E (OBE Load Combination)
D + R + E' (SSE Load Combination, Governing Load Combination)
D + L (Wind Load Combination)

Where: D = Dead load of structure and equipment plus any other permanent loads contributing stresses, such as soil or hydrostatic loads or operating pressures and live loads expected to be present when the plant is operating.

R = Jet force or pressure on structure due to rupture of any one pipe

E = Design earthquake load ground acceleration horizontal = 0.12g, vertical =0.08g (OBE)

E' = Maximum earthquake load ground acceleration horizontal = 0.24g, vertical = 0.16g (SSE)

L = Wind live load beyond normal building code requirements

A review of the analysis for these load combinations shows that since the SSE seismic loads are two times the magnitude of the OBE seismic loads, that the SSE load combinations produce the maximum resultant forces, moments and shears for the beams and connections.

Conclusions

The technical basis for the 10% operability overstress criteria (References A and C), is quantitatively corroborated by the case specific analysis results provided in Reference F as well as the material test results. The results of the material sampling are consistent with the industry experience and the ASTM specifications and thus provides an alternate method of verifying the material physical properties in lieu of the CMTRs, though we will continue our current effort to locate the original CMTRs. Therefore, the conclusions of the previous operability evaluation as provided in References A, C, D and E remain valid.

We will be revising the existing Earthquake response procedure to provide quidance to Operations for the necessary response to any earthquake. In addition, restrictions will be placed to prevent any additional long term loads being imposed on the steel.

To the best of my knowledge and belief, the statements contained in this document are true and correct. In some respects these statements are not based on my personal knowledge, but on information furnished by other Commonwealth Edison employees, contractor employees, and/or consultants. Such information has been reviewed in accordance with company practice, and I believe it to be reliable.

If there are any questions concerning this matter, or need for further clarification, please contact this office.

Sincerely,

E. S. Kraft, Jr.
Site Vice President

Attachments: Material Test Reports

cc: H. J. Miller, Regional Administrator - RIII
R. M. Pulsifer, Project Manager - NRR
C. G. Miller, Senior Resident Inspector - Quad Cities
D. C. Tubbs - MidAmerican Energy Company
R. J. Singer - MidAmerican Energy Company

April 2, 1996

To: Ms. S.L. Eldridge
Mod Design Engineering
Quad Cities Station

Subject: Quad Cities Unit 2 RHR Corner Room Structural Steel Hardness and Tensile Testing Results

This memo transmits the subject mechanical testing results. All sample identifications were assigned by Quad Cities personnel and locations are documented in er9602075 and ar960025539. The structural beams were reported to be ASTM A36 carbon steel.

On 3/31/96, a SMAD Metallurgy Group technician performed field hardness testing on ten structural beams. The results are listed in Attachment 1. The testing was performed using an 'EQUOTIP' device manufactured by the Proceq Company in Switzerland. The results were converted to equivalent Rockwell B scale hardnesses using the manufacturer's operating manual, and the approximate tensile strengths were estimated using ASTM A370, Table 2B conversion charts for non-austenitic steels. All calculated tensile strengths were above the 58 ksi minimum required for ASTM A36 steel.

Station personnel removed coupons from non-injurious locations on five beams using a band saw. Subsize tensile specimens were machined from the coupons and tested by Metallurgical Services Inc., a vendor approved by ComEd for safety related mechanical testing. The results are summarized in Attachment 2. All five samples met the ASTM A36 minimum tensile and yield strength requirements.

J.M. Chynoweth
SMAD-Metallurgy
-3661 CTEAM

cc. J.J. Hutchinson, SECM, Quad Cities
K.M. Schechter, Mod. Design, Quad Cities
G.S. Gerzen, NES, D/G ETW-III

96L00073.M

Attachment 1

Attachment 1

SYSTEM MATERIALS ANALYSIS DEPARTMENT
FIELD HARDNESS TESTING DATA SHEET

TATION: Quad Cities INSPECTION DATE: 3/31/96

ARDNESS TESTER ID: S/N 611-0887
Unit C #204097T

IMPACT POSITION CODES
VD- Vertical Down 45D- 45 Degrees Down
VU- Vertical Up 45U- 45 Degrees Up
H- Horizontal

IPLE ID	"L" VALUE READINGS 1	2	3	4	5	6	7	AVE. "L" *	ADJUSTMENTS IMPACT POS.	IMPACT ADJ.	TEMP. DEG.	TEMP. ADJ.	ADJ. "L"	CONV. HARDNESS VALUE	REMARKS
										N/A	N/A	N/A	N/A	HRB	Approx. Tensile Strength
#H4	380	369	~~371~~	377	~~391~~	379	375	376	V.D.					69.2	60 KSI
#H5	379	385	392	~~375~~	381	~~394~~	383	384	V.D					71.7	63 KSI
#H2	391	392	391	386	~~402~~	~~378~~	382	388	V.D.					72.9	64 KSI
#H1	386	380	~~379~~	~~398~~	388	384	386	385	V.D					71.7	63KSI
#H7	~~371~~	381	407	389	399	~~409~~	399	395	V.D.					74.7	66KSI
#H6	357	~~355~~	~~386~~	381	383	369	364	371	V.D.					67.5	59KSI
#H3	~~379~~	~~403~~	393	400	390	394	379	391	V.D.					73.5	65KSI
#H9	~~392~~	386	~~370~~	381	391	391	380	386	V.D.					72.3	63KSI
#H10	371	369	370	~~381~~	~~365~~	375	376	372	V.D.					67.9	59KSI
#H8	374	376	~~385~~	377	372	~~365~~	382	376	V.D.					69.2	60KSI

*Average "L" Values after discarding the highest & lowest of 7 readings

INSPECTED BY: James J. Stadler REVIEWER INITIAL/DATE: [initials] / 4-1-96

96L00073.M

Attachment 2

MSi Metallurgical Services Inc.
1201 S. Ninth Avenue
Maywood, Illinois 60153
708•343•3444

Commonwealth Edison Company
System Materials Analysis Dept.
555 S. Joliet Road
Bolingbrook, IL 60440

Report No.: 20317
Date: 4-1-96
Order No.: 808179
Page: 1 of 1

Attention: Mr. Jim Chynoweth

SUBJECT

Mechanical properties testing of five (5) structural support samples from Quad Cities, identified as C1, C2, C3, C4 and C5.

TEST RESULTS

	Sample C1	Sample C2	Sample C3	Sample C4	Sample C5
Tensile Strength, psi	63,100	63,100	69,800	69,800	63,300
Yield Strength, psi (.2% Offset)	41,700	36,300	42,600	44,300	39,800
% Elongation in 1.4"(4D)	32	34	30**	31	35
% Reduction of Area	65	66	64	66	66

* Testing performed in longitudinal direction in accordance with ASTM F606-90 and E8-95a. All testing was performed in accordance with the Metallurgical Services, Inc. Quality Assurance System Manual, Revision 1 dated October 1, 1990 and the Supplement for Commonwealth Edison to the Metallurgical Services, Inc. Quality Assurance System Manual dated June 18, 1991.

** % Elongation in 1" (4D).

Respectfully submitted,

Metallurgical Services Inc.

Mitchell A. Jacobs
Senior Metallurgical Engineer

MAJ/jf

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C.T.E.A.M. Facility
System Materials Analysis Dept.
CTEAM Facility
555 S. Joliet Road
Bolingbrook, IL 60440

Report No.: 20722
Date: 5-6-96
Order No.: 808179
Page: 1 of 1

Attention: Mr. Jim Chynoweth

SUBJECT

Tensile testing of one (1) sample identified as Quad Cities RHR Steel, Beam B5, Job No. M96-159S.

TEST RESULTS*

Tensile Testing

Tensile Strength, psi	63,700
Yield Strength, psi (.2% Offset)	40,000
% Elongation in 1" (4D)	33
% Reduction of Area	67

* Reduced section testing performed in accordance with ASTM E8-95a. All testing was performed in accordance with the Metallurgical Services, Inc. Quality Assurance System Manual, Revision 1 dated October 1, 1990 and the Supplement for Commonwealth Edison to the Metallurgical Services, Inc. Quality Assurance System Manual dated June 18, 1991.

Respectfully submitted,

Metallurgical Services Inc.

Mitchell A. Jacobs
Senior Metallurgical Engineer

MAJ/dh