COMMONWEALTH EDISON COMPANY
CALCULATION REVISION PAGE

CALCULATION NO. 9200-EΦ-S PAGE NO.:0.2.59

REV: 3 STATUS: APPROVED QA SERIAL NO. OR CHRON NO. DATE:

PREPARED BY: S J Chiabrera DATE: 4/8/96

REVISION SUMMARY:
TO DEMONSTRATE, USI. , A REPRESENTATIVE EXAMPLE, THAT THE REDUCTION OF TORSIONAL LOADS FROM THE AUXILIARY STEEL WILL SIGNIFICANTLY REDUCE THE IC VALUES FOR THE BEAM AND ITS CONNECTIONS. BEAM B2 OF UNIT 1 SE CORNER ROOM IS SELECTED AS AN EXAMPLE.

ADDED DCS PAGE 0.2.59

ADDED PAGES 89.34 - 89.42
ADDED PAGE FOR REFERENCE ONLY 89.42.A1

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION ☐ YES ☒ NO

REVIEWED BY: Richard W. Gallo DATE: 4/8/96

REVIEW METHOD: DETAILED COMMENTS (C OR NC): NC

APPROVED BY: Thomas J. Behrunger DATE: 4/8/96

REV: STATUS: QA SERIAL NO. OR CHRON NO. DATE:

PREPARED BY: DATE:

REVISION SUMMARY:

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION ☐ YES ☐ NO

REVIEWED BY: DATE:

REVIEW METHOD: DETAILED COMMENTS (C OR NC):

APPROVED BY: DATE:

COMMONWEALTH EDISON COMPANY
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COMMONWEALTH EDISON COMPANY

CALCULATION NO. 9200-Eϕ-S	**PROJECT NO.** 9200-00 (10004-002)	**PAGE NO.** 89.35
REVISION NO. 3		
PREPARED BY: S J Chhabra **DATE:** 4/3/96	**REVIEWED BY:** [signature] **DATE:** 4/3/96	

Purpose and Background

This calculation is performed as a response to an NRC question on the functionality calculations performed for Quad Cities corner rooms. A beam (Beam B2 in Quad Cities Unit 1, South East Corner Room) with high connection ICs in the preliminary LMS analysis was selected by NRC for further evaluation. It was requested that we demonstrate, using a representative example, that the reduction in torsional loads from the auxiliary steel will result in significantly reduced stress interaction coefficient (IC) for the beam and its connections. This calculation is made in response to the NRC request.

References

1. AISC Manual 6th edition
2. S&L Dwg. B-273 Rev G Quad Cities Unit 1
3. Sargent & Lundy Calc No. 8868-19-Q1-SE Rev 0 p. 5.1 of 6
4. Preliminary LMS Analysis Run ID SQ1SE Dated 8-26-91 16:42
5. Pipe Support Loading on existing Steel For Support M1611-32 Nutech Calc No. 28.0201-1111.31.01 pp. 14 of 16 (attached)
6. Sargent & Lundy Standard SDS E7 Rev 3

Methodology

The auxiliary (AUX) steel members framing into Beam B2 will be studied. Reduced torsional moments on the beam from the auxiliary steel will be used that account for the relative flexibility of the beam with respect to the AUX steel framing members.

Connection and beam allowables calculated previously in Ref. 3 will be prorated based on the functional evaluation criteria (i.e. plastic section modulus will be used where applicable).

Since this is functional evaluation, only SSE load combinations will be addressed. This is because the magnitude of other load combinations is enveloped by the load magnitudes of SSE combinations.

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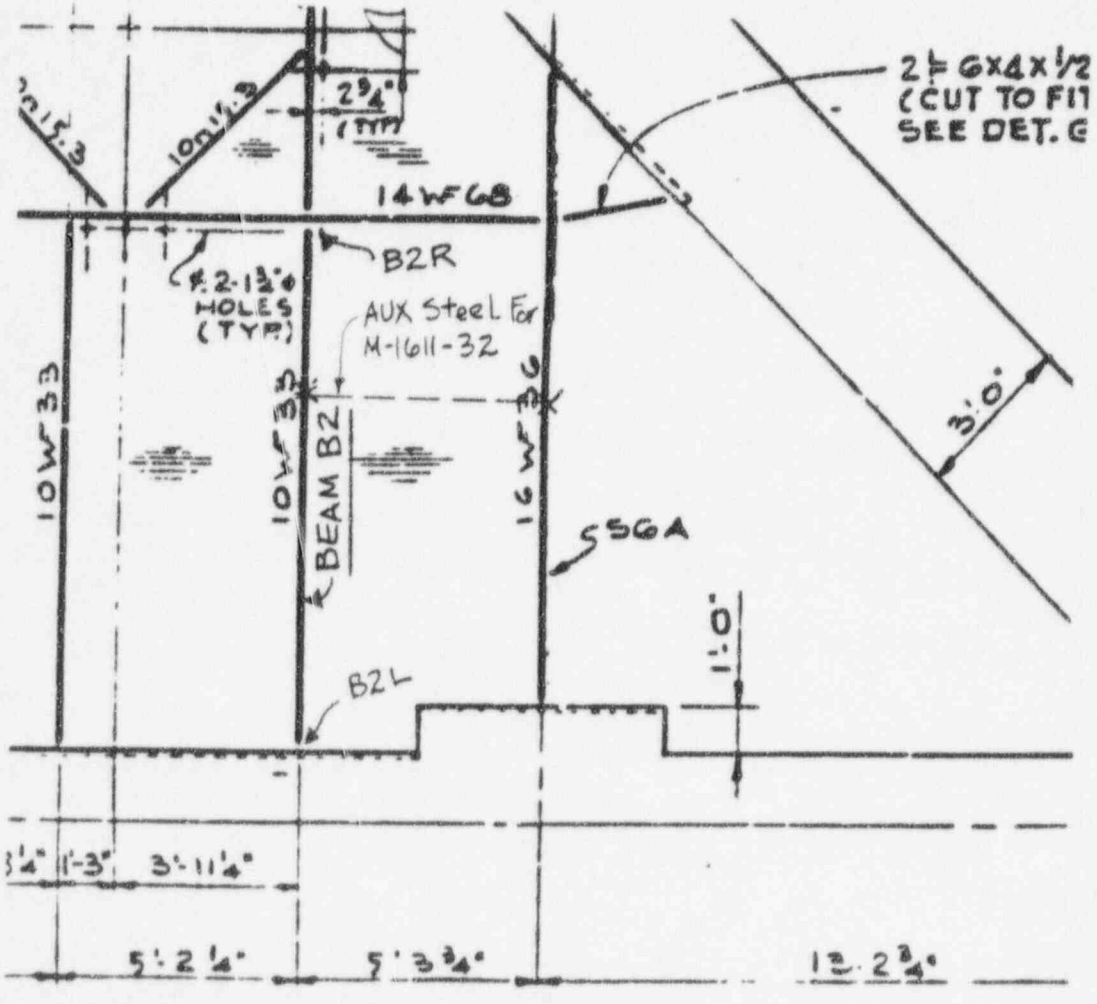
CALCULATION NO. 9200-Eϕ-S | PROJECT NO. 9200-00 (10004-002) | PAGE NO. 89.36

REVISION NO. 3

PREPARED BY: S J Chhabra DATE: 1/3/96 | REVIEWED BY: [illegible] DATE: 1/12/96

Framing Arrangement (2)



PLATFORM EL. 580'-1 1/4"

TOP OF STEEL EL. 580'-0"

N

Calculations

10WF33 Properties From AISC 6 th edition Manual (Ref 1):

bf = 7.964·in	tf = 0.433·in	
d = 9.75·in	tw = 0.292·in	
A = 9.71·in^2	Ix = 170.9·in^4	Sx = 35·in^3
	Iy = 36.5·in^4	Sy = 9.2·in^3
	ry = 1.94·in	
Fy = 36·ksi	Yield Stress	

Corodinates:

x = WF Major Axis; y = WF Minor Axis; z = WF Axial Axis

Beam B2 Ends:

Left = East
Right = West

Torsional Load on Beam B2

Review of Ref 4 indicates that torsional loads on this beam are from following auxiliary steel attachments:

Attachment	LMS Attachment ID	Loc. (from Left)	Torsion (SSE)
Gallery Attachment	M-GALL	8.23 ft	0.07 kip-ft
Hanger Attachment	M1611-32B	7.42 ft	2.39 kip-ft

The above torsional loads were used in the 1991 LMS analysis. Subsequently, the hanger attachment loads have been revised accounting for the relative flexibility of the structural steel with respect to the AUX steel framing (Ref 5). As a result, the torsional load due to support M1611-32B has been reduced from 2.39 kip-ft to 0.033 kip-ft (Ref 5). The revised torsional loads will be used in this calculation. Note that the vertical shear load from the support has remained virtually unchanged (2.60 kips in Ref. 5 vs 2.63 kip in Ref 4).

The revised torsional moment at the critical right connection is calculated below:

Torsional Moment	Location from the Left Beam End	LMS ID
$Mz = \begin{pmatrix} 0.07 \cdot kip \cdot ft \\ 0.033 \cdot kip \cdot ft \end{pmatrix}$	$Loc = \begin{pmatrix} 8.23 \cdot ft \\ 7.42 \cdot ft \end{pmatrix}$	M-GALL M1611-32B

Torsional Reaction at the right (west-end) connection of Beam B2 i.e. at B2R:

$$MzR = \sum_{i=1}^{2} \frac{Loc_i \cdot Mz_i}{11.06 \cdot ft}$$

Beam Span is 11.06 ft

$MzR = 0.07 \cdot kip \cdot ft$

Other loads at B2R (From Ref 4) under critical SSE load combination of WESTSSE:

$RxR = 0. \cdot kips$

$RyR = 6.1 \cdot kips$

$RzR = 2.9 \cdot kips$

B2R Allowables

The critical connection component with IC of 8.64 is out-standing leg bending of the clip angle in EASTOBE load combination. Under SSE load combinations, the critical load combination is WESTSSE producing a clip angle out-standing leg bending IC of 5.56. The connection allowables given in Ref 3 are based on S&L standard SDS E7 (Ref 6). These allowables for angle outstanding leg bending for axial load Rz, lateral load Rx, and torsional load Mz are based on 0.8 Mp (Mp*1.6/2.0), where Mp is the plastic capacity of the outstanding angle leg. Since the functional evaluation criteria allows for use of up to 0.95 Mp, prorate the allowables as follows:

$$ARX := 2.8 \cdot kips \cdot \left(\frac{0.95}{0.8}\right) \qquad ARX = 3.32 \cdot kips$$

$$ARZ := 10.3 \cdot kips \cdot \left(\frac{0.95}{0.80}\right) \qquad ARZ = 12.23 \cdot kips$$

$$AMZ := 0.32 \cdot kip \cdot ft \cdot \left(\frac{0.95}{0.80}\right) \qquad AMZ = 0.38 \cdot kip \cdot ft$$

Note that Ry load does not contribute to angle out-standing leg bending. Thus the revised interaction for out-standing leg bending is:

$$IC1 := \frac{RxR}{ARX} + \frac{RzR}{ARZ} + \frac{MzR}{AMZ}$$

$$IC1 = 0.43$$

For reference -- contribution of each component.

$$\frac{RxR}{ARX} = 0 \qquad \frac{RzR}{ARZ} = 0.24 \qquad \frac{MzR}{AMZ} = 0.2$$

Review of the LMS Run (Ref 4) also indicates that the 10WF33 web bending interaction is also high. Check the web bending IC for SSE, similar to the the calculation above. Note that for simplicity the Ry allowable will not be prorated to 0.95Mp since the Ry allowable is based on the elastic section of the coped WF section. Therefore, the calculation below is conservative:

$ARX\_w = 3.0 \cdot kips \cdot \left(\frac{0.95}{0.8}\right)$ $ARX\_w = 3.56 \cdot kips$

$ARY\_w = 21.7 \cdot kips$ Conservative

$ARZ\_w = 79.8 \cdot kips$ Axial allowable

$AMZ\_w = 0.32 \cdot kip \cdot ft \cdot \left(\frac{0.95}{0.8}\right)$ $AMZ\_w = 0.38 \cdot kip \cdot ft$

The web bending IC:

$$IC2 = \frac{RxR}{ARX\_w} + \frac{RyR}{ARY\_w} + \frac{RzR}{ARZ\_w} + \frac{MzR}{AMZ\_w}$$

$IC2 = 0.51$ Conservative

For reference -- contribution of each component.

$\frac{RxR}{ARX\_w} = 0$ $\frac{RyR}{ARY\_w} = 0.28$ $\frac{RzR}{ARZ\_w} = 0.04$ $\frac{MzR}{AMZ\_w} = 0.2$

Review of the LMS connection allowables indicates that all other connection components are less critical. Thus the connection IC for B2R, based on functional allowables is significantly less than 1.0. Thus OK.

Beam B2 Stress IC

The highest SSE beam IC in Ref. 4 is 0.58 (WESTSSE and EASTSSE). Therefore no further evaluation is needed.

Connection B2L

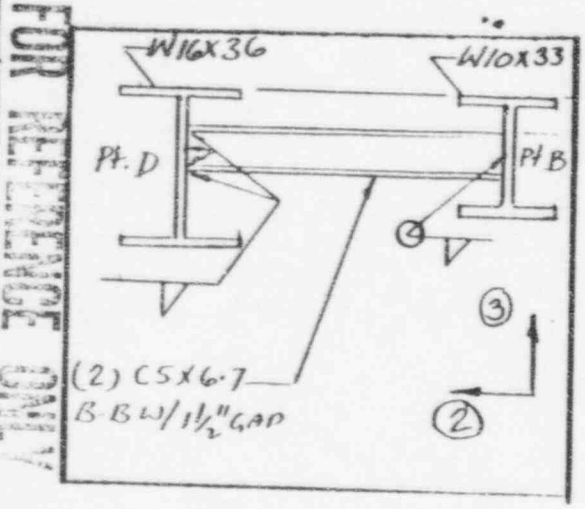
The highest SSE connection IC in Ref. 4 is 0.57 (EASTSSE). Therefore no further evaluation is needed.

Conclusion

It has been demonstrated that the connection ICs can be significantly reduced by reducing the magnitude of torsional moment on the beam. Based on these calculations, beam B2 and its connections are functional.

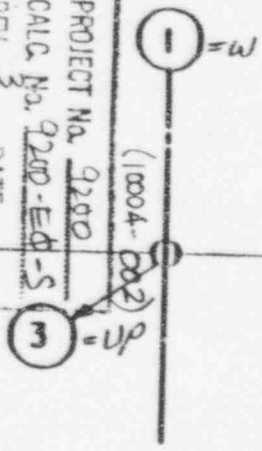
PIPE SUPPORT LOADING ON EXISTING STEEL

REFERENCES:
SKETCH NO. M-1611-32, REV. B (PG 2 of 4)
STRUCTURAL B273
ISOMETRIC EDS-M494A-SHT. 20
PROBLEM NO. _____ PT. ___

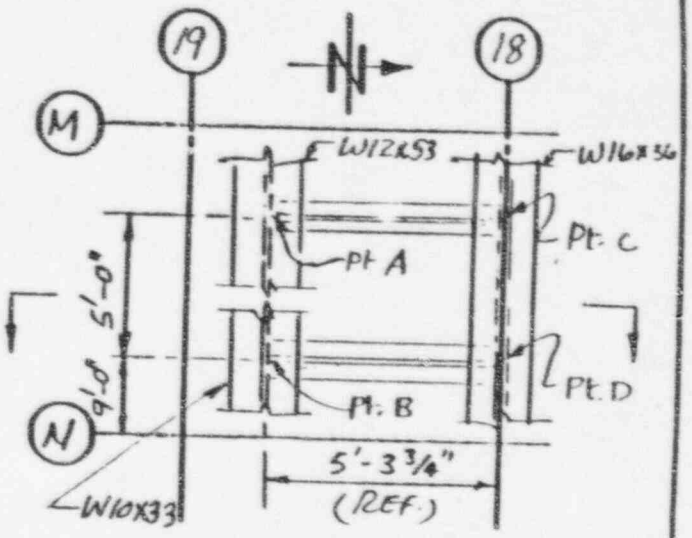


VIEW OF EXISTING STEEL

PLAN ☐ ELEVATION ☑



LOCAL COORDINATES



LOCATION PLAN

PLANT AREA REACTOR
APPROX. ELEV. 580'-0"
STEEL SIZE W16X36, W10X33

NOTES:
1. LOAD UNITS-FORCE IN KIPS.
MOMENT IN KIP-FEET.
2. LOADS ARE MAXIMUM ABSOLUTE VALUE UNLESS NOTED OTHERWISE.
3. LOCAL STRESS EFFECTS ON I.P. STEEL HAVE BEEN EVALUATED. STIFFENERS NOT REQUIRED 3

REACTONS @ Pt. B

PLANT CONDITION		LOAD IN DIRECTION: 1	2	3
NORMAL/ UPSET (OBE)	F	—	—	2.6
	M	0.033	—	—
FAULTED (DBE)	F	—	—	2.6
	M	0.033	—	—

3

FOR REFERENCE ONLY

REV.	BY	DATE	CHECKED	DATE
1	KOI Nakata	6-7-91	K.M. Mauck	6-11-91
2	Rumbaua	12-20-91	H.J. Pollock	12/30/91

FOR CONCURRENCE

CLIENT: CECO PROJECT: QUAD CITIES UNIT-1
REPORT OF LOADS ON EXIST. STRUCTURAL STEEL
JOB NO. XCE-57 PAGE 14
CALC NO. 28.0201-1111-31.01 OF 16

Figure 2
ADDENDUM-1