STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

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CLIENT & PROJECT	PAGE 1
TEXAS UTILITIES GENERATING CO./COMANCHE PEAK SES - UNIT NO. 1 & 2	TOTAL NO. OF PAGES- 72

CALCULATION TITLE (Indicative of the Objective):

GENERIC CALCULATION: PARALLEL SNUBBERS

☒ - NUCLEAR SAFETY RELATED

☐ -NON-NUCLEAR SAFETY RELATED

CALCULATION IDENTIFICATION NUMBER			OPTIONAL WORK PACKAGE NO
J.O. OR W.O NO	DIVISION & GROUP	CURRENT CALC. NO	
15454	NZ(c)-	GENX-242	N/A

PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	REV. NO	SUPERSEDES CALC NO OR REV. NO.	CONFIRMATION REQUIRED (✓) YES	NO
T. Ginwala 10/15/87	Kawai R. Ho 10/16/87	RAHMAT RADIZADEH R. T. Radizadeh 10/30/87	0	NA		✓
T. Ginwala 1/21/88	Kawai R. Ho 1-21-88	Kawai R. Ho 1-21-88	1	0		✓

DISTRIBUTION

GROUP	NAME & LOCATION	COPY SENT Revision 0	1	2	GROUP	NAME & LOCATION	COPY SENT (✓)
FIRE FILE	B. NICHOLSON 245/1	X					
ORIGINALS TO PROJECT FILE	SR. CLERK CHOC 4YL	X					
EMD.	T. GINWALA (5GR)	X					
RECORDS MGMT.	B. EXCELL - NYOC/36	X					
TUE INTERIM CALC FILE	D. GOODMAN	X					

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REVISION STATUS TABLE

REV NO.	PAGE NO.	DESCRIPTION/REASON
0	ALL	ORIGINAL ISSUE
1	A	REVISED TOTAL SUPPORT NO.
	5	CORRECTED SPELLING FOR HYDRAULIC.

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OBJECTIVE:- REFERENCE-1

NUCLEAR STANDARD NE-E-79, SECTION XI. 3.1 REQUIRES THAT PARALLEL SNUBBERS SHALL NOT BE MISMATCHED IN ORDER TO PERFORM THEIR INTENDED FUNCTION. THE REQUIREMENTS OF MATCHED SNUBBERS ARE a) THE DIFFERENTIAL LOST MOTION BETWEEN TWO SNUBBERS SHALL NOT EXCEED 0.02 INCH. b) THE DIFFERENTIAL ACTIVATION SHALL NOT EXCEED 0.005 g OR 50% OF THE SMALLEST ACTIVATION LEVEL, THE OBJECTIVE IS TO CHECK WHETHER THE SNUBBERS MEET THE ABOVE (a & b) CRITERIA.

METHOD :— a) LIST OF ALL THE SUPPORTS WHICH HAVE PARALLEL SNUBBERS IS OBTAINED (REFFERENCE-2) FROM SITE, WITH SNUBBER MODEL NUMBER AND SERIAL NUMBER. TOTAL SUPPORTS ARE 235.

b) A TEST DATA SHOWING LOST MOTION & ACTIVATION LEVEL FOR EACH OF ABOVE SNUBBERS WERE OBTAINED FROM PACIFIC SCIENTIFIC, (REF-3)

C) DIFFERENTIAL LOST MOTION & ACTIVATION LEVEL BETWEEN PAIR OF SNUBBERES

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METHOD (CONT.).

USED IN EACH SUPPORT ARE CALCULATED

d) DIFFRENTIAL MOTION IS COMPARED TO THE 0.02 IN MAXIMUM.

e) DIFFERENTIAL ACTIVATION LEVEL IS COMPARED TO THE 0.005 G OR 50% OF THE SMALLEST ACTIVATION LEVEL.

REFERENCES:-

1) NUCLEAR STANDARD NE-E-79 "MECHANICAL AND HYDRAULIC SNUBBERS FOR NUCLEAR APPLICATION" SEPTEMBER 1984.

2) INCOMING CORROSPONDANCE "CH-ICPI-825 DATED 5/13/87 JOB BOOK R 2.1.2.

3) INCOMING CORROSPONDANCE CH-ICPI-992.

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CONCLUSIONS :-

THE COMPARISON OF LOST MOTION FOR MATCHED SNUBBERS SHOWED THAT THE DIFFERENTIAL LOST MOTION WAS WITH IN THE 0.02 IN LIMIT FOR ALL SUPPORTS. THE COMPARISON OF ACTIVATION LEVEL SHOWED THAT FOR 17% OF SUPPORTS, THE DIFFERENTIAL ACTIVATION LEVEL EXCEEDED THE 0.005g OR ½ OF SMALLEST ACTIVATION LEVEL. HOWEVER APPENDIX XI·3.1 OF THE REF-1 STATES THAT "LOAD SHARING IS A STRONG FUNCTION OF MISMATCH OF LOST MOTION AND END FITTINGS CLEARANCE AND A LESSER FUNCTION OF MISMATCH OF ACTIVATION LEVEL AND RELEASE RATE." IT IS COMMON INDUSTRY PRACTICE TO MATCH ONLY THE CLEARANCE/LOST MOTION OF SNUBBERS TO ENSURE THE PROPER LOAD SHARING OF MULTIPLE SNUBBERS. (SEE ATTACHMENT A). BASED ON THIS IT IS CONCLUDED THAT MULTIPLE SNUBBERS ON PIPE SUPPORTS ON CPSES SATISFY THE LOAD SHARING CRITERIA OF REFERENCE-1.

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23 x 13 x 2 = 596 PAIRED SNUBBERS

SUPPORT No	SNUBBER No	Model	ACT LEVEL G	Δ G	LOST MOTION IN	Δ LOST MOTION IN	REMARK
CS-1-106-720-C42K	9075 9078	1/2	0.014 0.012	0.002	0.016 0.015	0.001	ok
RC-1-134-703 C92K	16159 15329	1/4	0.0122 0.0165	0.0043	0.015 0.020	0.005	ok
RH-1-SB-012 002-2	11404 9737	1/2	Deleted				
RH-1-SB-012 009-2	9720 9736	1/2	Deleted				
AF-1-096-009 533K	17823 23008	1	Deleted				
AF-1-096-020 533K	19536 19537	1/4	0.0165 0.014A	0.002	0.015 0.013	0.002	ok
FW-1-091-700 562K	10186 10746	10		DELETED			
AF-1-098-005 543K	16505 16506	3	NA NA		0.015 0.013	0.002	
AF-1-099-002 533K	12826 24254	1	Deleted				
AF-1-099-007 533K	9832 10309	1/2	0.015 0.01	0.005	0.01 0.017	0.007	
AF-1-099-033 543K	24269 24299	1	0.006 0.007	0.001	0.028 0.028	0.00	
FW-1-092-700 562K	11717 H765	10		DELETED			
AF-1-059-700 562K	18041 24186	1	Deleted				

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PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
AF-1-101-007 S331C	28085 28092	1/4	0.010 0.010	0.0	0.020 0.023	0.003	
SI-1-051-028 C42K	17818 18053	1	0.008 0.004	0.004	0.022 0.023	0.001	9 > ½ MA
SI-1-087-012 S42K	8380 8414	3	NA NA		0.009 0.01	0.001	
SI-1-097-017 C42F	19038 19042	1	0.006 0.007	0.001	0.026 0.028	0.002	
SI-1-088-009 C42K	19044 22062	1	0.006 0.007	0.001	0.026 0.015	0.009	
SI-1-058-010 C42K	14919 8370	3	NA NA	—	0.016 0.010	0.006	
SI-1-181-003 C41K	15063 15073	10	0.007 0.014	0.007	0.028 0.022	0.006	▲ 9 > 0.005g 9 0.007 2
SI-1-306-024 C42K	28089 28099	1/4	0.010 0.009	0.001	0.019 0.022	0.003	
SI-1-306-028 C42K	17780 18043	1	0.008 0.007	0.001	0.017 0.026	0.009	
SI-1-304-029 C42K	17793 18132	1	0.008 0.012	0.004	0.018 0.025	0.007	
SI-1-306-031 C42K	17805 18126	1	0.006 0.010	0.004	0.022 0.023	0.001	9 > ½ x 3.006
RH-1-001-009 C41K	27948 27950	3	Deleted				
RH-1-001-010 C41K	4890 4901	10	Deleted				

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PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
RH-1-002-009 C41K	16902 27954	3	NA 0.005		0.016 0.020	0.004	
RH-1-002-012 C41K	10053 10702	10	0.011 0.013	0.002	0.010 0.020	0.010	
CT-1-009-007 522K	10781 7378	3 10	DELETED				
CT-1-009-008 522K	10295 12742	1	Deleted				
CT-1-010-010 522K	21000 21004	3	Deleted				
CT-1-007-010 522K	10790 10797	3	NA NA		0.011 0.027	0.016	
CT-1-013-007 522K	12344 12357	1/2	0.009 0.011	0.002	0.017 0.015	0.002	
CT-1-014-012 542K	16469 16513	3	Deleted				
CT-039-429 C42K	9833 10350	1/2	0.017 0.012	0.005	0.016 0.014	0.002	
CS-1-001-015 C42K	8517 8518	1/2	Deleted				
CS-1-079-022 C42K	11390 11412	1/2	Deleted				
RC-1-115-011 C74K	10431 11619	10	0.016 0.012	0.004	0.020 0.021	0.001	
RC-1-018-051 C51K	20308 24194	1	0.010 0.008	0.002	0.132 0.022	0.01	

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PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	SIZE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
CC-1-239-007 C53K	34442	1/4	0.012	0.0	0.026	0.002	
	34448		0.012		0.024		
CC-1-212-005 C53K	12024	1	0.007	0.001	0.009	0.001	
	12025		0.008		0.010		
CC-1-218-012 C53K	10782	1 1/4	0.012	0.002	0.013	0.003	
	10783		0.010		0.010		
CC-1-215-012 C53K	10789	1/4		DELETED			
	19294						
CC-1-008-021 A33K	24507	3	0.003	0.001	0.026	0.00	
	24508		0.004		0.026		
CC-1-010-005 A43K	16525	3	NA		0.014	0.002	
	16526		NA		0.016		
CC-1-043-011 A43K	15987	3	NA		0.017	0.002	
	16462		NA		0.015		
CC-1-043-017 A43K	4294	10	0.015	0.0	0.010	0.001	
	4298		0.015		0.011		
CC-1-156-002 A53K	8386	3	Deleted				
	8389						
CC-2-044-700 A43K	11724	10	0.018	0.004	0.02	0.005	
	11763		0.014		0.025		
CC-2-045-703 A33K	12956	3	Deleted				
	1492						
RH-1-007-005 S22K	11997	3	NA		0.018	0.005	
	16947		NA		0.013		
SL-1-071-004 S32K	15956	3	NA		0.018	0.006	
	15957		NA		0.012		

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PAIRED SNUBBERS

SUPPORT No	SNUBBER No	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
RH-1-024-009 S22K	16517	3	NA		0.011	0.005	
	16518		NA		0.016		
MS-1-074-015 C52K	8400	1/2	0.008	0.006	0.013	0.004	$\Delta g > \frac{1}{2}$ (0.008) & 0.005 ✓
	8401		0.014		.009		
MS-1-074-014 C52K	8373	1/2	0.015	0.002	0.013	0.001	
	8374		0.013		0.014		
MS-1-151-020 C52K	10756	1/4		DELETED			
	10757						
MS-1-151-032 C52K	12358	1/4		DELETED			
	19554						
MS-1-151-040 C52K	10378	1	Deleted				
	10391						
MS-1-151-043 C52K	8909	1	Deleted				
	8911						
MS-1-150-032 C52K	34451	1/4	0.008	0.004	0.024	0.002	
	35251		0.012		0.026		
MS-1-150-050 C52K	35219	1/4	0.010	0.00	0.020	0.004	
	35231		0.010		0.024		
MS-1-344-004 C52K	21891	1	0.105	0.005	0.028	0.002	$\Delta g > \frac{1}{2}$ 0.005
	24214		0.01		0.026		
MS-1-345-004 C52K	9790	1/2	0.014	0.002	0.013	0.005	
	9791		0.012		0.008		
MS-1-028-029 533K	17809	1	0.008	0.0	0.023	0.002	
	18124		0.008		0.025		
Do-1-034-001 563K	5596	10	0.007	0.003	0.011	0.006	
	9229		0.01		0.017		

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PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
VA-1-005-016 C92K	12686 12687	1	0.008 0.012	0.004	0.005 0.01	0.005	
VA-1-005-013 C92K	10373 21792	1	Deleted				
FW-2-094-404 S62K	15078 26961	3	CHANGE SNUBBERS TO STRUT				
51-2-051-412 C42K	12706 15891	1	NA 0.01	—	0.011 0.020	0.009	
51-2-051-418 C42K	20607 20614	1	0.006 0.010	0.004	0.022 0.028	0.006	Δ9 > ½(0.01K)
51-2-095-413 C42K	24649 24664	3	0.005 0.006	0.001	0.028 0.030	0.002	
51-2-087-411 C42K	13012 20250	1	0.009 0.007	0.002	0.013 0.030	0.017	
51-2-087-412 C42K	20177 20196	1	0.008 0.007	0.001	0.030 0.028	0.002	
51-2-087-417 C42K	20183 20640	1	0.009 0.010	0.001	0.038 0.022	0.016	
51-2-090-403 C41K	6329 6339	3	NA NA		0.011 0.010	0.001	
51-2-088-409 C42K	20646 20667	1	0.008 0.005	0.003	0.029 0.022	0.002	Δ9 > ½(0.005)
51-2-088-410 C42K	482 605	1L	SUPPORT MODIFIED DCA-0 26798		& LETTER 2-CPO-477		
51-2-306-426 C42K	16467 16471	1	0.01 0.008	0.002	0.002 0.002	0.0	

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PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARKS
RC-2-135-405 C42K	15190	10	0.010	0.002	0.020	0.0	
	15195		0.008		0.020		
RH-2-002-409 C44K	2910	3	NA		0.009	0.001	
	3789		NA		0.008		
CT-2-051-408 C72K	12995	3	NA		0.013	0.013	
	24535		0.007		0.026		
WP-2-030-422 C46K	16454	1	0.010	0.0	0.026	0.006	
	16463		0.010		0.020		
CS-2-001-415 C42K	21816	1	0.006	0.002	0.020	0.004	
	21817		0.008		0.024		
CS-2-001-417 C42K	12684	1	0.006	0.001	0.011	0.017	
	15916		0.007		0.028		
RC-2-052-428 C41K	19045	1	0.008	0.001	0.030	0.002	
	19054		0.007		0.032		
CS-2-079-412 C42K	20187	1	0.008	0.001	0.030	0.002	
	20292		0.007		0.028		
CS-2-079-411 C42K	21481	1	0.007	0.002	0.028	0.002	
	21735		0.009		0.026		
CS-2-079-414 C42K	20424	1	0.005	0.005	0.026	0.004	$\Delta g > \frac{1}{2}(0.005)$
	21719		0.01		0.022		
RC-2-115-411 C76K	15808	10	0.014	0.008 x1.G.	0.028	0.002	$\Delta g > \frac{1}{2}(.006)$ & $0.005g$
	15809		0.006		0.026		
RC-2-115-431 C56K	15776	10	0.008	.008 N.G.	0.024	0.006	$\Delta g > \frac{1}{2}(.008)$ & $0.005g$
	15778		0.016		0.030		
MS-2-344-4.4 C52K	19131	1	0.01	0.0	0.030	0.0	
	19132		0.01		0.030		

< 0.005

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PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	NOM	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
MS-2-344-407 C52K	10453 21124	1	0.01 0.005	0.005	0.028 0.024	0.004	$\Delta g > k$ 0.015
SB-2-023-406 E25K	10754 21348	3	N.A. 0.005		0.007 0.024	0.017	
AF-1-001-017 533K	15988 15989	3	NA NA	NA	0.012 0.013	0.001	
AF-1-001-021 Y33K	13041 24162	1	0.006 0.006	0.00	0.010 0.026	0.016	
AF-1-096-013 533K	21812 21824	1	0.01 0.008	0.002	0.024 0.024	0.0	
AF-1-096-001 543K	19539 19540	1/4	0.0119 0.0139	0.002	0.014 0.014	0.00	
AF-1-094-049 553K	11808 2140	1/2	0.013 0.012	0.001	0.016 0.008	0.008	
AF-1-097-043 563K	14604 14612	1	0.009 0.009	0.0	0.013 0.019	0.006	
AF-1-097-044 553K	28055 28068	1/4	0.012 0.014	0.002	0.019 0.02	0.001	
AF-1-098-030 533K	10287 10335	1/2	0.007 0.013	0.006	0.015 0.012	0.003	$\Delta g > \frac{1}{2}$(0.007) & 0.005g
AF-1-102-002 543K	8450 8455	1/2	0.01 0.009	0.001	0.017 0.009	0.008	
BRX-044-009 A53K	10468 10537	1/2	0.01 0.012	0.002	0.015 0.01	0.005	
CC1-008-015 A33K	9232 9242	3	Deleted				

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15457	NZ(C)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
CC1-017-010 A33K	15949	3	NA	—	0.013	0.012	
	21018		0.006		0.025		
CC1-028-004 A33K	4744	35	0.0019	0.0004	0.030	0.001	
	4798		0.0023		0.031		
CC1-028-022 S33K	6451	35	0.0059	0.0021	0.028	0.0	g > ½ 0.032
	6631		0.0038		0.028		
CC1-028-713 S33K	11611	10	0.014	0.004	0.030	0.013	
	11617		0.01		0.017		
CC1-043-015 A43K	15958	3	NA		0.013	0.001	
	15959		NA		0.012		
CC1-043-029 A43K	10717	10	0.012	0.001	0.024	0.001	
	10719		0.013		0.023		
CC1-043-030 A33K	11574	35	0.003	0.0	0.016	0.01	
	11575		0.003		0.026		
CC1-065-005 S33K	26539	3	0.003	0.001	0.026	0.002	
	26561		0.004		0.028		
CC1-066-013 S33K	14703	10	0.010	0.006	0.028	0.0	Δ g > ½ x 0.01 ≥ 0.005
	14710		0.016		0.028		
CC1-078-005 S33K	14032	3	Deleted				
	14033						
CC1-105-012 E33K	20325	¼	0.017	0.002	0.013	0.0	
	20342		0.019		0.013		
CC1-191-013 C42K	25038	¼	0.014	0.0	0.017	0.0	
	25041		0.014		0.017		
CC1-211-004 C53K	10791	¼	0.014	0.003	0.018	0.005	
	15359		0.017		0.013		

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15454	NZ(C)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
CC1-218-005 C53K	10777 10778	1/4	0.013 0.009	0.004	0.014 0.014	0.0	
CC1-218-009 C53K	10779 10780	1/4	0.013 0.009	0.004	0.014 0.014	0.0	
CC1-218-016 C53K	25064 25009	1/4	0.016 0.018	0.002	0.020 0.017	0.003	
CC1-240-005 C53K	24180(A) 24117(B)	-	Deleted				
CC1-258-009 C53K	16906 16907	3	Deleted				
CC1-268-003 C53K	16156 16162	1/4	0.010 0.012	0.002	0.017 0.010	0.007	
CC1-271-004 C53K	15395 19262	1/4	0.015 0.014	0.001	0.016 0.011	0.005	
CC1-272-003 C53K	19946 19990	1/4		DELETED			
CCX-040-014 A75K	6138 6161	3	Deleted.				
CCX-066-017 A75K	21034 20497	3	0.004 0.004	0.12	0.025 0.022	0.003	
C11-016-024 545K	2181 2194	1/2	Deleted.				
CS1-018-017 552K	12988 12989	3	NA NA		0.013 0.017	0.004	
CS1-242-709 A42K	12658 12659	1	0.010 0.007	0.003	0.013 0.011	0.002	

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J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15454	NZ(C)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
CS1-315-024 S53K	12999	3	Deleted				
	13000						
CS1-333-019 S53K	12671	—	Deleted				
	12670						
CT1-014-025 S32K	10360	1	NA	—	0.011	0.002	
	13031		0.007		0.009		
CT1-014-404 C52K	12035	1	0.008	0.002	0.007	0.001	
	12036		0.010		0.008		
CT1-014-412 C72K	10784	10	0.012	0.002	0.027	0.002	
	10782		0.010		0.029		
CT1-014-431 C52K	15103	10	0.007	0.002	0.024	0.002	
	15105		0.009		0.026		
CT1-021-004 S22K	26371	1/4	0.016	0.0	0.017	0.007	
	26372		0.016		0.024		
CT1-024-003 S22K	16792	3	NA		0.008	0.001	
	16793		NA		0.007		
CT1-024-004 S22K	14893	3	NA		0.008	0.003	
	14894		NA		0.005		
CT1-025-007 S22K	14898	3	NA		0.013	0.001	
	14899		NA		0.012		
CT1-029-023 C92K	18006	1/2	Deleted				
	18007						
CT1-031-018 C92K	26122	1/4	0.014	0.0	0.020	0.001	
	26123		0.014		0.019		
CT1-031-019 C92K	26400	1/4	0.014	0.004	0.016	0.001	
	26407		0.018		0.015		

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CALCULATION IDENTIFICATION NUMBER				PAGE 17
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
1543-A	NZ(C)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
CT1-034-019 C82K	9781 11792	1/2	0.015 0.018	0.003	0.009 0.020	0.011	
CT1-034-020 C82K	10525 11372	1/2	0.017 0.015	0.003	0.015 0.012	0.003	
CT1-038-437 C62K	20327 20406	1/4	0.015 0.012	0.003	0.015 0.012	0.003	
CT1-002-003 532K	11978 11989	3	NA NA	—	0.021 0.024	0.003	
CT1-007-007 522K	10763 16929	3	NA NA		0.015 0.011	0.004	
CT1-009-004 522K	12031 12998	1	0.007 0.01	0.003	0.011 0.007	0.004	
CT1-012-007 522K	14888 14889	3	NA NA		0.008 0.009	0.001	
CT1-013-023 542K	4914 4915	10	0.015 0.015	0.0	0.010 0.012	0.002	
CT1-013-414 C82K	3291-3 3291-4	3	INFORMATION OF THESE SNUBBERS IS NOT AVAILABLE				
CT1-013-415 C62K	9203 9209	10	0.012 0.015	0.003	0.020 0.013	0.007	
CT1-013-416 C52K	12016 12019	3	NA NA		0.028 0.020	0.008	
CT1-013-418 C82K	28857 28861	3	0.004 0.005	0.001	0.018 0.016	0.002	
CT1-014-008 542K	4356 4361	10	0.015 0.014	0.001	0.010 0.010	0.0	

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 18
15454	NZ(1)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
CT1-014-010 S42K	9234	10	0.011	0.003	0.009	0.001	
	9235		0.014		0.010		
CT1-014-016 S32K	10769	3	NA	—	0.006	0.003	
	10770		NA		0.009		
CT1-038-441 C52K	27599	1/4	0.016	0.0	0.025	0.002	
	28654		0.016		0.023		
CT1-039-443 C42K	19968	1/4	0.018	0.003	0.009	0.008	
	19949		0.015		0.017		
CT1-044-022 C92K	10268	1/2	deleted				
	10358						
CT1-046-006 C52K	12039	1	0.007	0.001	0.012	0.003	
	12038		0.006		0.009		
CT1-046-011 C92K	8375	1/2	Deleted				
	8999						
CT1-046-016 C52K	28589	1/4		DELETED			
	28655						
CT1-048-007 C52K	10078	1	NA	—	0.008	0.005	
	10234		NA		0.013		
CT1-049-008 C82K	9819	1/2	0.013	0.003	0.012	0.003	
	10306		0.010		0.015		
CT1-049-010 C52K	20359	1/4	0.014	0.003	0.017	0.003	
	20383		0.011		0.014		
CT1-049-404 C82K	16176	1/4	0.014	0.002	0.015	0.002	
	16177		0.012		0.013		
CT1-051-415 C72K	16795	3	NA	—	0.015	0.005	
	16917		NA		0.010		

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J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15454	NZ (C)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT No	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
CT1-051-416 C72K	14598	1	0.007	0.001	0.017	0.0	
	14609		0.008		0.017		
CT1-051-417 C72K	14556	1	0.008	0.003	0.018	0.004	Δ9 > ½ (0.005)
	14563		0.005		0.022		
CT1-051-418 C72K	12313	½	0.015	0.007	0.012	0.006	9 > ½ 0.008 & 0.005
	12352		0.008		0.018		
CT1-051-419 C72K	14586	1	0.007	0.002	0.015	0.003	
	14592		0.009		0.012		
CT1-054-433 C42K	16180	¼		DELETED			
	16181						
CT1-074-410 C82K	19980	?	Deleted				
	19963						
CT1-075-406 C62K	12041	1	0.008	0.0	0.009	0.005	
	12042		0.008		0.014		
CT1-076-404 C82K	14572	1	0.009	0.003	0.015	0.004	
	14582		0.006		0.019		
CT1-076-408 C82K	12017	3	NA		0.025	0.001	
	12020		NA		0.024		
CT1-077-407 C72K	12010	3	NA		0.021	0.00	
	12013		NA		0.021		
CT1-097-403 C52K	12043	1	Deleted				
	12044						
CT1-097-414 C42K	19942	¼	0.017	0.002	0.015	0.003	
	19947		0.015		0.012		
CT1-117-412 C62K	12354	½	0.009	0.003	0.016	0.005	
	12383		0.012		0.011		

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CALCULATION IDENTIFICATION NUMBER				PAGE 20
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15454	NZ(C)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
CT1-117-415 C62K	19194 24201	1	Deleted				
CT1-124-415 C72K	12645 12646	1	0.008 0.010	0.002	0.005 0.013	0.008	
CT1-124-416 C72K	8429 8430	1/2	Deleted				
DD2-003-496 Y36K	28373 28376	3	0.003 0.003	0.00	0.020 0.020	0.00	
DD2-003-487 Y36K	20294 20295	1	0.008 0.007	0.001	0.026 0.024	0.002	
DD2-006-483 S36K	7134 7140	3	NA NA	—	0.014 0.018	0.004	
D01-029-001 S53K	11601 11613	10	0.011 0.013	0.002	0.035 0.023	0.012	
D01-035-001 S53K	20998 21009	3	0.005 0.005	0.00	0.029 0.031	0.002	
D01-038-003 S63K	6990 7471	35	0.0026 0.0056	0.003	0.039 0.025	0.014	$g > \frac{1}{2}$ 0.0026
D01-038-005 S53K	16891 16966	3	NA NA	—	0.016 0.009	0.007	
D01-040-003 S45K	26378 26382	1/4	0.014 0.014	0.0	0.023 0.023	0.0	
D01-058-001 S53K	16975 21011	3	NA 0.005		0.008 0.027	0.019	
D01-070-001 S53K	16819 16974	3	NA NA		0.014 0.006	0.008	

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CALCULATION IDENTIFICATION NUMBER				PAGE 21
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
154 C4	N2-(c)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT No	SNUBBER No	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
DD1-003-088 S35K	20633	1	0.005	0.004	0.026	0.002	ΔG > 1/8 · 005
	20635		0.009		0.028		
DD1-003-074 S35K	12138	1/2	0.017	0.004	0.015	.001	
	12148		0.013		0.014		
D01-071-001 S63K	10744	10	0.008	0.005	0.026	0.006	ΔG > 1/2(0.008)
	11610		0.013		0.020		
D01-071-003 S63K	8890	35	0.0043	0.0007	0.028	0.005	
	8881		0.0036		0.023		
D01-071-006 S53K	11624	10	0.012	0.001	0.031	0.005	
	11625		0.011		0.026		
D01-069-004 S65K	12935	10	0.008	0.002	0.017	0.0	
	12920		0.006		0.017		
D01-090-001 S65K	10755	3	NA	—	0.010	0.003	
	10756		NA		0.013		
D01-090-003 S65K	11605	10	0.008	0.005	0.025	0.010	ΔG > 1/8 (0.008)
	11626		0.013		0.035		
FW1-017-023 C72K	16867	3	Delete				
	16888						
FW1-017-710 C42K	8374	35	0.0019	0.0018	0.014	0004	ΔG > 1/2 (0.0019)
	8379		0.0037		0.010		
FW1-017-707 C72K	1453	100	0.009	0.006	0.033	0.005	ΔG > 1/8 (0.003) ≥ 0.005
	1459		0.003		0.028		
FW1-017-709 C72K	1426	100	0.0031	0.0005	0.038	0.008	
	1429		0.0026		0.030		
FW1-017-712 C72K	1420	100	0.004	0.001	0.030	0.005	
	1421		0.003		0.035		

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CALCULATION IDENTIFICATION NUMBER				PAGE 22
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15454	NZ(c)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
FW1-018-016 C52K	11586 11587	35	0.005 0.005	0.0	0.020 0.018	0.002	
FW1-018-700 C72K	1454 1457	100	0.003 0.003	0.0	0.025 0.024	0.001	
FW1-018-708 C72K	1433 1424	100	0.006 0.003	0.003	0.030 0.037	0.007	Δ9>½(0.003)
FW1-018-709 C72K	1455 1456	100	0.004 0.005	0.001	0.020 0.018	0.002	
FW1-019-701 C42K	8788 8790	35	0.0013 0.0014	0.0001	0.014 0.018	0.004	Δ9>0.0022/2
FW1-020-700 C42K	1427 1432	100	0.0022 0.0041	0.0019	0.030 0.030	0.0	
FW1-095-011 C62K	14921 14922	3	NA NA		0.012 0.018	0.006	
FW1-095-700 C62K	21001 21013	3	0.006 0.006	0.0	0.025 0.025	0.00	
FW1-095-701 C62K	13001 13005	3	NA NA		0.013 0.019	0.006	
FW1-096-700 C62K	12026 21007	3	NA 0.006		0.022 0.022	0.00	
FW1-096-701 C62K	11984 16904	3	NA NA		0.025 0.014	0.011	
FW1-096-702 C62K	12008 12009	3	NA NA		0.018 0.028	0.01	
FW1-096-704 C62K	16866 16943	3	Deleted				

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CALCULATION IDENTIFICATION NUMBER				PAGE 2-3
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15454	NZ(L)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	
FW1-096-705 C62K	10709 10714	10	0.009 0.014	0.005	0.023 0.023	0.0	$\Delta g > \frac{1}{2}$ 0.009
FW1-096-706 C62K	10052 10058	10	0.01 0.012	0.002	0.008 0.008	0.0	
FW1-096-707 C62K	14855 21041	3	Deleted				
FW1-097-040 C62K	21044 21045	3	Deleted				
FW1-097-701 C62K	14891 14906	3	NA NA		0.008 0.018	0.01	
FW1-097-702 C62K	12905 4903	10	0.009 0.016	0.007	0.021 0.009	0.012	$\Delta g > \frac{1}{2}$ (0.009 ∴ 0.005)
FW1-097-705 C62K	28401 28416	3	0.005 0.003	0.002	0.022 0.022	0.00	$\Delta g > \frac{1}{2}$ (0.003)
FW1-098-013 C62K	28847 28848	3	0.007 0.008	0.001	0.016 0.016	0.00	
FW1-098-700 C62K	21003 21006	3	0.008 0.007	0.001	0.017 0.027	0.010	
FW1-099-701 C62K	8365 8357	3	NA NA		0.009 0.019	0.01	
FW1-100-702 C52K	13302 13310	3	NA NA	—	0.012 0.017	0.005	
FW1-101-007 C52K	16788 16805	3	NA NA	-	0.018 0.017	0.001	
FW1-101-009 C52K	16870 16938	3	NA NA	—	0.013 0.008	0.005	

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J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15454	NZ(C)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	
FW1-101-700 C62K	28555 28558	3	0.002 0.003	0.001	0.022 0.016	0.006	
MS1-002-014 C72K	9629 9630	35	0.004 0.004	0.0	0.012 0.010	0.002	
MS1-002-0[illegible] C72-	7897 7938	35	0.0033 0.0045	0.0012	0.016 0.017	0.001	
MS1-002-008 C72K	6570 6581	35	0.0022 0.0048	0.0026	0.036 0.030	0.006	Δ G > ½ (0.0022)
MS1-002-013 C72K	7922 7945	35	0.0025 0.0017	0.0008	0.017 0.020	0.003	
MS1-003-007 C72K	1413 2072	100	0.0014 0.004	0.0026	0.035 0.024	0.011	Δ G > ½ 0.0014
MS1-003-009 C72K	1428 1435	100	0.0038 0.0025	0.0013	0.035 0.030	0.005	Δ G > ½ 0.0025
MS1-003-010 C72K	1408 1411	100	0.0019 0.0031	0.0012	0.030 0.037	0.007	Δ G > ½ (0.0015)
MS1-003-014 C72K	2075 2076	100	0.005 0.004	0.001	0.027 0.034	0.007	
MS1-004-007 C72K	8403 8414	35	0.0017 0.0036	0.0019	0.011 0.025	0.014	Δ G > ½ 0.0017
MS1-004-009 C62K	8870 8872	35	0.0035 0.0038	0.0003	0.014 0.025	0.009	
MS1-028-018 S33K	10233 10077	1	Deleted				
MS1-070-003 T44K	10111 10118	35	0.005 0.003	0.002	0.028 0.022	0.006	Δ G > ½ 0.003

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J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15757	NZ(C)	GENX-242	-	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
MSI-071-003 T44K	10100	35	0.005	0.002	0.024	0.008	9 > 1/2 .013
	10101		0.003		0.016		
MSI-073-013 C52K	19507	1/4	0.012	0.004	0.010	0.004	
	20351		0.016		0.014		
MSI-150-025 C52K	16185	1/4	0.017	0.007	0.020	0.006	9 > 1/2 .01 9 > .005
	34421		0.01		0.026		
MSI-150-033 C52F	450	1L	Deleted				
	478						
MSI-150-035 C52K	13032	1	Deleted				
	13033						
MSI-150-051 C52K	501	1L	0.011	0.00	0.003	0.0	
	522		0.011		0.003		
MSI-150-054 C52K	20639 No Section Number Assigned	1					
MSI-150-062 C52K	19284	1/4	0.013	0.001	0.011	0.003	
	19321		0.012		0.014		
MSI-151-043 C52F	8909	1	Deleted				
	8911						
MSI-151-046 C52K	10350	1	Deleted				
	21892						
MSI-223-001 S72K	14034	3	NA		0.018	0.002	
	14035		NA		0.020		
MSI-240-001 S72K	12903	10	0.010	0.001	0.025	0.005	
	12918		0.009		0.020		
MSI-257-001 S72K	14796	3	NA	—	0.017	0.008	
	16912		NA		0.009		

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J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15454	XZCW	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	REMARK
MSI-274-001 S72K	11753	10	0.013	0.002	0.030	0.0	
	11761		0.011		0.030		
MSI-344-008 C52K	9118	1/2	0.015	0.002	0.017	0.006	
	9128		0.013		0.011		
MSI-345-003 C52K	9754	1/2	Deleted				
	11355						
RCI-097-001 C56K	7405	10	0.016	0.004	0.013	0.017	
	10813		0.012		0.030		
RHI-010-004 S22K	17761	1	Deleted				
	17796						
RHI-016-700 S22F	16920	3	NA	—	0.012	0.004	
	16925		NA		0.008		
RHI-024-006 S22K	12908	3	NA	—	0.008	0.003	
	12912		NA		0.011		
RHI-024-012 S22F	22973	1	Deleted				
	24245						
SAX-019-038 A35K	12018	1	0.008	0.001	0.010	0.001	
	12019		0.007		0.009		
SAX-019-703 A35K	26380	1/4	0.016	0.009	0.014	0.008	Δg > ½ (0.017)
	26381		0.007		0.022		
SBI-060-020 S55K	12004	3	NA	—	0.015	0.001	
	11979		NA		0.016		
SBI-060-028 S55K	16951	3	NA		0.015	0.01	
	16980		NA		0.005		
SFX-031-011 F53K	12022	3	NA		0.019	0.011	
	16994		NA		0.008		

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15454	NEC)	GENX-242	—	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	HOT	ACT LEVEL G	Δ G	LOCK MOTION IN	Δ IN	
S11-029-053 Y32F.	10156 10159	35	0.003 0.006	0.003	0.020 0.016	0.004	3 1/4 0.003
S11-031-022 Y32F	4918 4919	10	0.015 0.015	0.0	0.011 0.012	0.001	
S11-031-071 S32F	28437 28453	3	0.001 0.004	0.003	0.018 0.022	0.004	3 1/2 0.001
S11-051-015 C42F	14568 14580	1	0.009 0.007	0.002	0.019 0.021	0.002	
S11-072-005 S32F	15087 27974	3	NA 0.005	—	0.018 0.026	0.008	
S11-087-016 C42F	14488 16487	3	NA NA	—	0.015 0.011	0.004	
S11-178-747 A32F	27616 28611	1/4		DELETED			
SW1-001-017 F33F	5308 5309	10	0.014 0.014	0.00	0.010 0.010	0.0	
SW1-002-019 F33F	5306 5307	10		DELETED			
SW1-004-011 A33F	7107 7110	3	Deleted				
SW1-011-026 F33F	5300 5301	10	0.012 0.015	0.003	0.011 0.010	0.001	
SW1-011-027 F33F	7055 7057	3	Deleted				
SW1-012-023 F33F	4332 5329	10	0.011 0.012	0.001	0.010 0.011	0.001	

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

▲ 5010.55

CALCULATION IDENTIFICATION NUMBER				PAGE 28
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
15454	N/E (C)	GENX-242	-	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	
SW1-012-026 E33F	7129	3	NA		0.019	0.00	
	7130		NA		0.019		
SW1-013-005 A33F	7120	3	NA		0.014	0.00	
	7121		NA		0.014		
VA1-005-030 C72C	21831	1	0.008	0.003	0.026	0.002	$g > \frac{1}{2}$ 0.005
	21883		0.005		0.024		
VAX-005-716 A73F	16483	3	NA		0.013	0.003	
	16484		NA		0.016		
WPX-542-004 A55F	17797	1	0.009	0.003	0.021	0.001	
	17836		0.006		0.022		
CC-1-RB-001-003 -3	19511	1/4	0.017	0.001	0.009	0.009	
	26359		0.016		0.018		
CC-1-RB-009-001 -3	28088	1/4	0.014	0.004	0.020	0.018	
	35229		0.018		0.002		
CC-1-RB-033-008 -3	10547	1/4	Deleted				
	10548						
CC-1-RB-039A-001 -3	19336	1/4	0.011	0.005	0.017	0.003	
	19478		0.016		0.014		
CS-1-RB-004-014 -2	20357	1/4		DELETED			
	20363						
CS-1-RB-004-017 -2	11375	1/4		DELETED			
	34459						
DO-1-DA-007-011 -3	28642	1/4	0.012	0.006 N.G.	0.022	0.006	$g > 0.005$
	28652		0.018		0.028		
SW-1-SB-004B -020-3	15413	1/4	0.013	0.004	0.015	0.002	
	19853		0.017		0.013		

CH-1-CPO-1949

Job No. 15454

ATTACH-A PAGE 1 OF 1

15454-NZ(C)-GENX-242

Chrono File R2.1.15
Job Book

STONE & WEBSTER ENGINEERING CORPORATION

Time 9:00 a.m.

COMANCHE PEAK STEAM ELECTRIC STATION
UNIT 1 J.O. No. 15454
TELEPHONE MEMORANDUM

Date 5/21/87

Incoming
Outgoing ✓

Between T. GNWALA/S. ALI of SWEC and F. FEDRICKSON of PECIFIC SCIENTIFIC

Subject PARRELLEL SNUBBERS.

THE JOB BOOK NUMBER MUST BE PLACED IN UPPER RIGHT

SUMMARY

(1) T. Gnwala asked F. Fedrickson whether to consider tolerances at the pin in calculating differential lost motion of 0.02 as specified in Nuclear Standard NE E7-9. F. Fedrickson stated that the standard specifies differential lost motion of 0.02 and is applicable only to the lost motion internal to the Snubber. Therefore the tolerance shall not be considered.

(2) S. Ali inquired about the impact of exceeding the differential activation level of 0.005 g specified in Nuclear Standard.

F. Fedrickson replied that the effect of differential activation level is not critical & is not normally matched for parallel snubbers.

Action Assigned:

COPIES TO:

F. Fredrickson
Pacific Scientic

✓ RPKlause	JAchacoso	✓ E. EVANS
KYChu	TYChang	✓ S. ALI
✓ AWChan	CButt	✓ T. Gnwala
RWrucke		

ATTN: G 15454 NEC) - 35NX-242

Kin-Tech Division

Pg 1 OF 15

PACIFIC SCIENTIFIC

COVER SHEET FOR FAX

DATE: 5/13/87

FROM: Lee Camacho

DIVISION: Engineering

TO: Jim Walla

COMPANY: Comanche Peak Stone Webster

TELEPHONE # 609-422-4020

TELECOPY #

# of PAGES: Cover Sheet + 3

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FAX OPERATOR: Doris

TIME: A.M. 1:00 P.M.

1346 S. State College Boulevard, Anaheim, California 92803, (714) 774-5217, TELEX 65-6421

ATT- 12

15454 NAC(C). GENX-242

Pg 8 of 15

1.0 PURPOSE

1.1 To assure compliance of production units of the Shock Arrestor Assembly with referenced drawings.

2.0 SCOPE

2.1 This test establishes both visual and functional characteristics which could be expected to vary through dimensional variation or improper assembly and adjustment.

3.0 REFERENCE DOCUMENTS

3.1 PSCo Drawings 1801107 and 1801117

4.0 EQUIPMENT

4.1 1801TF-2 Universal Shock Arrestor Tester

4.2 Holding Fixture 1801 HF-1

4.3 Holding Fixture 1801 HF-2

4.4 .0001 Dial Indicator

5.0 INDIVIDUAL TESTS

5.1 Examination of Product

5.1.1 Each unit shall be subjected to a dimensional examination to determine compliance with applicable Sales assembly drawing.

5.1.2 Each unit shall be visually inspected to assure completeness of assembly, freedom from burrs and sharp edges, alignment of parts, security of fasteners, and dimensional integrity.

5.1.3 Units shall be visually inspected for general appearance of plating, painting, freedom from nicks and damage of finishes.

5.1.4 Units shall be inspected to assure the accuracy and legibility of marking and identification.

6.0 FINAL FUNCTIONAL TESTS

6.1 Breakaway Friction Force (100 lbs. max.)

6.1.1 Install unit in 1801 HF-1 Holding Fixture and the starting force in both the extension and retraction modes measured with a spring scale. Load measured shall not exceed 100 pounds. Starting

force shall be measured at three (3) positions throughout entire travel in both directions of extension and retraction. Approximate positions for force check are one (1) inch from either end and mid position. At each position the starting force shall not exceed 100 pounds.

6.2 Lost Motion (.040 max.)

6.2.1 Install the snubber on the 1801 HF-1 Fixture and adjust the dial indicator such that it will record movement at the clevis end of the snubber. With the snubber extended at approximately its mid-position, hold the inertia mass stationary using hand pressure and apply a load of 120 lbs. to the snubber, zero out the indicator, and apply a reverse load of 120 lbs. to the snubber while maintaining hand pressure to prevent movement of the inertia mass. Relative movement noted on the dial indicator shall not exceed .040 inch. (A)

6.3 Acceleration/Load Test

6.3.1 The unit shall be installed in the 1801 TF-2 Universal Shock Arrestor Tester with the unit extended approximately midway from full extension. The 1801 TF-2 Tester pressure gage shall be set for 130 PSI, which is equal to 13,750 lbs. load. (C) With the required pressure applied to the unit, the time as recorded by the timer for the snubber to extend 1" shall be .51 sec. minimum. This test shall be repeated by retracting the unit and again the minimum time recorded shall be .51 second. (A)

ATT. 1B 5454 NECO GEOY-242

REPORT NO. IT-535
PAGE 4 OF 6
Rev. D

ADDENDUM Pg 10 OF 15

Final Inspection Check List

PSCo 1801107
1801117

Shock Arrestor

Ref. paragraphs refer to paragraphs from this procedure, I.T. 535

Part No._____ Serial No._____

PSCo P.O. No._____ Date_____

Shop Order No._____ Customer_____

I. Visual Examination (para. 5.1)

(a) Dimensional (Actual dim. listed on Page 5 of 6)..... ☐

(b) Workmanship..... ☐

II. Final Functional Tests

(a) Breakaway Friction Force (100 lbs. max.)(para. 6.1) _____ Actual

(A) (b) Lost Motion (.040 max.)(para. 6.2).....Actual_____

(c) Acceleration/Load Test (.51 sec. min./1.000 travel) (para. 6.3)

Actual Time
Extending_____

Retracting_____

Inspector_____

Stamp_____ Date_____

Kin-Tech Division

PACIFIC SCIENTIFIC

COVER SHEET FOR FAX DATE: 6-12-87

FROM: LEE CAMACHO
DIVISION: KIN-TECH

TO: GIN WALLA TELEPHONE (609) 482-4140
COMPANY: COMANCHE PEAK STONE & WEBSTER TELECOPY (609) 482-4029

# of PAGES: Cover Sheet + 4
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FAX OPERATOR: Gloria
TIME: 9:00 A.M. _____ P.M.

ATT-B
(5454 N76)-GENK-242 Pg 1 of 15

REPORT NO. DR 1432

DATE 17 October 1977

DATA REPORT 1432

TEST EVALUATION OF PSA-10 SNUBBER ON ECCENTRIC TYPE FIXTURE (1801103-TF-2)

FROM

PACIFIC SCIENTIFIC
KIN-TECH DIVISION

PREPARED BY

Ramon Arriaza

R. Arriaza
Sr. Designer

APPROVED BY

J. E. Glauser
Director of Engineering

REV	DATE	BY	APPD BY	PAGES AFFECTED	
2	12-17-77				

This test is intended to replace the acceleration test currently performed on PSA-10 Snubbers (1801-TF-2).

The Eccentric Type Test Fixture consists of an eccentric shaft that fits the spherical bearing of the snubber and drives the snubber with a reciprocating motion. The shaft is driven by a constant torque gear motor through a roller chain drive. The sprocket at the gear motor rotates at 41 RPM and the sprocket at the eccentric shaft rotates at 76 RPM (1.85 ratio) when there is no load (snubber not installed). The sprocket at the eccentric shaft is mounted on a friction type clutch. When the snubber is installed, the gear motor attempts to drive it at 76 RPM, equal to .049 g's. The snubber tries to contain this reciprocating motion to less than .02g. The braking action of the snubber creates a difference in RPM of the eccentric shaft. This difference in RPM is an overload taken by the friction switch installed in the eccentric shaft. A counter records the rotation of the eccentric shaft, in conjunction with an internal timer which allows the tester to run for a preset amount of time (1 min or 30 sec).

The readings obtained are RPM and they can be translated into g's. The following results were obtained on a test run of 108 units and compared to their respective acceleration times.

Snubber Qty	RPM	AAT*	Percentage
7	20	1.03	6.48
8	23	.92	7.41
6	26	.89	5.56
3	28	.88	2.77
12	30	.81	11.11
11	32	.75	10.19
7	34	.71	6.48
11	36	.72	10.19
12	38	.70	11.11
16	40	.67	14.82
9	42	.65	8.33

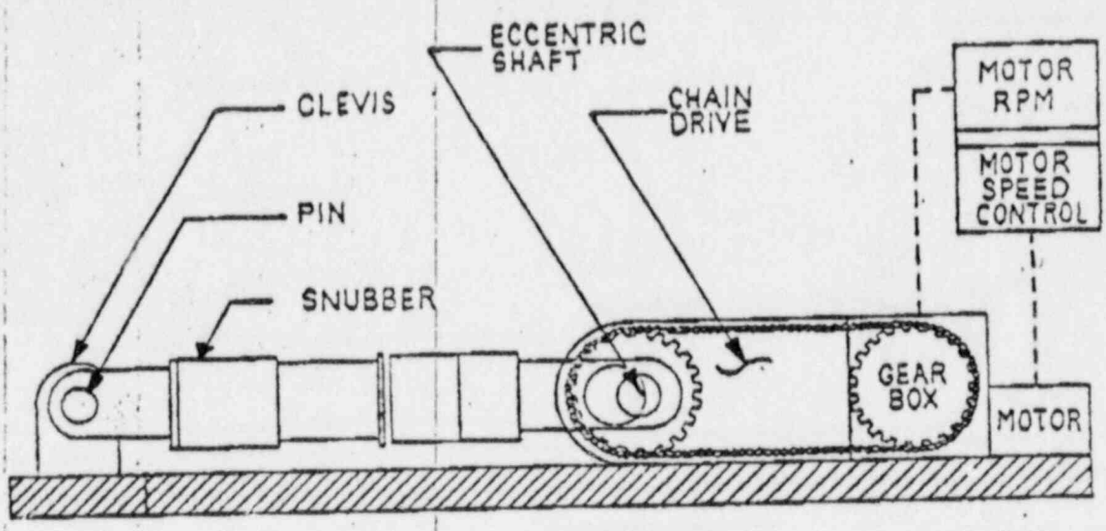
Snubber Qty	RPM	AAT*	Percentage
4	44	.62	3.7
2	50	.53	1.85

*AAT = Average acceleration time of the extension and retraction cycle for the total number of snubbers in the same RPM group.

Based on the above, a value of 44 RPM will be used as an acceptable criteria, with the option of using the standard acceleration tester as an alternate test method for snubbers exceeding 44 RPM. It is also recommended that those units with readings below 20 RPM be inspected closely.

20 → 44 GOOD
→ LOOK.
LOOK. ←

(5454.020) GEN X-24E



$$\text{MAX. } f_{(rpm)} = \sqrt{\frac{G's}{.1022 \times .300"}} \times 60$$

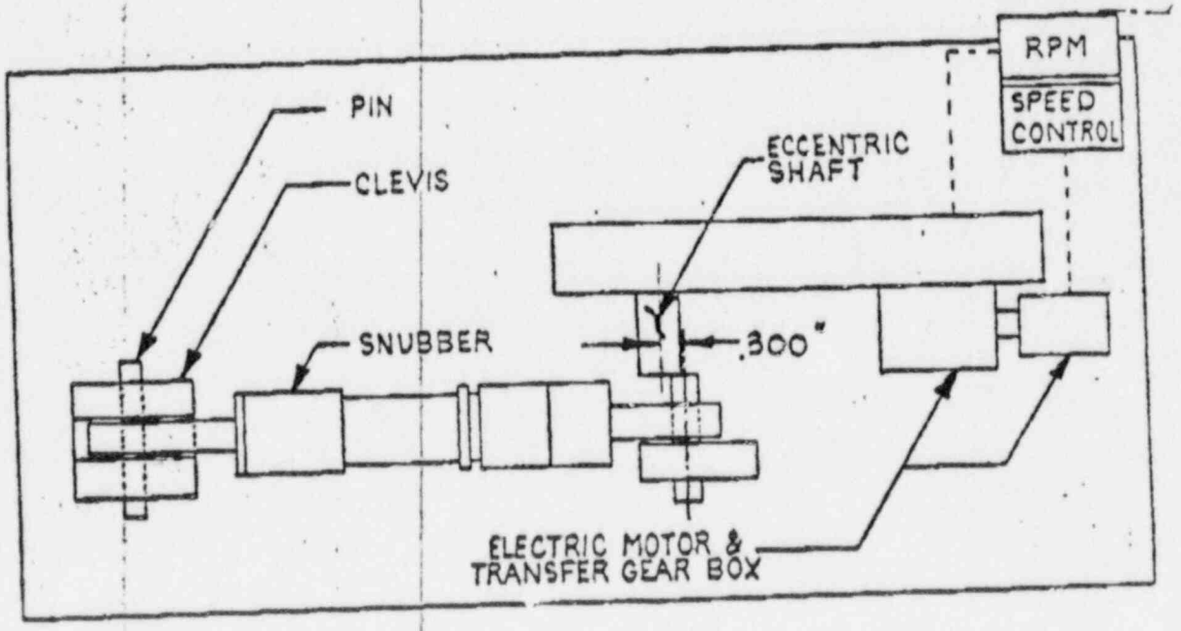


FIG. 3
MODEL PSA 10

C. INMAN

ATT-C 1545A-N2(6)-GENX-242

INTEROFFICE CORRESPONDENCE

TO: HAROLD MOSCOW	LOCATION NYOC/36	SUBJECT / REFERENCE / J.O. NO. 15454O5
FROM: T. GINWALA / S. ALI	LOCATION 3GR	PARALLEL SNUBBERS.

MESSAGE: —

PLEASE REVIEW THE ATTACHED LIST OF PARALLEL SNUBBERS (ON UNIT 1) AND INFORM US IF ANY OF THESE SNUBBERS ARE DELETED BY 5/15/87

5/11/87 (DATE)

T. Ginwala / Syed A. Ali (SIGNATURE) A140. (TELEPHONE)

REPLY:

Gerald
Please respond to
the above request -
Harold H 5-15-87

Mrs. Ginwala, should you have any
question, please call Steve
Schwartz x6083 NYO.
Finish Date →
5/21/87

DATE SIGNATURE TELEPHONE

▲ 040.138

ATT-C 15454-NZ(C)-GENX-242

STONE & WEBSTER ENGINEERING CORPORATION

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CALCULATION SHEET

▲ 5010 85

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 1

23 x 13 x 2 = 598 PAIRED SNUBBERS COMMENTS OR PROB # DELETED EXIST (V) ~~AF = DIFF (DELETED)~~

SUPPORT NO	SNUBBER NO	MODEL	~~ACT LEVEL~~ G	~~A~~ GT	~~LOST MOTION~~ LM	Δ IH	PSE IWE 102-1T
CS-1-106-720-C42K	9075 9078	1/2				NOT IN HITS LISTINGS	1 2 102
RC-1-134-703 C52K	16159 15329	1/4				NOT IN HITS LISTINGS	1 0 102
RH-1-SB-012 002-2	11404 9737	1/2	1-074	✓		PSE 514 NO SA	1 0.
RH-1-SB-012 004-2	9720 9736	1/2	1-074	✓		PSE NO SA 514	1 0.
AF-1-096-009 533K	17525 23008	1	010C	✓		PSE 1190	1 0. SA-1-256
AF-1-096-020 533K	19536 19537	1/4	010C		SNUBBER MOD TO RY	SA-1-256 MOD.	1 0.
FW-1-091-700 562K	10186 10746	10	010C	✓		PSE 1190	1 0 102 SA-1-256
AF-1-099-005 543K	16505 16506	3	012D		SNUBBER MOD TO RY.	SA 1-187 MOD	1 0 102
AF-1-099-002 533K	17526 24254	1	012D	✓		PSE 1190	1 0 102
AF-1-099-007 533K	9832 10309	1/2	012D		SNUBBER MOD TO RY	SA-1-187 MOD	1 0 102
AF-1-099-033 543K	24269 24299	1	012D		SNUBBER MOD TO RY	SA-1-187 MOD	1 0 102
FW-1-092-700 562K	11717 11745	10	012D	✓		PSE 1190	1 0 102 SA-1-187
AF-1-059-700 562K	15041 24126	1	012E	✓		CPPA 57,629	1 0 102 SA-1-162

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

▲ 5010.65

CALCULATION IDENTIFICATION NUMBER				PAGE 2
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	~~ACT LEVER~~ PROB^B	~~A~~ DELETED	~~LOST MOTION~~ COMMENTS OR EXIST (✓)	Δ IN	PROB^B (C)-A
AF-1-101-007 S331C	28085 29092	1/4	012E		SNUBBER MOD. TO R2	SA1-162 MOD	(C)-B
S1-1-051-028 C42K	17818 18053	1	014			HOC 2999-1 NCMR	(C)-B
S1-1-087-012 C42K	8380 8414	3	016		MOD IN FIELD	WPT 8425	(C)-B
S1-1-097-017 C42K	1903B 19042	1	016		MOD IN FIELD	WPT 8425	(C)-B
S1-1-099-009 C42K	19044 22062	1	017D		✓	PSM-1-1733	(C)-B
S1-1-099-010 C42K	14919 8370	3	017D		MOD IN FIELD	WPT — MOD/	(C)-B
S1-1-181-003 C41K	15063 15073	10	017C		MOD IN FIELD	WPT 8380 MOD/-	(C)-B
S1-1-306-024 C42K	29099 29099	1/4	018		MOD IN FIELD	WPT 8433 MOD/ST.	(C)-B
S1-1-306-028 C42K	17780 18043	1	018		MOD IN FIELD	WPT 8433 MOD/ST	(C)-B
S1-1-306-029 C42K	17795 19132	1	018		MOD IN FIELD	WPT 8433 MOD/ST	(C)-B
S1-1-306-031 C42K	17805 1912E	1	018		MOD. IN FIELD	WPT 8433 MOD/-	(C)-B
RH-1-001-009 C41K	27948 27950	3	013A	✓		PSE 418	(C)-B
RH-1-001-010 C41K	4890 4901	10	013A	✓		PSE 418	(C)-B

(5452-N2(c)-GENX-242

ATT-2

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Pg 4 of 27

J10.85

CALCULATION IDENTIFICATION NUMBER				PAGE 3
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	

PAIRED SNUBBERS

COMMENTS OR EXIST(V) PROB DELETED

SUPPORT NO	SNUBBER NO	MODE	~~ACT LEVEL~~ G	~~A~~ G	~~LOST MOTION~~ LM	Δ IN	PERM. 10C-A
RH-1-002-009 C41K	10502 27954	3	013B		HOLD		1 C 10
RH-1-002-012 C41K	10053 10762	10	013B		MOD IN FIELD	WPT 8441 MOD	1 C 10
CT-1-009-007 522K	10781 7378	3 10	027	~~E~~ T	~~LOST~~	SA-1-121	
CT-1-009-008 522K	10295 12742	1	027	✓		CPPA SA449	1 C 10 SA-1-121
CT-1-010-010 522F	21000 21004	3	027	✓		CPPA SA449	1 C 10 SA-1-121
CT-1-007-010 522K	10790 10797	3	031		SNUBBER MOD. TO Rx	SA-1-068 MOD	1 C 10
CT-1-013-007 522K	12344 12357	1/2	032		SNUBBER MOD. TO Rz	SA-1-100 MOD	1 C 10
CT-1-014-012 542K	16469 16513	3	033	✓		CPPA 54921	1 C 10
CT-039-428 C42K	9933 10350	1/2	035D		KSK MOD. TO KSK	SA-1-14 MOD	1 C 10
CS-1-001-015 C42K	8517 8518	1/2	041	✓		CPPA SA565	1 C 10
CS-1-079-022 C42K	11390 11412	1/2	043B	✓		PSE 265	1 C 10
RC-1-115-011 C76K	10431 11619	10	053		✓	PSM-1 1731 MOD	WPT 8411 1 C 10
RC-1-015-051 C51K	20305 24190	10	053D		✓	PSM-1-1687 MOD	1 C 10

▲ 5010 65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 4

PAIRED SNUBBERS COMMENTS Prob# Delete EXIST (✓)

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL ℄	Δ ℄	LOST MOTION IN	Δ IN	
CC-1-259-007 C53K	34442 34448	1/4	055B		Mod. To RY	SA-1-171 Mod.	
CC-1-212-005 C53K	12024 12025	1	055C		KY Mod To KY	SA-1-172 Mod	
CC-1-218-012 C53K	10792 10793	1/4	055C		KX Mod. To KX	SA-1-172 Mod	
CC-1-215-012 C53K	10789 19240	1/4	059A	✓		PSE 640	SA-1-239
CC-1-009-021 A33K	26507 26509	3	062B		Mod To RX	SA-1-164 Mod	
CC-1-010-003 A43K	16525 16526	3	062B		Mod To SX	SA-1-164 Mod	
CC-1-043-011 A43K	15987 16462	3	062B		Mod To SX	SA-1-164 Mod	
CC-1-013-017 A43K	4294 4298	10	062B		Mod. To RX	SA-1-164 Mod	
CC-1-156-002 A53K	8356 8359	3	064B	✓		CPPA 57666	SA-1-163
CC-2-044-700 A43K	11724 11765	10	066B				
CC-2-045-703 A33K	12956 14920	3	066B	✓		CPPA 5766A	
RH-1-007-003 S22K	11497 16547	3	069		Mod SX To SX	SA-1-176 Mod	
SI-1-071-004 S32K	15956 15957	3	069		Mod SX To SX	SA-1-176 Mod	

A 5010.65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 5

PAIRED SNUBBERS COMMENTS OR PROB# DELETE EXIST

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PERM = .02 - ΔT
RH-1-024-009 S22K	10517 10518	3	070		MOD Sx To Sx	SA-1-177 MOD.	.0102
MS-1-074-015 C52K	8400 8401	1/2	075		MOD K_2 To K_2	SA-1-201 MOD.	.0102
MS-1-074-014 C52K	8373 8374	1/2	075		MOD K_2 To K_2	SA-1-201 MOD.	.0102
MS-1-151-020 C52K	10756 10757	1/4	076A	✓		PSE 541	.0152 SA-1-202
MS-1-151-032 C52K	12558 19554	1/4	076B	✓		PSE 1190	.0102 SA-1-230
MS-1-151-040 C52K	10378 10391	1	076B	✓		PSE 1190	.0102 SA-1-230
MS-1-151-043 C52K	8909 8911	1	076B	✓		PSE 1190	.0102 SA-1-230
MS-1-150-032 C52K	34451 35231	1/4	077		MOD K_{SK} To K_{SK}	SA-1-229 MOD	.0102
MS-1-150-050 C52K	35219 35231	1/4	077		MOD. To Rx	SA-1-229 MOD	.0102
MS-1-344-004 C52K	21891 24214	1	077		MOD K_2 To K_2	SA-1-229 MOD.	.0102
MS-1-345-004 C52K	9790 9791	1/2	078		MOD S_2 To S_2	SA-1-241 MOD	.0102
MS-1-029-029 S33K	17809 19124	1	080B		MOD. To Rx	SA-1-205 MOD.	.0102
DO-1-033-001 S63K	5546 5229	10	167C		MOD. S_2 To S_2	SA-1-212 MOD	.0102

15454-NZ(C)-GENK-242 ATT-C

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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▲ 5010.65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 6

PAIRED SNUBBERS Pros# Deleted — COMMENTS OR EXIST.(✓)

SUPPORT No	SNUBBER No	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PERM = .02 − ΔT
VA-1-005-016 C92K	12680 12697	1	180		Mod To Rst	SA-1-217 Mod	.0102
VA-1-005-018 C92K	10373 21792	1	180	✓		PSE 840	.0102 SA-1-217
FW-2-094-404 S62K	15078 26961	3					.0102
S1-2-051-412 C42K	12706 15891	1					.0102
S1-2-051-413 C42K	20607 20614	1					.0102
S1-2-095-413 C42K	24649 24664	3					.0102
S1-2-087-411 C42K	13012 20250	1					.0102
S1-2-087-412 C42K	20177 20196	1					.0102
S1-2-087-417 C42K	20183 20640	1					.0102
S1-2-090-403 C41K	6329 6339	3					.0102
S1-2-089-409 C42K	20646 20687	1					.0102
S1-2-088-410 C42K	482 605	1L					.0102
S1-2-306-426 C42K	16467 16471	1					.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 7

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PERM = .02 LT
RC-2-135-405 C42K	15190 15195	10					.0102
RH-2-002-409 C44K	2910 3799	3					.0102
CT-2-051-408 C72K	12995 24535	3					.0102
WP-2-030-422 C46K	16454 16463	1					.0102
CS-2-001-415 C42K	21816 21817	1					.0102
CS-2-001-417 C42K	12694 15916	1					.0102
RC-2-052-428 C41K	19045 19054	1					.0102
CS-2-079-422 C42K	20187 20292	1					.0102
CS-2-079-411 C42K	21481 21735	1					.0102
CS-2-079-414 C42K	20624 21719	1					.0102
RC-2-115-411 C76K	15808 15809	10					.0102
RC-2-115-431 C56K	15776 15779	10					.0102
MS-2-344-404 C52K	19131 19132	1					.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 8

PAIRED SNUBBERS COMMENTS: PROBE DOUBLE EXIST (V)

SUPPORT NO	SNUBBER NO	MODE	~~ACT LEVEL~~	~~LOAD~~	~~LOAD~~	~~LOAD~~	PERMS .02-AT
MS-2-344-407 C52K	10453 21121	1					.0102
SB-2-023-406 E25K	10754 21348	3					.0102
AF-1-001-017 533K	15995 15994	3	011A		✓ REVISED SNUBBER SIZE	PSM 1-5543 MOD/ST	.0102
AF-1-001-021 Y33K	13041 24102	1	011A		✓ REVISED SNUBBER SIZE	PSM-1-1742 MOD/-	.0102
AF-1-096-013 533K	21817 21824	1	010C		SNUBBER MOD. TO Rx	SA-1-256 MOD	.0102
AF-1-096-041 543K	19539 19540	1/4	010C		SNUBBER MOD TO Ry	SA-1-256 MOD	.0102
AF-1-096-049 553K	11809 2100	1/2	010C		SNUBBER MOD. TO Rx	SA-1-256 MOD	.0102
AF-1-097-013 563K	14604 14612	1	010C		SNUBBER MOD TO Rz	SA-1-256 MOD	.0102
AF-1-097-044 553K	29055 29068	1/4	010C		SNUBBER MOD. TO Rx	SA-1-256 MOD	.0102
AF-1-096-030 533K	10257 10335	1/2	010A		IN PREP.		.0102
AF-1-102-002 543K	9450 9455	1/2	010B		SNUBBER MOD. TO Ry	SA-1-255 MOD	.0102
BRX-044-008 A53K	10468 10537	1/2	090		✓	PSC/1.090-4	.0102
CC1-008-015 A33K	9232 9242	3	062B	✓		CPPA 57.666	.0102 SA-1-164

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CALCULATION IDENTIFICATION NUMBER				PAGE 9
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	

PAIRED SNUBBERS COMMENTS
PROP DELETED EXIST (✓)

SUPPORT NO	SNUBBER NO	MODEL	~~ACI~~ LEVEL G	~~A~~ G	~~LOST~~ MOTION TN	Δ IN	PERM = .02-ΔT
CC1-017-010 A33K	15943 21018	3	061B		✓	PSC/Y	.0102
CC1-025-004 A33K	4744 4798	35	061A		✓	PSC-1-061A-1	.0102
CC1-029-022 S33K	6451 6631	35	061A		✓	PSM-1-1225	.0102
CC1-025-713 S33K	11611 11617	10	061A		✓	PSC/Y	.0102
CC1-043-015 A43K	15955 15959	3	062B		MOD TO RX	SA-1-164 MOD	.0102
CC1-043-029 A43K	10717 10719	10	062B		✓		.0102
CC1-043-030 A33K	11574 11575	35	062B		✓	PSM-1-0090	.0102
CC1-065-005 S33K	26559 26561	3	061C		SENT TO FIELD VIA I.O.C METHOD		.0102
CC1-066-013 S33K	14703 14710	10	062B		✓	PSC-1-0628	.0102
CC1-078-005 S33K	14032 14033	3	061C	✓		SA-1-182	.0102
CC1-105-012 E33K	20325 20362	1/4	061C		SUPPT. TO BE REEVALUATED	PSM 1-0350	.0102
CC1-191-015 C42K	25038 25041	1/4	058		✓ REVISED SNUBBER SIZE	PSM-1-1442	.0102
CC1-211-004 C53K	10791 15359	1/4	055C		MOD. TO RY	SA-1-172 MOD	.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 15

PAIRED SNUBBERS COMMENTS OR PROBLEM DELETED EXIST (√)

SUPPORT NO	SNUBBER NO	NOM	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PERMA .02-.1T
CC1-218-003 C53F	10777 10778	1/4	055C		MOD. TO RX	SA-1-172 MOD.	.0102
CC1-218-009 C53F	10779 10780	1/4	055C		MOD. TO RX	SA-1-172	.0102
CC1-218-016 C53K	25064 25069	1/4	055C		✓	PSC-1-055C-5	.0102
CC1-240-005 C53F	24180(A) 24117(B)	?	055B	✓		PSE 541	SA-1-171
CC1-255-009 C53F	16906 16907	3	056A	✓		PSE 640	.0102 SA-1-174
CC1-265-003 C53K	16156 16162	1/4	055B		✓	PSC-1-055B	.0102
CC1-271-004 C53F	15355 19262	1/4	055D		✓	PSM-1-535	.0102
CC1-272-009 C53F	19946 19990	1/4	055C	✓		CPPA 57629	.0102 SA-1-172
CCX-066-014 A75F	6159 6161	3	063A	✓		PSE 840	.0102 SA-1-249
CCX-066-017 A75F	21034 26497	3	063A		✓	PSC-1-063A-6	.0102
CII-016-024 545F	2181 2184	1/2	N061	✓		PSE 404	.0102 SA-1-037
CS1-018-017 552F	12998 12999	3	N068		✓	PSC-1-N068-4	.0102
CS1-242-709 A42F	12698 12699	1	N019		✓	PSC-1-N019-1	.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 11

PAIRED SNUBBERS COMMENTS PROB# DELETED OR EXIST(✓)

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	P=ΣM= 102-CT
CS1-315-024 S53K	12999 13000	3	N012	✓		PSE 840	.0102 SA-1-270
CS1-333-017 S53K	12671 12670	?	N066	✓		PSE 840	SA-1-052
CT1-014-022 S52K	10360 13031	1	033		✓	PSM-1-1533	.0102
CT1-014-404 C52K	12035 12036	1	037W		✓ REVISED SNUBBER SIZE	PSM-1-0252	.0102
CT1-014-412 C72K	10704 10732	10	037W		✓ REVISED SNUBBER SIZE	PSM-1-0021	.0102
CT1-014-431 C52K	15143 15145	10	037W		POTENTIAL MOD.	SA/Y MOD	.0102
CT1-021-004 S22K	26371 26372	1/4	028		✓		.0102
CT1-024-003 S22K	16792 16793	3	027		MOD TO RX	SA-1-121 MOD	.0102
CT1-024-004 S22K	14893 14890	3	027		✓ REVISED SNUBBER SIZE	PSM 1-1114	.0102
CT1-025-007 S22K	14898 14899	3	028		✓	PSC/Y	.0102
CT1-029-023 C92K	18006 18007	1/2	029K	✓		PSE 640	.0102 SA-1-237
CT1-031-015 C92K	26122 26123	1/4	029M		MOD. BY FIELD	PSM-1 0380	.0102
CT1-031-019 C92K	26402 26407	1/4	029M		MOD. BY FIELD	PSM-1-0355	.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 12

PAIRED SNUBBERS COMMENTS OR PROB# DELETED EXIST (V)

SUPPORT NO	SNUBBER NO	MODEL	~~ACI LEVEL~~ G	A G	~~LOST MOTION~~ IN	Δ IN	PERM = .02-LT
CT1-034-019 C52K	9781 11792	1/2	036		MOD TO RSK	SA-1-106	.0102
CT1-034-020 C52K	10525 11372	1/2	036		MOD. TO RSK	SA-1-106	.0102
CT1-038-437 C42K	20327 20426	1/4	035A		MOD. TO RSK	SA-1-208	.0102
CT1-002-003 532K	11978 11989	3	031		MOD TO RY	SA-1-068	.0102
CT1-007-007 522K	10763 16929	3	031		MOD TO RY	SA-1-068	.0102
CT1-009-004 522K	12031 12995	1	027		MOD. IN FIELD	PSM-1-0221	.0102
CT1-012-007 522K	14888 14889	3	028		✓		.0102
CT1-013-023 542K	4914 4915	10	032		✓	PSM-1-1381	.0102
CT1-013-414 C52K	3291-3 3291-4	3	035A		✓	PSC-1-035A-4	.0102
CT1-013-415 C62K	9203 9209	10	035A		MOD TO RY		.0102 SA-1-208
CT1-013-416 C52K	12016 12019	3	035A		MOD. IN FIELD	PSM-1-1481	.0102
CT1-013-418 C52K	25857 25861	3	035A		MOD TO RSK	SA-1-208	.0102
CT1-014-008 542K	4356 4361	10	033		HOLD		.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 13

PAIRED SNUBBERS

COMMENTS OR EXIST (✓)

SUPPORT No	SNUBBER No	Mode	ACT LEVEL G	Δ G	LOST MOTION TH	Δ IH	PERM = .02 - ΔT
CT1-014-010 S42K	9234 9235	10	033		Mod IN FIELD	PSM-1 0235 Hold Ref	.01 Ω
CT1-014-016 S32K	10769 10770	3	033		✓	PSM-1-0277	.01 Ω
CT1-033-441 C52K	27599 29654	1/4	035A		✓	PSC-1-035A-7	.01 Ω
CT1-039-443 C42K	19963 19969	1/4	035A		✓ REVISED SNUBBER SIZE	PSM-1-1158	.01 Ω
CT1-044-022 C92K	10268 10358	1/2	29L	✓		CPPA 57624	.01 Ω SA-1-070
CT1-046-006 C52K	12039 12038	1	029N		✓	PSM-1-0145	.01 Ω
CT1-046-011 C92K	8375 8999	1/2	029N	✓		CPPA 54938	.01 Ω SA-1-049
CT1-046-016 C92K	29559 29655	1/4	029N	✓		SA-1-049 MOD	.01 Ω
CT1-049-007 C52K	10078 10234	1	037B		✓		.01 Ω
CT1-049-008 C82K	9819 10306	1/2	037W		Mod To RSK	SA-1-265 MOD.	.01 Ω
CT1-049-010 C82K	20359 20353	1/4	037W		Mod. To RSK	SA-1-265 Mod	.01 Ω
CT1-049-404 C52K	16176 16177	1/4	037W		✓ REVISED SNUBBER SIZE	PSM-1-0304	.01 Ω
CT1-051-415 C72K	16795 16917	3	037W		✓	PSM-1-1612	.01 Ω

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CALCULATION IDENTIFICATION NUMBER				PAGE 14
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	COMMENTS OR EXIST (✓) PROB # DELETED
CT1-051-416 C72K	14598 14609	1	037W		✓	PSC/4	.010Z
CT1-051-417 C72K	14556 14563	1	037W		✓	PSC/4	.010Z
CT1-051-418 C72K	12313 12352	1/2	037W		✓	PSC/4	.010Z
CT1-051-419 C72K	14590 14592	1	037W		✓	PSC/4	.010Z
CT1-054-435 C42K	16180 16181	1/4	037Z	✓		CPPA S4921	.010Z SA-1-129
CT1-074-410 C82K	19980 19963	?	037W	✓		PSE 1917	SA-1-265
CT1-075-406 C62K	12041 12042	1	037W		✓ REVISED SNUBBER SIZE	PSM-1-0264	.010Z
CT1-076-404 C82K	14572 14582	1	035A		✓ REVISED SNUBBER SIZE	PSM-1-5509	.010Z
CT1-076-408 C82K	12017 12020	3	035A		✓		.010Z
CT1-077-407 C72F	12010 12013	3	035A		MOD. TO R4	SA-1-208 M.O	.010Z
CT1-097-403 C52K	12043 12044	1	037W	✓		CPPA 1917	.010Z SA-1-265
CT1-097-414 C42K	19942 19947	1/4	037W		HOLD	PSM-1-(NO 1397	Release Date) .010Z
CT1-117-412 C62K	12354 12393	1/2	037W		✓ REVISED SNUBBER SIZE	PSM-1-0069	.010Z

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 15

PAIRED SNUBBERS COMMENTS PROB # DELETED OR EXIST (V)

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PER N= .02-AT
CT1-117-415 C62K	19194 24201	1	037W	✓		PSE 1917	.0102 SA-1-265
CT1-124-415 C72K	12645 12646	1	035C		Mod To Rx	SA-1-166 Mod	.0102
CT1-124-416 C72K	8429 8430	1/2	035C	✓		CPPA 57666	.0102 SA-1-166
DD2-003-456 Y36K	28373 28376	3					.0102
DD2-003-457 Y36K	20294 20295	1					.0102
DD2-006-493 536K	7134 7140	3					.0102
D01-029-001 553K	11601 11613		167C		HOLD		
D01-035-001 553K	20998 21009	3	167C		✓	PSM 1-0858	.0102
D01-038-005 563K	6990 7471	35	167C		HOLD		.0102
D01-034-001 553K	16941 16966	3	167C		✓	PSM-1-0695	.0102
D01-040-003 545K	26378 26382	1/4	—		SITE SCOPE PER CPPA 32947		.0102
D01-059-001 553K	16975 21011	3	167F		HOLD		.0102
D01-070-001 553K	16969 16974	3	167F		HOLD		.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 16

PAIRED SNUBBERS

COMMENTS Prob # Deleted or EXIST(J)

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PERM .02
DD1-003-099 S35K	20633 20635	1		—		PROB NO NOT LISTED	.0102
DD1-003-074 S35K	12139 12149	1/2				PROB. NO NOT LISTED	.0102
D01-071-001 S63K	10744 11610	10	167F NY		HOLD		.0102
D01-071-003 S63K	8990 8981	35	167F		HOLD		.0062
D01-071-006 S53K	11624 11625	10	167F		HOLD		.0102
D01-069-004 S65K	12934 12940	10	167C		HOLD		.0102
D01-090-001 S65K	10755 10756	3	167F		HOLD		.0102
D01-090-003 S65K	11605 11626	10	167F		HOLD		.0102
FW1-017-023 C72K	16867 16868	3	007	✓		PSE 2521	.0102 SA-1-266
FW1-017-710 C42K	9374 9379	35	007		✓	PSE-1 5539	.0062
FW1-017-707 C72K	1453 1459	100	007		✓	PSM-1-1757	.0052
FW1-017-709 C72K	1426 1429	100	007		MOD BY FIELD	PSM-1-1744	.0052
FW1-017-712 C72K	1420 1421	100	007		MOD BY FIELD	PSM-1-1772	.0052

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CALCULATION IDENTIFICATION NUMBER				PAGE 17
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	

PAIRED SNUBBERS — COMMENTS OR EXIT (√) — Prob # Deleted

SUPPORT No	SNUBBER No	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IH	PERM = .02
FW1-018-016 C52K	11596 11587	35	006		✓	PSM-1-5553 HOLD	.0042
FW1-018-706 C72K	1454 1457	100	006		✓	PSC-006-1	.0052
FW1-018-705 C72K	1433 1424	100	006		SNUBBER MOD. TO P2	SA-1-165 MOD	.0052
FW1-018-709 C72K	1455 1456	100	006		✓	PSC-1-0064	.0052
FW1-019-701 C42K	8788 8790	35	005		✓ REVISED SNUBBER SIZE	PSM-1-0615	.0062
FW1-020-700 C42K	1427 1432	100	008		✓	PSM-1-5457	.0062
FW1-095-011 C62K	14921 14922	3	152		MOD BY FIELD	PSM 1-1555	.0102
FW1-095-700 C62K	21001 21013	3	152		MOD BY FIELD	PSM-1-1220	.0102
FW1-095-701 C62K	13001 13005	3	152		✓	PSC/4	.0102
FW1-096-700 C62K	12026 21007	3	153		POTENTIAL MOD.	PSM/4	.0102
FW1-096-701 C62K	11984 16904	3	153		IN PREP		.0102
FW1-096-702 C62K	12008 12009	3	153		✓ REVISE SNUBBER SIZE	PSM-1-5252	.0102
FW1-096-704 C62K	16866 16913	3	153	✓		SA-1-259 PSE 1190	.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 18

PAIRED SNUBBERS COMMONS OR PROB# DELETED EXIST(N)

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PLANT 10%
FW11-096-705 C62K	10709 10714	10	153		✓	PSM-1-5362	.0102
FW11-096-706 C62K	10052 10058	10	153		✓	PSC/Y	.0102
FW11-096-707 C62F	14955 21041	3	012D	✓		PSE 1190	.0102 SA-1-187
FW11-097-040 C62K	21044 21045	3	154	✓		PSE CC5	.0102 SA-1-211
FW11-097-701 C62K	14891 14906	3	154		MOD TO RX	SA-1-211 MOD	.0102
FW11-097-702 C62K	12905 4903	10	154		✓	PSM-1-5273	.0102
FW11-097-705 C62K	28401 28416	3	154		FIELD TO MODIFY	PSM-1-1301	.0102
FW11-099-013 C62K	25847 25848	3	155		FIELD TO MODIFY	PSM-1-1567	.0102
FW11-099-700 C62K	21003 21006	3	155		✓	PSC/Y	.0102
FW11-099-701 C62K	8365 8357	3	152		MOD TO RY	SAM-134 MOD	.0102
FW11-100-702 C52F	13302 13310	3	153		✓		.0102
FW11-101-007 C52K	16755 16805	3	154		POTENTIAL MOD.	PSM-1-(NO 5342	Release Date) .0102
FW11-101-009 C52K	16870 16930	3	154		✓	PSC/Y	.0102

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATIO'. NO.	OPTIONAL TASK CODE	PAGE 19

PAIRED SNUBBERS PROB# DELETED COMMENTS OR EXIST (V)

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PERMIT .02-ΔT
FW11-101-700 C62K	28555 28558	3	154		✓	PSC/Y	.0102
MS1-002-004 C72K	9629 9630	35	002		Mod. By Field	PSM-1-0136	.0062
MS1-002-006 C72K	7997 7938	35	002		✓	PSM 1-1154 PSM V0-0FF	.0062
MS1-002-008 C72K	6570 6581	35	002		✓	PSM-1-1112	.0062
MS1-002-013 C72K	7922 7945	35	002		✓		.0062
MS1-003-007 C72K	1413 2072	100	003		Hold		.0052
MS1-003-009 C72K	1429 1435	100	003		Hold		.0052
MS1-003-010 C72K	1408 1411	100	003		Hold		.0052
MS1-003-014 C72K	2078 2076	100	003		✓		.0052
MS1-004-007 C72K	E403 E414	35	004		✓ SNUBBER ARM TO BE REPLACED	PSM-1-0372	.0062
MS1-004-009 C62K	E870 E872	35	004		Hold		.0062
MS1-029-015 S33K	10033 10077	1	080C	✓	—	PSE 301	.0102 SA-1-206
MS1-070-003 T44K	10111 10118	35	100	—		No Record	.0062

ATT-C
15454.NZ(C) GGIX-222

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Pg 21 OF 27

A 5010 65

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 20

PAIRED SNUBBERS COMMERCIAL PROB^A DELETED OR EXIST (√)

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IH	PERIOD IST-AT
MSI-071-003 T44K	10100 10101	35	100			NO RECORD	.0062
MSI-073-013 C52K	19507 20351	1/4	078		✓	PSC-1-078-3	.0102
MSI-150-025 C52K	16185 34421	1/4	077		IN PREP.		.0102
MSI-150-033 C52K	450 475	1L	077	✓		PSE 640	.0102 SA-1-229
MSI-150-035 C52K	13032 13035	1	077	✓		PSE 640	.0102 SA-1-229
MSI-150-051 C52K	501 512	1L	077		HOLD		.0102
MSI-150-054 C52K	20639 ?	1	077		✓		.0102
MSI-150-062 C52K	19294 19321	1/4	077		✓		.0102
MSI-151-043 C52K	8909 8911	1	076B	✓		PSE 1190	.0102 SA-1-230
MSI-151-046 C52K	10350 21892	1	076B	✓		PSE 1190	.0102 SA-1-230
MSI-223-001 572K	14034 14035	3	023C		✓	PSM-1-1601	.0102
MSI-240-001 572K	12903 12915	10	023B		HOLD		.0102
MSI-257-001 572K	16746 16912	3	023A		MOD. BY FIELD	PSM-1-1583	.0102

15454 NEC(J) GENX-242 ATT C

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Pg 220F27

▲ 5010.08

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 21

PAIRED SNUBBERS COMMENTS OR Prob* Deleted EXIST(J)

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PETMAN .02-AT
MS1-274-001 572K	11753 11761	10	023D		MOD BY FIELD	PSM-1-1585	.010C
MS1-344-005 C52K	9116 9125	1/2	077		✓	PSM-1-930	.010C
MS1-345-003 C52K	9754 11355	1/2	078	✓		PSE 665	.010C SA-1-241
RC1-097-001 C66K	7405 10813	10	053		MOD BY FIELD	PSM-1-1542	.010C
RH1-010-004 522K	17761 17796	1	070	✓		PSE 1190	.010C SA-1-177
RH1-016-700 522K	16920 16925	3	070		MOD TO RZ	SA-1-177 MOD	.010C
RH1-024-005 522K	12408 12912	3	071A		MOD. TO RZ	SA-1-131 MOD	.010C
RH1-024-012 522K	22773 24245	1	071A	✓		CPPA 54853	.010C SA-1-131
SAX-019-035 A35K	12018 12019	1	135A		✓ REVISED SNUBBER SIZE	PSM-1-55 Rev	.010C
SAX-019-705 A35K	26360 26361	1/4	135C		✓		.010C
SB1-060-020 555K	12004 11979	3	079E		✓	PSM-1 1767	.010C
SB1-060-025 555K	16951 16980	3	079E		✓		.010C
SI X-031-011 F53K	12022 16994	3	151B		✓	PSC/1-1518	.010C

▲ 5010.65

CALCULATION IDENTIFICATION NUMBER				PAGE 22
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	

PAIRED SNUBBERS comments on Prob # DELETED EXIST (✓)

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PSI/M .02
S11-029-053 Y32K	10156 10159	35	024		✓	PSM-1-0125	.006
S11-031-022 Y32K	4918 4919	10	047B		MOD BY FIELD	PSM-1-1713	.012
S11-031-071 S32K	28437 28453	3	047B		✓		.012
S11-051-015 C42K	14569 14580	1	014		—	NOT SELECTED PER MASTER TRACK.	.012
S11-072-003 S32K	15087 27974	3	069		HOLD		.012
S11-087-016 C42K	14486 16487	3	016		—	NOT SELECTED PER MASTER TRACK.	.012
S11-178-747 A32K	27616 28611	1/4	N035	✓		PSE 840	.012 SA-1-073
SW1-001-017 F33K	5308 5309	10	067W		✓ REVISED SNUBBER SIZE	PSM-1-5556	.012
SW1-002-019 F33K	5306 5307	10	067S	✓		PSE 840	.012 SA-1-108
SW1-004-011 A33K	7107 7110	3	067S	✓		PSE 840	.012 SA-1-108
SW1-011-026 F33K	5300 5301	10	068S		MOD. TO RE	SA-1-155 MOD	.012
SW1-011-027 F33K	7055 7057	3	068S	✓		CPPA SA921	.012 SA-1-155
SW1-012-023 F33K	4332 5329	10	068W		✓	PSE/4	.012

ATT-C

1545.N&(1)-GENX-242

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Pg 24 OF 27

▲ 5/10 85

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 23

PAIRED SNUBBERS COMMENTS OR PROB# DELETED EXIST(✓)

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PETN = .02 —
SWI-012-026 F33K	7129 7130	3	068W		MOD. BY FIELD	PSM-1-1543	.0102
SWI-013-005 A33K	7120 7121	3	068W		✓ REVISED SNUBBER SIZE	PSM-1-1573	.0102
VA1-005-030 C72K	21931 21893	1	180		✓ REVISED SNUBBER SIZE	PSM-1-1193	.0102
VAX-005-716 A73K	16483 16488	3	178A		✓ REVISED SNUBBER SIZE	PSM-1-0063	.0102
WPX-542-004 A55K	17797 17830	1	N042		MOD BY FIELD	PSM-1-1537	.0102
CC-1-RB-001-003 -3	19511 26359	1/4	055A		MOD. TO RY	SA-1-169 MOD	.0102
CC-1-RB-004-001 -3	25095 35229	1/4	055D		✓	PSC/1-055D-S	.0102
CC-1-RB-033-008 -3	10544 1054B	1/2	055A	✓		PSE 341	.0102 SA-1-169
CC-1-RB-039A-004 -3	19336 19479	1/4	S075			NO RECORD	.0102
CS-1-RB-004-014 -2	20357 20363	1/4	045T	✓		PSE 1536	.0102 SA-1-168
CS-1-RB-004-017 -2	11375 34459	1/4	045T	✓		PSE 1536	.0102 SA-1-168
DO-1-DG-007-011 -3	28642 28652	1/4	S143			NO RECORD	.0102
SW-1-SB-004B -020-3	15413 19853	1/4	S197			NO RECORD	.0102

(13)

1545.NZ(C).GENX.242 ATT-C

Pg 250 of 27

INTEROFFICE CORRESPONDENCE

TO: ROMON RACELIS	LOCATION 482.	SUBJECT / REFERENCE / J.O. NO. 1545405
FROM: T. GINWALA / S. ALI	LOCATION 3GR	PARALLEL SNUBBERS.

MESSAGE: —

PLEASE REVIEW THE ATTACHED LIST OF PARALLEL SNUBBERS (ON UNIT 2) AND INFORM US IF ANY OF THESE SNUBBERS ARE DELETED, BY 5/14/87

5/11/87 (DATE) — T. Ginwala / Syed A. Ali (SIGNATURE) — R 4140 (TELEPHONE)

REPLY:

AS OF THIS DATE 5/13/87 THERE ARE ONLY (2) SUPPORTS THAT WERE DELETED ON UNIT 2. SEE ATTACHED LIST.

5/13/87 (DATE) — R. Racelis (SIGNATURE) — 3616 (TELEPHONE)

▲ 040 138

A 5010 85

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 6

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODE	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PETM = .02 - ΔT
VA-1-005-016 C92K	12680 12697	1					.0102
VA-1-005-013 C92K	10373 21792	1					.0102
FW-2-094-404 S62K	15078 26961	3	FUNCTION CHANGE, SNUBBER TO STRUT				.0102
S1-2-051-412 C42K	12706 15891	1					.0102
S1-2-051-418 C42K	20607 20614	1					.0102
S1-2-095-413 C42K	24649 24664	3					.0102
S1-2-087-411 C42K	13012 20250	1					.0102
S1-2-087-412 C42K	20171 20196	1					.0102
S1-2-087-417 C42K	20183 20640	1					.0102
S1-2-090-403 C42K	6329 6339	3					.0102
S1-2-088-409 C42K	20646 20687	1					.0102
S1-2-088-410 C42K	482 605	1	MODIFIED ✓ ~~DCA-02998~~		2-GPD-477		.0102
S1-2-306-426 C42K	16467 16471	1					.0102

STONE & WEBSTER ENGINEERING CORPORATION

ATT-C
15452-NEC(L)-GENX-24

CALCULATION SHEET

Pg 27 OF 27

▲ 5010.55

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 4

PAIRED SNUBBERS

SUPPORT NO	SNUBBER NO	MODEL	ACT LEVEL G	Δ G	LOST MOTION IN	Δ IN	PERMISSIBLE .02·ΔT
CC-1-239-007 C53K	34442 34448	1/4					.0 10
CC-1-212-005 C63K	12024 12025	1					.0 10
CC-1-218-012 C53K	10752 10753	1/4					.0 10
CC-1-215-012 C53K	10789 19294	1/4					.0 10
CC-1-008-021 A33K	26507 26508	3					.0 10
CC-1-010-005 A43K	16525 16526	3					.0 10
CC-1-043-011 A43K	15987 16402	3					.0 10
CC-1-043-017 A43K	4294 4298	10					.0 10
CC-1-156-002 A53K	2256 8359	3					.0 10
CC-2-044-700 ~~A43K~~	11724 11763	10					.0 10
CC-2-045-703 A33K	12956 14926	3	ENTIRE SUPPORT DELETED				.0 10
RH-1-007-005 S22K	11497 16547	3					.0 10
SI-1-071-004 S32K	15956 15957	3					.0 10

Job No. 15454.05

Enclosure 1
Page 1 of 5
October 10, 1985

TEXAS UTILITIES GENERATING CO. (TUGCO)
COMANCHE PEAK STEAM ELECTRIC STATION

LARGE BORE FIELD WALKDOWN REPORT

Prepared By _____
J. J. Oliver
Field Walk Task Leader

Reviewed By _____
R. R. Wrucke
Project Engineer

Approved _____
R. P. Klause
Project Manager

INTRODUCTION

A sample verification of existing unit 1 as-built documentation for large bore Class 2 and 3 piping systems was performed in accordance with Project Procedure CPPP-5. The purpose of this effort was to establish sufficient confidence in the adequacy of dimensions and functions shown on the as-built drawings to support initiation of the pipe stress requalification effort. This report summarizes the findings and conclusions of the verification effort.

This walkdown does not (and was not intended to) verify TUGCO's as-built program. However, the results of this walkdown tend to indicate that the as-built program implemented by TUGCO is adequate. Verification of the as-built program is within the scope of the Construction Adequacy Program (Appendix B of Comanche Peak Response Plan and Issue-Specific Action Plans). Each revision to piping system as-built documentation, resulting from all project activities (including the Construction Adequacy Program) will be evaluated by SWEC for specific impact on the piping requalification effort and the need to revise the applicable pipe stress and support package.

SCOPE

Four unique samples were randomly selected to verify the following attributes:

(a) Valve Location
(b) Pipe Support Location
(c) Pipe Support Function
(d) Valve and Support Orientation

These attributes were selected because they have the greatest potential for impact on the pipe stress effort. Other less significant attributes exist, but the methods of verifying the above attributes (distance from elbows, tees, valves, supports, etc.) indirectly verify other attributes (e.g., dimensions and configurations).

The total population and sample size for each attribute is shown on Attachment 1. The sample sizes and accept/reject criteria were determined from SWEC Quality Assurance Directive (QAD) 7.11 Rev. A.

SWEC tolerances were established for each attribute. These tolerances are consistent with tolerances previously used by SWEC on other as-built programs. The tolerances also consider the sensitivity of the data to the pipe stress analyses.

SUMMARY OF RESULTS

Approximately 1800 manhours were expended, over a period of three weeks, to complete the physical walkdown.

The results of the fieldwalk follow:

- Valve Location - Valve locations are adequately described. Seventy-nine of the 80 valves were found to be within SWEC tolerances. Valve number 1-8107A was determined to be outside SWEC required tolerances. (See Attachment A)

- Pipe Support Location - Pipe support locations are adequately described. Of the two hundred supports sampled, 199 were within SWEC tolerances. Pipe Support Number CT-1-014-405-C82K was determined to be outside SWEC required tolerances. (See Attachment B)

- Pipe Support Function - All 200 of the pipe support functions are adequately described.

- Valve And Support Orientation - Valve and support orientations are not adequately described. One hundred-ninety of the 200 supports and valves sampled were within SWEC tolerances. The following discrepancies were observed:

Valve/Support Number	As-Built Dimension	SWEC Tolerance	Actual Dim. By SWEC	Diff of As-Built Vs Actual	See Attachment
AF-1-101-027-S63R	5°-31'	±5°	0.3°	5.2°	C
CS-1-155-036-S42R	0°	±5°	6.3°	6.3°	D
CS-1-217-002-A42K	0°	±5°	6.2°	6.2°	E
CS-1-258-702-A53R	0°	±5°	6.7°	6.7°	F
CT-1-010-008-S22K	0°	±5°	6.0°	6.0°	G
CT-1-122-002-S32R	0°	±5°	6.1°	6.1°	H
SW-1-037-007-J03R	0°	±5°	7.0°	7.0°	I
CC-1-007-043-A63R	0°	±5°	6.0°	6.0°	J
1AF-055	45°	±5°	55.0°	10.0°	K
1CH-073	60°	±5°	35.0°	25.0°	L

During the conduct of the walkdown there were only 14 items that were inaccessible. These items were replaced with other items, using the same random sample selection process used for initial sample selection.

CONCLUSIONS

1. The as-built documentation of pipe support and valve orientation is adequate to initiate the stress requalification effort. However, the stress results cannot be finalized until appropriate corrective action relative to verification of valve orientation and the orientation of pipe supports fabricated with catalog components is implemented. All instances where supports were not oriented within SWEC tolerances involved catalog components (i.e., struts or snubbers). The catalog components' paddles were misaligned with the clamps. No cases of misalignment were observed with box frame type supports (i.e. no catalog components.)

NOTE: A review of the sub-populations (supports with and without catalog components) was made to verify that a sufficient number of supports without catalog components were sampled. More than 70 of these supports were verified and all were within tolerance. Therefore, sufficient samples were reviewed to support the conclusion that the concern is limited to supports with catalog components.

Upon investigation of the discrepancies identified, SWEC discovered that two of the out of tolerance situations were previously identified by the TUGCO As-Built Group but are currently not resolved by the project.

ACTION REQUIRED

1.1 Orientation of all ASME valves that could cause eccentric loading on the pipe (e.g. motor operated valves, but not gate valves) should be verified. This effort should begin as soon as possible to minimize the impact on the requalification effort. SWEC will oversee this effort on an auditing basis.

1.2 Orientation of ASME pipe supports fabricated with catalog components should be reverified to identify and resolve all situations which exceed specified tolerances. Resolution of this concern in many cases will require rework of the supports to properly align the clamp and strut/snubber end paddle. SWEC will oversee this effort on an auditing basis.

1.3 The valve and support orientation concern shall be resolved. Appropriate preventive action should be taken to assure that the final as-installed condition is not changed in the future (e.g. during maintenance activities).

1.4 All TUGCO As-Built Group identified items, that have not been resolved by NCR or drawing revision, should be reviewed to determine the cause and extent of this concern and appropriate corrective and preventive action should be implemented.

2. The project implemented the same As-Built Program for all Class 1 piping, High Energy Class 2 and 3 small bore piping and all Class 2 and 3 large bore piping. Since the same program was implemented, the results of the large bore walkdown can be considered representative for all of this piping, provided the corrective action to be implemented includes all Class 1 piping and high energy Class 2 and 3 small bore piping. For those lines which were not as-built in accordance with the large bore As-Built Program, a walkdown shall be performed to establish sufficient confidence in the accuracy of dimensions and support functions shown on the latest design documents to initiate the small bore stress requalification.

ACTION

2.1 TUGCO should identify the small bore stress problems that were not as-built in accordance with the As-Built Program.

2.2 SWEC will perform a walkdown for the piping identified by TUGCO. This walkdown shall be similar to the program described in Project Procedure CPPP-5, and this report.

COMMENTARY

In addition to the specific conclusions identified above, some engineering inferences about the adequacy of the as-built documentation (to support stress requalification) can be made. These inferences are:

1. All installed components are appropriately reflected on the as-built documentation. The location of supports and valves were verified by measurement to the next component (e.g., support, valve, fitting) installed within the system. No components, within the Class 2 and 3 stress systems, were observed to be installed but not identified on the drawings.

2. The piping and support configuration (layout and geometry) are appropriately described on the drawings. The method of verifying valve and support location (distance from elbows, tees, valves, supports etc.) indirectly verified the piping system dimensions and configuration.

Although one of the four attributes did not meet the established acceptance criteria, it is not necessary to perform any additional walkdowns for large bore piping prior to initiation of pipe stress analysis. This decision was based on the following judgements:

1. All attributes with significant impact on analyses have been walked down.

2. The Construction Assessment Program will fully assess the adequacy of as-built documentation against the construction tolerances. Changes to the as-built documentation that affect pipe stress analysis and support designs will be fully evaluated by SWEC on an ongoing basis.

LARGE BORE FIELD WALKDOWN

POPULATION AND SAMPLE SIZE/SELECTION

I. Population/Sample Size

ATTRIBUTE	TOTAL POPULATION	SAMPLE SIZE	Source of Total Population	Accept/ Reject
Valve Location	913	80	Note 1	1/2
Support Location	8042	200	Note 2	5/6
Support Function	8042	200	Note 2	5/6
Valve and Support Orientation	8955	200	Note 3	5/6

NOTE 1 - List of valves developed by SWEC from review of BRP Drawings in SWEC Scope.

NOTE 2 - "As-Built-LBH-PROB-RPT" - Computer listing of Comanche Peak Large Bore Supports sorted by Stress Package, dated 6-20-85.

NOTE 3 - Combination of both lists identified in Notes 1 and 2 above.

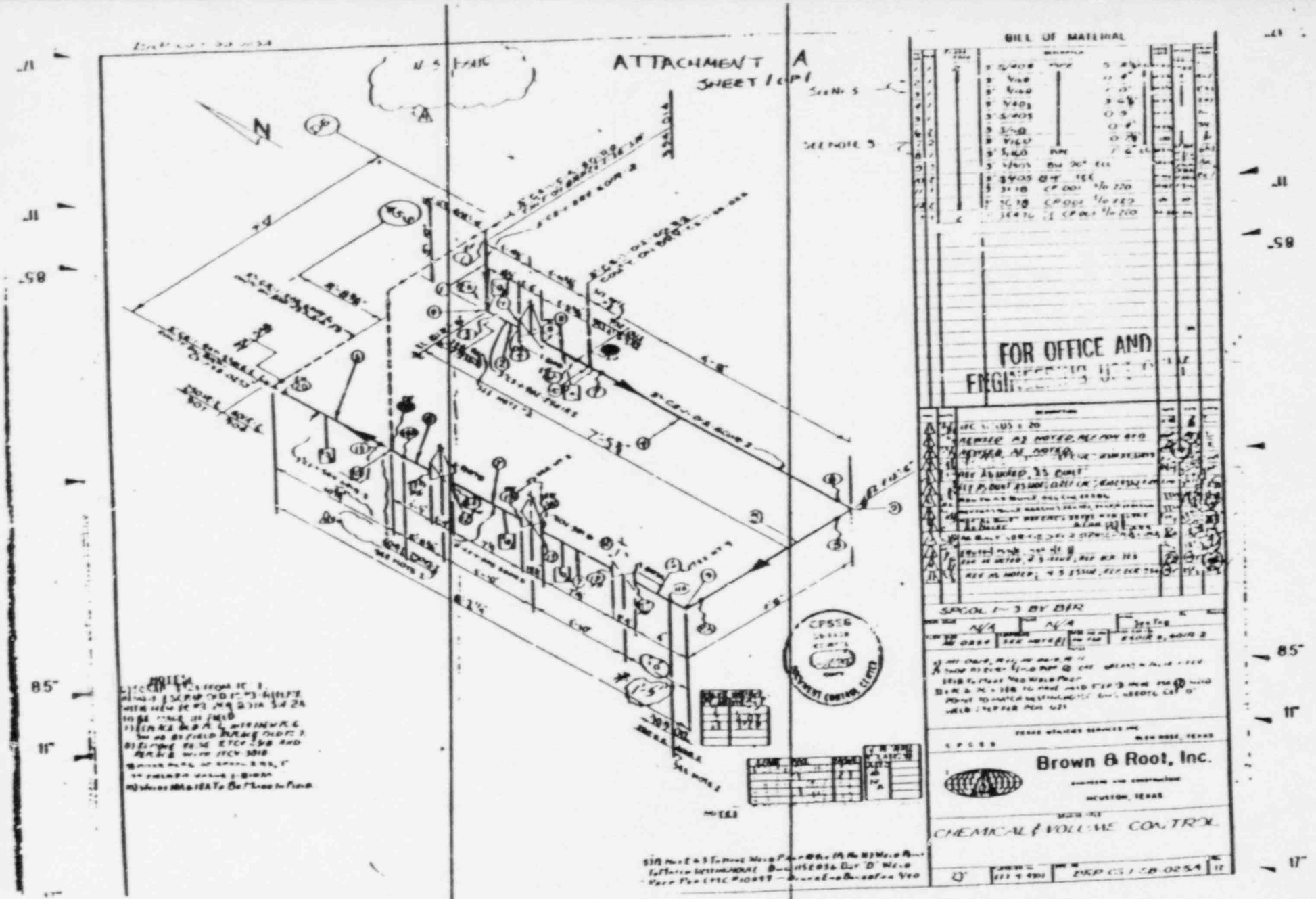
II. Sample Selection

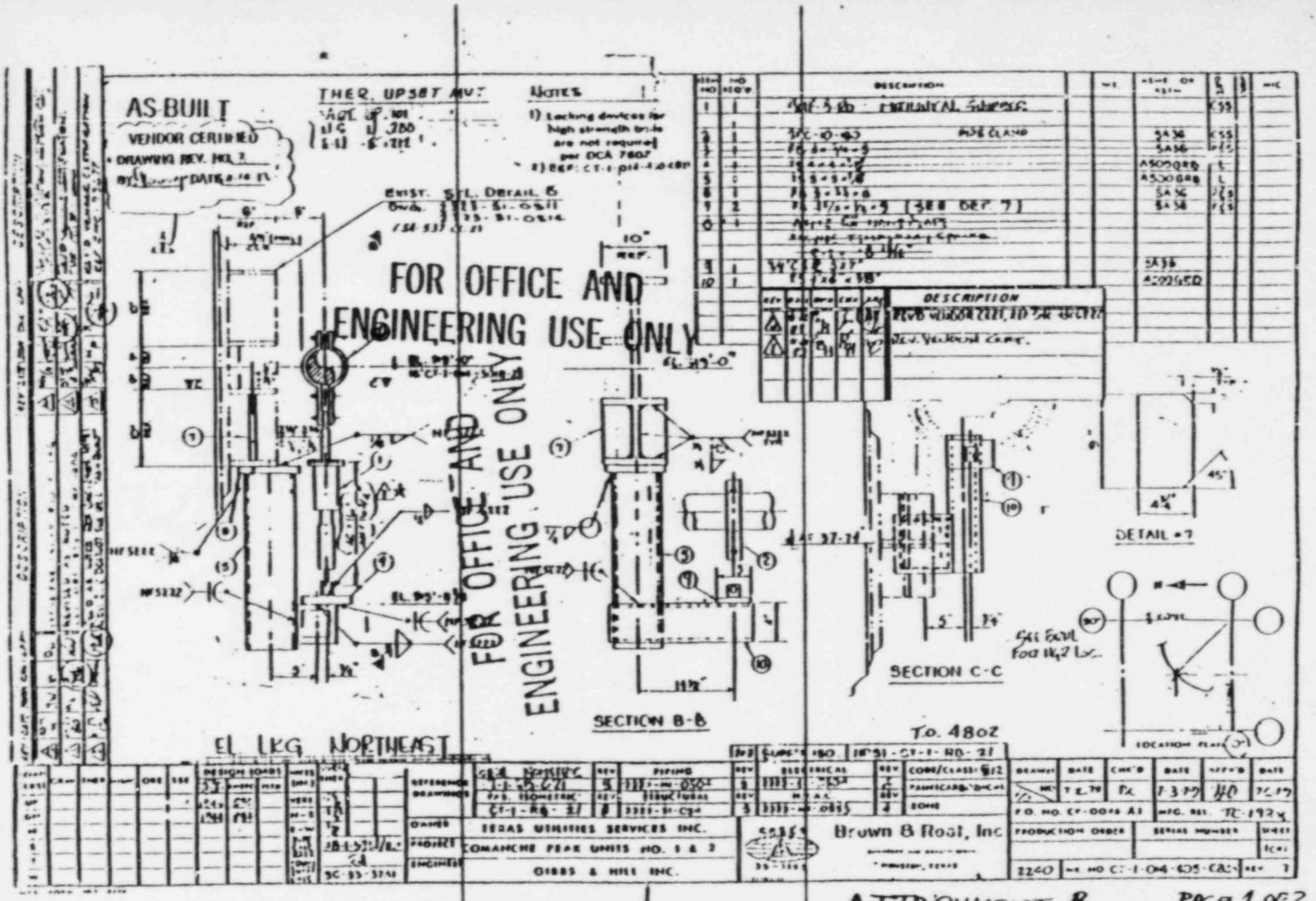
The specific samples were selected as follows:

1. Consecutive numbers (from 1 to the population size) were assigned to each item listed in the appropriate index (Notes 1, 2 and 3).

2. Four sets of numbers (one set for each attribute) were selected from a random number table.

3. The item (valve or support) corresponding to the random number was selected for the walkdown.

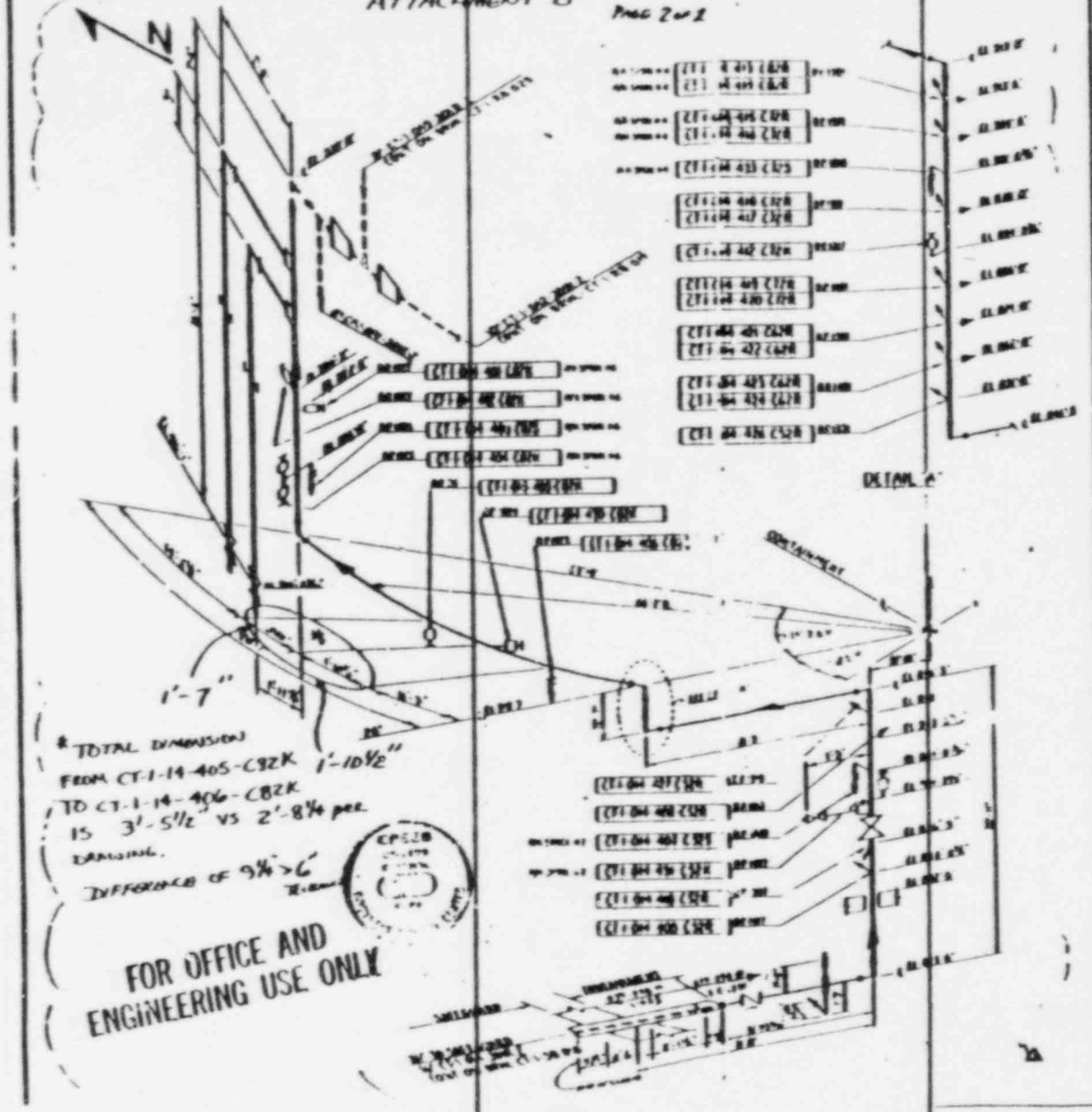

ATTACHMENT A
SHEET 1 of 1
BILL OF MATERIAL
FOR OFFICE AND
SPOOL 1 – 3 BY BIR
Brown & Root, Inc.
CHEMICAL & VOLUME CONTROL



ATTACHMENT B PAGE 1 OF 2

ATTACHMENT 8

Page 2 of 2



BILL OF MATERIAL

STONE & WEBSTER ENGINEERING CORP
DATA CERTIFIED CORRECT

DESCRIPTION	
ORIGINATOR	
VERIFICATION	
APPROVED	
DATE APPROVED	7-1-85

Brown & Root, Inc.
HOUSTON, TEXAS

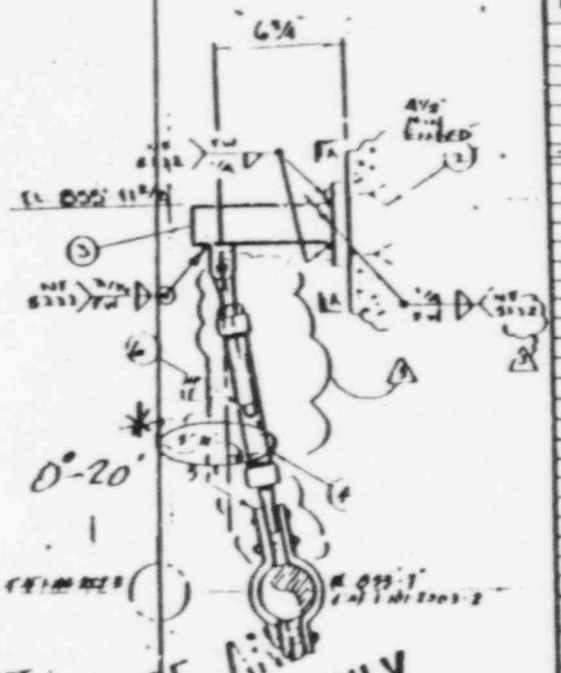
CONTAINMENT SPRAY

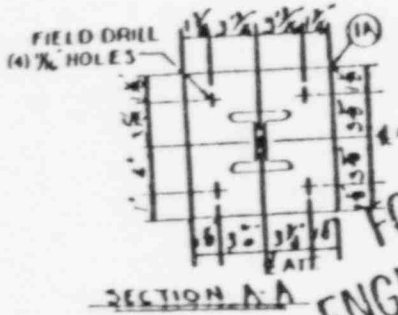
BRHL-CT-1-RB-021

ATTACHMENT C SHEET 1 OF 1

AS BUILT
VENDOR CERTIFIED
DRAWING REV. NO. 3
BY CA DATE 11 9 92

CPSES
31185
DOCUMENT CONTROL CENTER





FOR OFFICE AND ENGINEERING USE ONLY.

ITEM NO	MATERIALS & OPERATIONS	QUAN	SHIP
	SEISMIC SWAY STRUT ASSEMBLY CONSISTING OF:	ONE	
1A	MC Carbon Steel Plate (SA 515 GR. 65 or [illegible]) Per Section A-A	1	
2	[illegible]" Hilti Kwik Concrete Anchor [illegible]	5	
3	W[illegible] (SA 36) 0'-8 1/8" Long [illegible]	1	
4	Pipe 2½" "A" Sway Brace Assembly.	2	
5	1½" O. D. Pipe, Carbon Steel, [illegible]		
6	[illegible]	1	
7	[illegible]	1	
8	NPT Tee w/ Anchor	1	
	SEISMIC ASSEMBLY SKETCH AND ENGINEERING BUNDLE AND TAG PUNCH # XF-1-[illegible]-027-563R	1	
	Apply one coat of Carbo Zinc #11 to above 660°F except those which shall be coated w/8 Mule preventative.		

MK	QUAN	SHIP	DESCRIPTION
A	[illegible]	Q	[illegible] 62996

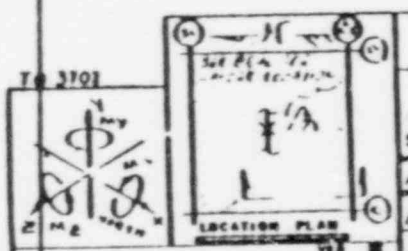
Approved By: DRC
Date: 10/22/92

FOR MATERIALS AND OPERATIONS SEE SKETCH NO. SHEET OF

NOTES

4) [illegible] FOR HIGH STRENGTH BOLTS ARE NOT REQUIRED PER DCA [illegible]

Base Iso [illegible] REV 3
Iso [illegible]
Date Rec'd: [illegible]
Pipe Mat'l SA-[illegible] Gr. [illegible]
Insul. — Bldg. [illegible]



THIRD PARTY INSPECTION
CODE CLASS: [illegible] III-2

Brown & Root, Inc.

REF DRAWING NUMBERS
PIPE: [illegible]
STEEL: [illegible]
ELECT: [illegible]
HV.A.C: [illegible]

CONDITIONS	Fx	Fy	Fz	Mx	My
DESIGN					
OPERATING & WIND					
EMERGENCY					
FAULTED					

MK	DATE	DESCRIPTION
3	[illegible]	ISSUE FOR CONST REV [illegible]
2	[illegible]	REVISED PER CHG [illegible] PUNCH DCA [illegible]
1	[illegible]	4, AS BUILT
		REV AS BUILT PER CHG [illegible]

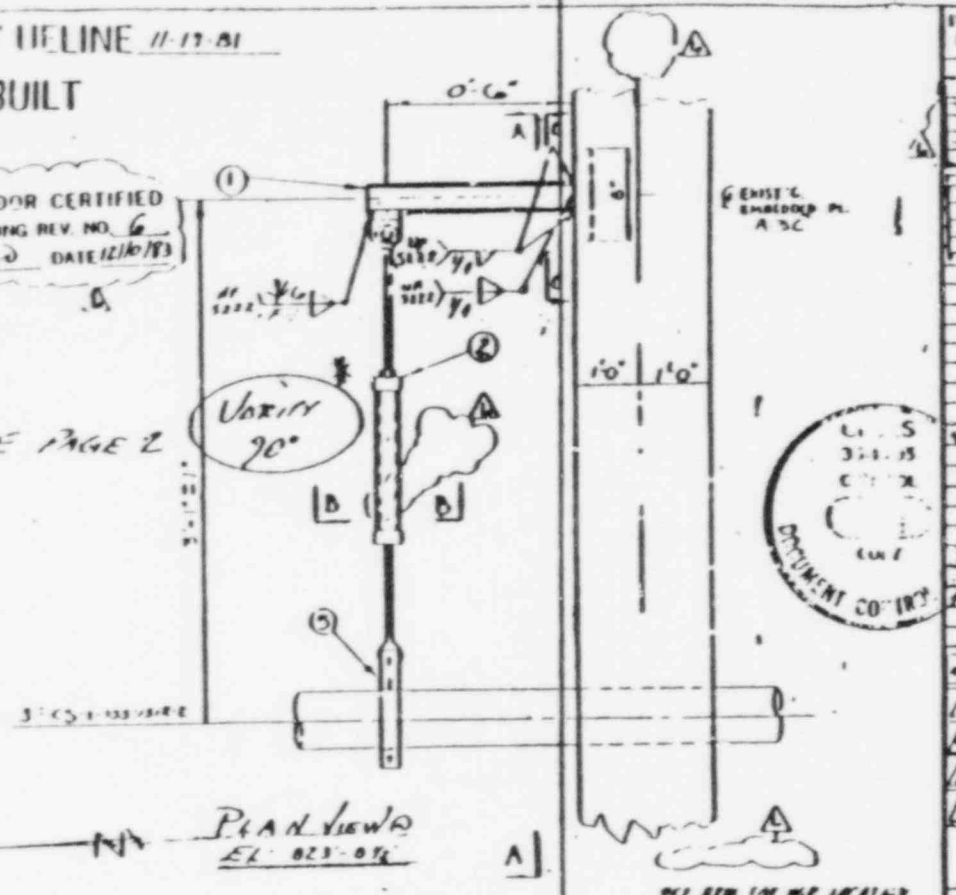
CUSTOMER [illegible]
ORDER OR CONT NO [illegible]
JOB NAME
MARK NO [illegible]
SKETCH NO
SHEET 1 OF 1 REV 3

ATTACHMENT D PAGE 1 of 2

B' LINE 11-17-81

AS BUILT

VENDOR CERTIFIED
DRAWING REV. NO. 6
BY [illegible] DATE 12/10/83



ITEM NO.	NO REQD	PART CALLOUT	DESCRIPTION	MATERIAL	MIC NO.	WT.
1	1	[illegible]		SA 36		
2	1	[illegible]	3 WAY STRUT			
3	1	[illegible]				
4	1	[illegible]				
5	1	[illegible]	PIPE [illegible]	SA 53		

EXISTING ASSEMBLY SKETCH & ENGINEERING
BUNDLE & TAG
MARK NO CS-1-1SS-036-B02R

Applicant's Name Brown & Root, Inc.

Applicant's Address [illegible]

Description of Work [illegible]

Approved By: C.E.G.
Date: 1-12-84

FOR OFFICE AND ENGINEERING USE ONLY

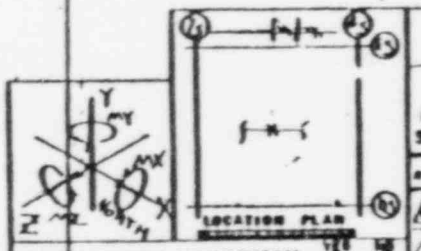
REV	DATE	DRAWN	CHK	APP	DESCRIPTION
6	12/10/83	[illegible]			REV'D AS NOTED, [illegible]
5	11/17/83	[illegible]			REVISED PIPING LOCATION [illegible]
4	10/31/83	[illegible]			[illegible]
3	10/19/83	[illegible]			[illegible]
2	9/8/83	[illegible]			[illegible]

FOR MATERIALS AND OPERATIONS SEE SKETCH NO. ____ SHEET ____ OF ____

NOTE:
1. Locking devices for high strength bolts are not required per DCA 7607

PARTS:
X [illegible]

BRH ISO CS-1-SB-030 P1
ERP Iso CS-1-SB-30 Rev 0
Data relat [illegible]
Pipe Mat'l SA 312 TP 304
Insul [illegible] Bldg SB
T.O. 4901



THIRD PARTY INSPECTION
CODE CLASS: ASME III-2

Brown & Root, Inc.

REF. DRAWING NUMBERS
PIPE: [illegible] ELECT: [illegible]
STEEL: [illegible] HVAC: [illegible]

REV	DATE	DRAWN	CHK	APP	DESCRIPTION
2	1/12/84	[illegible]			ISSUE FOR CONST [illegible]
1	9/16/83	[illegible]			REV PER NPSI REV 4 A [illegible]
0	8/1/83	[illegible]			[illegible]

CONDITIONS	Fx	Fy	Fz	Mx	My
DESIGN					
NORMAL & VENT			350		
EMERGENCY			231		
FAULTED					

CUSTOMER Texas Utilities Generating
ORDER OR CONT NO CP 0016
JOB NAME Comanche Peak S.E.S.
MARK NO CS-1-1SS-021R-2
SKETCH NO
SHEET 1 OF 2 REV

ATTACHMENT D PAGE 2 OF 2

BLUELINE 11-19-91

AS-BUILT

VENDOR CERTIFIED
DRAWING REV. NO. G
BY [illegible] DATE 11/19/91

[illegible]

Maint 90°

N 023° 00'

9" 5"

N 065° 0' 0" — 9"CC-1-197-152-3

N 065° 0' 0" — 8"CC-1-197-152-3

SECTION A-A

EMBED EXISTS (A-36)

ATT.

EMBED ft

SECTION C-C

FOR OFFICE AND ENGINEERING USE ONLY

G

N 065° 0' 0" — 8"CC-1-197-152-3

N 065° 0' 0" 8"

SECTION B-B

CPSES
[illegible]
DOCUMENT CONTROL

5/8" CLAMP

STRUT FOUND BOUND

5/8" STRUT

6.3°

5.6°

℄ PIPE

EL. Looking North

T.O. 4901

Approved By: [illegible]
Date: 1-22-92

REV	DATE	DWN	CHK	APP	DESCRIPTION
4	[illegible]				REVD AS BLT. REF. [illegible]
3	[illegible]				REVD AS BLT. REF. DCA 8011
2	[illegible]				[illegible]
1	[illegible]				[illegible]

REV	DATE	DWN	CHK	APP	DESCRIPTION
A	[illegible]				ISSUE FOR CONST (M)
1	[illegible]				REVD AS BUILT. REF. [illegible]
0	[illegible]				DELTD. NTS 1-3. ADD FWG 1-8. AS BUILT

THIRD PARTY INSPECTION
CODE CLASS: ASME III-2

Brown & Root, Inc.

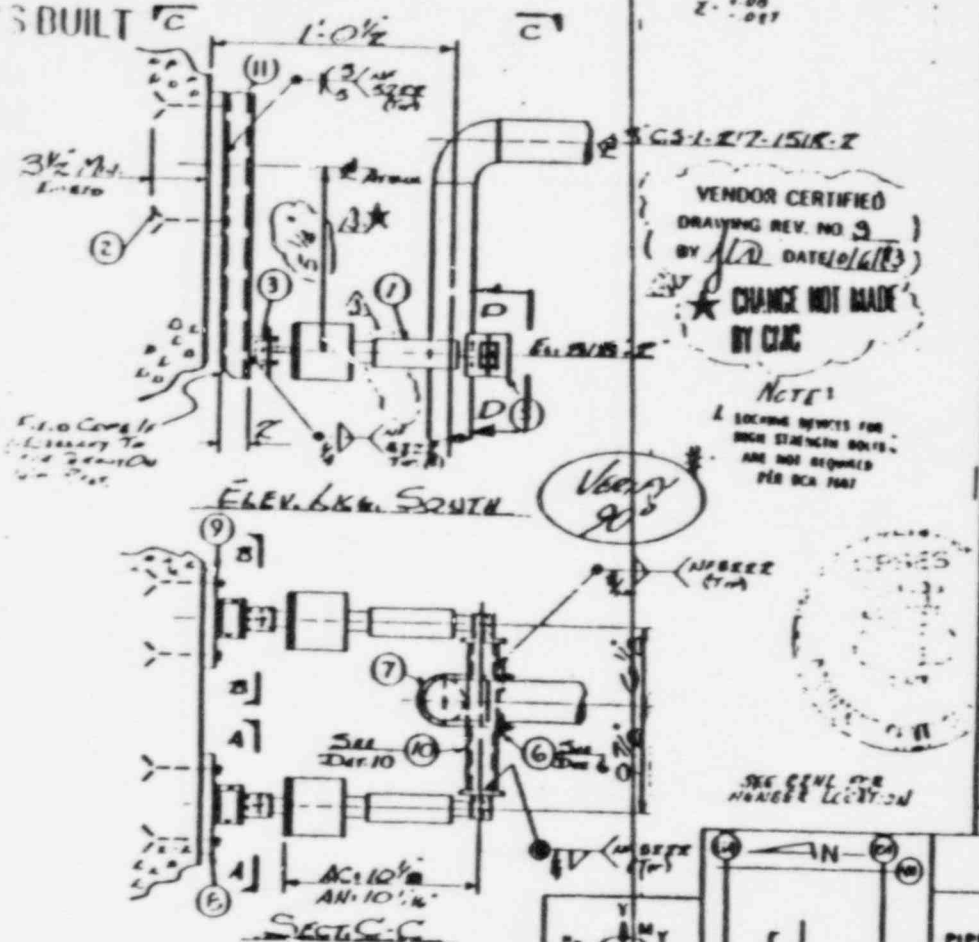
REF. DRAWING NUMBERS
PIPE:
STEEL:
ELECT:
H.V.A.C.:

CUSTOMER TEXAS UTILITIES ELECTRIC CO.
ORDER OR CONT. NO. CP-0096
JOB NAME COMANCHE PEAK UNIT
MARK NO. CC-1-197-036-G1 (M)
SKETCH NO.
SHEET 2 OF 3 REV. 4

ATTACHMENT E SHEET 1 OF 2

BLUELINE 9-29-81

AS BUILT



ITEM NO	MATERIALS & OPERATIONS	QUAN	SHIP
1	[illegible]	[illegible]	
2	[illegible]	[illegible]	
3	[illegible]	[illegible]	
4	[illegible]	[illegible]	
5	[illegible]	[illegible]	
6	[illegible]	[illegible]	
7	[illegible]	[illegible]	
8	[illegible]	[illegible]	
9	[illegible]	[illegible]	
10	[illegible]	[illegible]	
11	[illegible] FIELD TRIM TO SUIT	2	

FOR OFFICE AND ENGINEERING USE ONLY

MARK # G3-L-Z17-GQZ-A12K
PAINT: CRA80 ZINC W 11

ITEM NO	MATERIALS & OPERATIONS	QUAN	SHIP

FOR MATERIALS AND OPERATIONS SEE SKETCH NO ____ SHEET ____ OF ____

Pipe Iso G3-L-Z17-151R-Z
I.P.D. Iso G3-L-Z17-GQZ-A12K
Data Point [illegible]
Pipe Mat'l SA376 TP304
Insul ____ Bldg A
T.O. el 4901

BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS

REF DRAWING NUMBERS
PIPE: M-Z17-K-Z ELECT: E-Z17-K-1
STEEL: S-Z17-K-Z HVAC: M-Z17-K-Z

CONDITIONS	Fx	Fy	Fz	Mx	My	Mz
DESIGN						
NORMAL & UPSET						
EMERGENCY						
FAULTED						

DESCRIPTION
[illegible]
REV'D VENDOR CERT

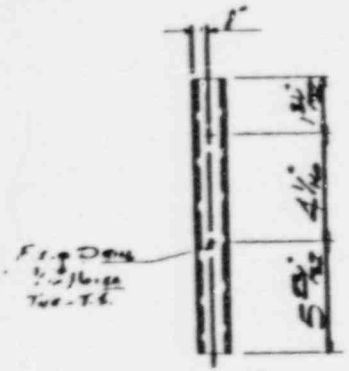
THIRD PARTY INSPECTION
CODE CLASS: ASME III-2

CUSTOMER Texas Utilities Service, Inc
ORDER OR CONT NO CP-0046
JOB NAME Comanche Peak 1&2
MARK NO G3-L-Z17-GQZ-A12K
SKETCH NO
SHEET 1 OF 2 REV 3

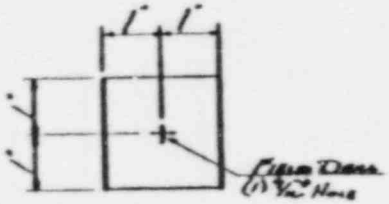
ATTACHMENT E SHEET 2 OF 2

BLUELINE 9.23.81

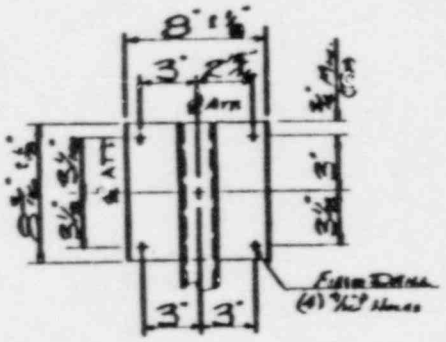
AS BUILT



DET. 12

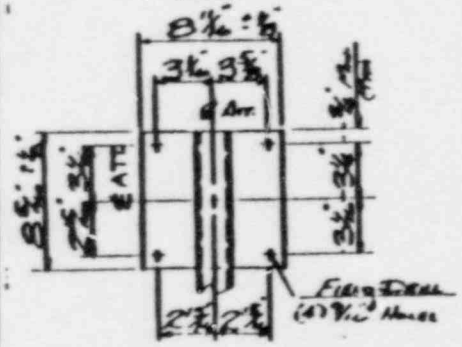


DET. 6

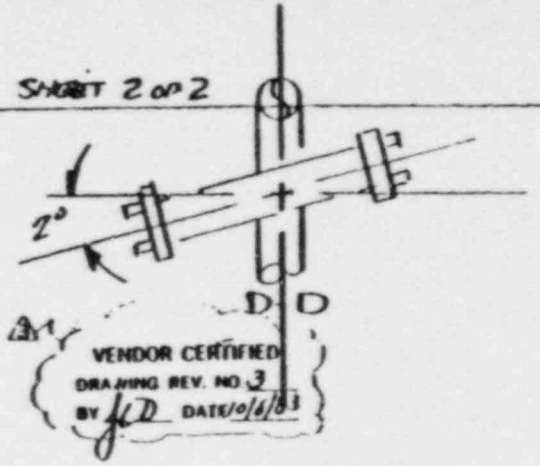


SECT. A-A

℄ ATTACH. PIPE VARIES 11" (TYP.)



SECT. B-B



FOR OFFICE AND ENGINEERING USE ONLY

BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS

REF. DRAWING NUMBERS

PIPE: ELECT:
STEEL: HVAC:

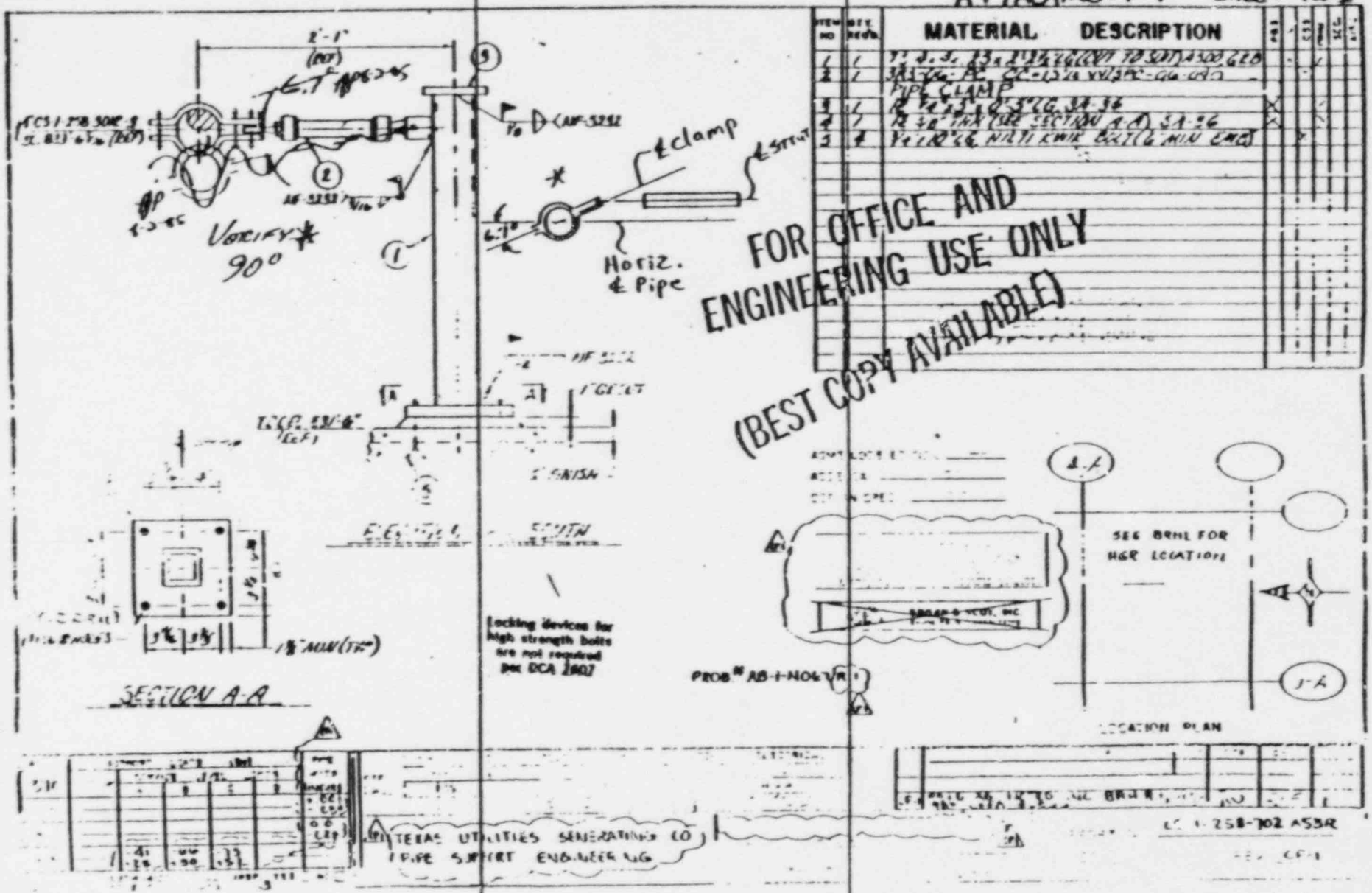
CUSTOMER T.U.S.I.
ORDER OR CONT. NO CP-0046
JOB NAME Comanche Peak, Unit
MARK NO. CS-1-217-002-A2XX
SKETCH NO.
SHEET 2 OF 2 REV. 3

					DESCRIPTION
					REV'D VENDOR CERT

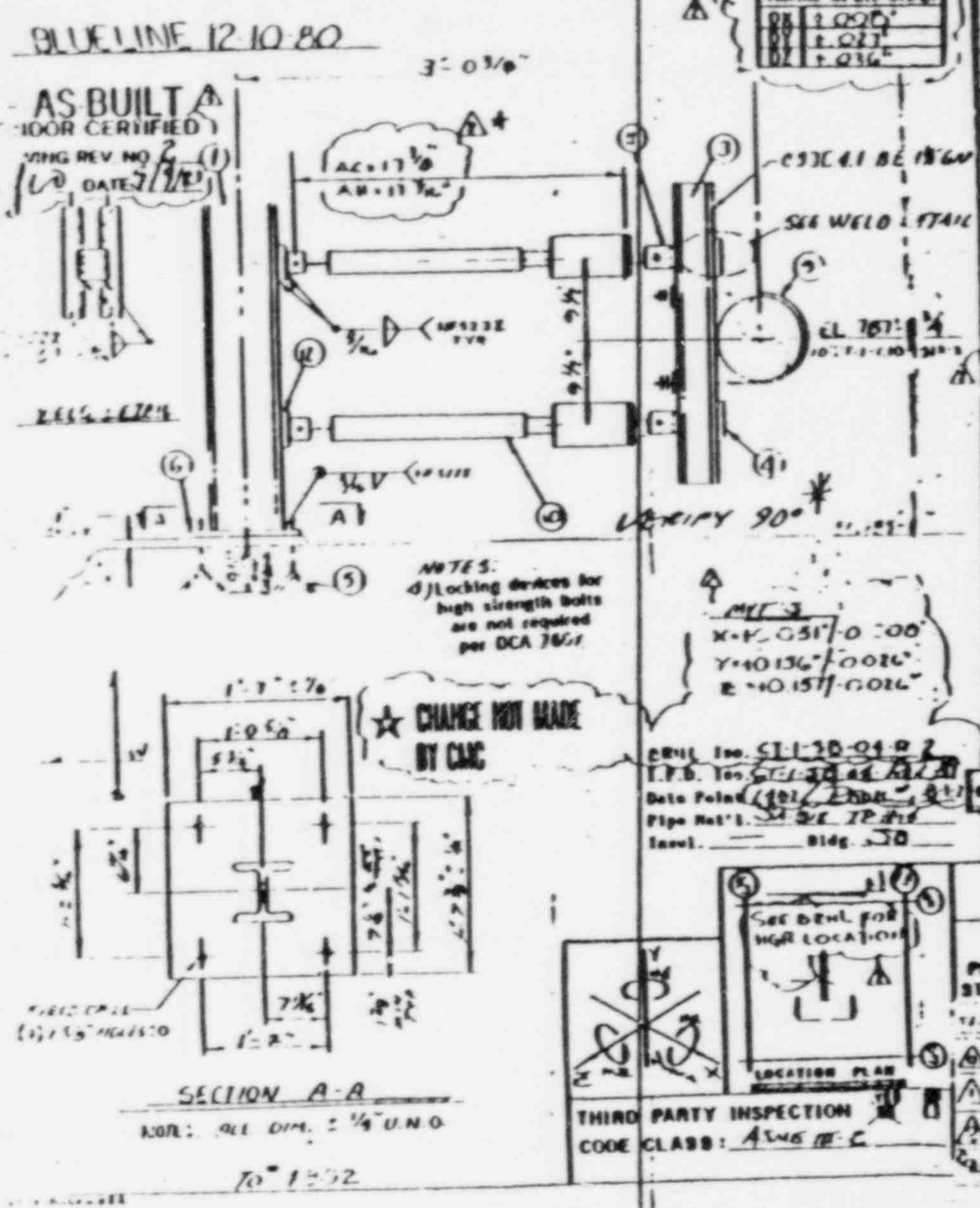
THIRD PARTY INSPECTION
CODE CLASS: ASME III-2

T.O.# 4901

ATTACHMENT F SHEET 1 OF 1



ATTACHMENT G SHEET 1 OF 2



ITEM NO.	MATERIALS & OPERATIONS	QUAN	SHIP
	SEISMIC MECHANICAL SHOCK SUPPRESSOR ASSEMBLY CONSISTING OF:	LINE	
	MATERIAL EXISTS		
1	[illegible]	1	
2	[illegible]	1	
3	[illegible]	2	
4	[illegible] (REV-06)	1	
5	"SUPER HILTI-KWIK" CONCRETE ANCHOR	4	
6	[illegible]	1	
7	[illegible]		
10	PSA-[illegible] SNUBBER	2	
11	PSA-10 REAR BRACKETS	2	
12	1" x 4" C.S. PL. [illegible]	2	
	SEISMIC ASSEMBLY SKETCH & ENGINEERING HGR CP-1-010-008-E23K		

FOR OFFICE AND ENGINEERING USE ONLY

FOR MATERIALS AND OPERATIONS SEE SKETCH NO. SHEET OF

Brown & Root, Inc.

REF. DRAWING NUMBERS

PIPE: [illegible] ELECT: [illegible]
STEEL: [illegible] HVAC: [illegible]

CONDITIONS	Fx	Fy	Fz	Mx	My	Mz
DESIGN						
NORMAL & UPSET						
EMERGENCY						
FAULTED						

DESCRIPTION

- ISSUED FOR CONSTRUCTION
- AS BUILT
- REV. [illegible]
- CMC 80306 R2 [illegible] CERTIFICATION REF [illegible] 64707

CUSTOMER: Texas Utilities Services, Inc.
ORDER OR CONT NO.: CP-0046
JOB NAME: Comanche Peak 1 & 2
MARK NO.: CP-1-010-033-S22K
SKETCH NO.
SHEET 1 OF 1 REV 2

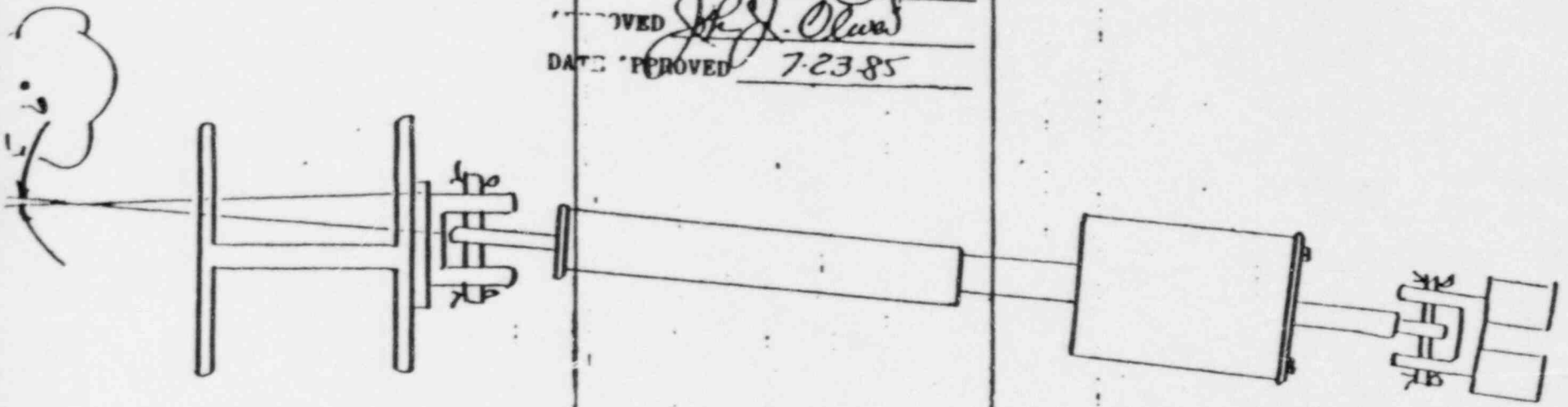
THIRD PARTY INSPECTION
CODE CLASS: ASME III-C

ATTACHMENT G SHEET 2 OF 2

North

STONE & WEBSTER ENGINEERING CORP.
DATA CERTIFIED CORRECT
VERIFICATION TEAM MEMBER [signature] 7-23-85
VERIFICATION TEAM MEMBER [signature] 7-23-85
APPROVED [signature]
DATE APPROVED 7-23-85

Bottom Swabber Same as Top!



PLAN VIEW

FLOOR ELEV. 105'6"
Room # 607
SafeGuard's Bldg.

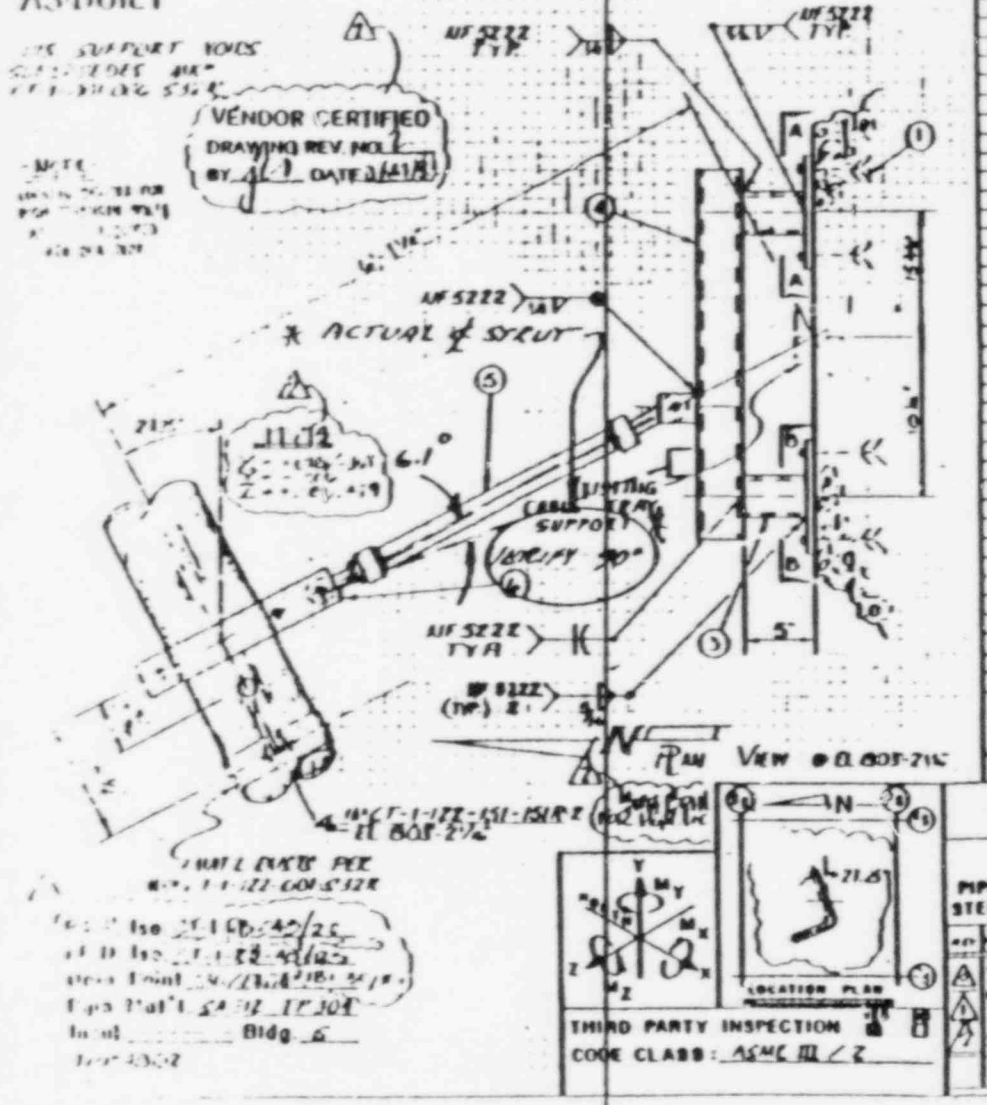
REF. CT-1-010-008-52CK

7-23-85
SC 7-23-85
KN 7-23-85

ATTACHMENT H SHEET 1 OF 2

PIPELINE 1-25-02

AS BUILT



ITEM NO	MATERIALS & OPERATIONS	QUAN	SHIP
1			
2			
3			
4			
5			
6			
7			

FOR OFFICE AND ENGINEERING USE ONLY

CPSES

MARK NO CT-1-122-CVE-SIZE
PAINT CARBO ZINC 11

FOR MATERIALS AND OPERATIONS SEE SKETCH NO SHEET OF

BROWN & ROOT, INC.
ENGINEERS & CONSTRUCTORS

REF. DRAWING NUMBERS

PIPE : SKETCH 214 ELECT : ELEC-01
STEEL : SKETCH 52 HVAC : MECH-2

CONDITIONS	Fx	Fy	Fz	Mx	My	Mz
DESIGN						
NORMAL & UPSET						
EMERGENCY						
FAULTED						

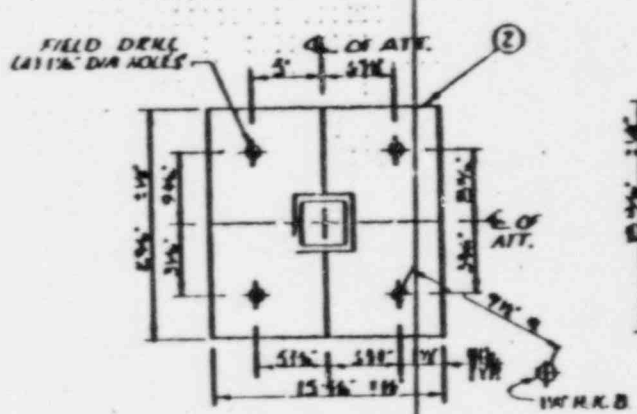
						DESCRIPTION
A						ISSUED FOR CONST.
1						
2						

CUSTOMER Texas Utilities Service, Inc
ORDER OR CONT NO CF-0046
JOB NAME Comanche Peak 1&2
MARK NO CT-1-122-CVE-SIZE
SKETCH NO
SHEET 1 OF 2 REV 2

ATTACHMENT H SHEET 2 OF 2

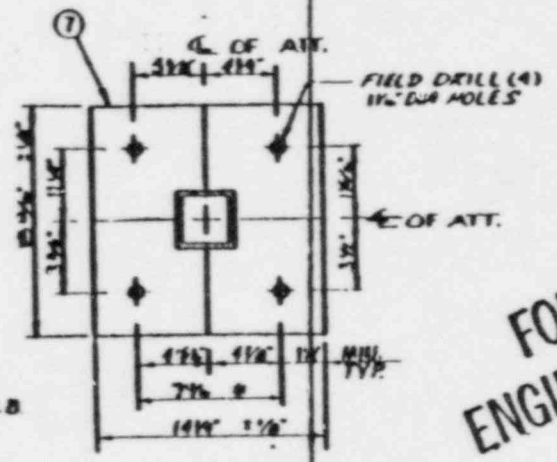
BLUELINE 1-25-82

AS BUILT VENDOR CERTIFIED DRAWING REV NO. 2 BY [illegible] DATE [illegible]



SECTION 'A-A'

CTR LINE OF ATT MAY VARY ± 1/4" @ MULTI VIOLATION EXISTS PER NCR-FS-0059 MK 690 (Cable Tray Supports)



SECTION 'B-B'

CTR LINE OF ATT. MAY VARY ± 1/4" @ MULTI VIOLATION

FOR OFFICE AND ENGINEERING USE ONLY

CPSES 38-1°C3 CORREL

BROWN & ROOT, INC. ENGINEERS & CONSTRUCTORS

REF. DRAWING NUMBERS

PIPE: ELECT:

STEEL: HVAC:

REV	DESCRIPTION
2	ISSUED FOR CONST. REF. CAMS (LIFT)
1	ISSUED FOR CONST. REF. CAMS (LIFT)

CUSTOMER Texas Utilities Service, Inc.

ORDER OR CONT. NO. CP-0046

JOB NAME Comanche Peak 1&2

MARK NO. CP-1-222-502-S12R

SKETCH NO.

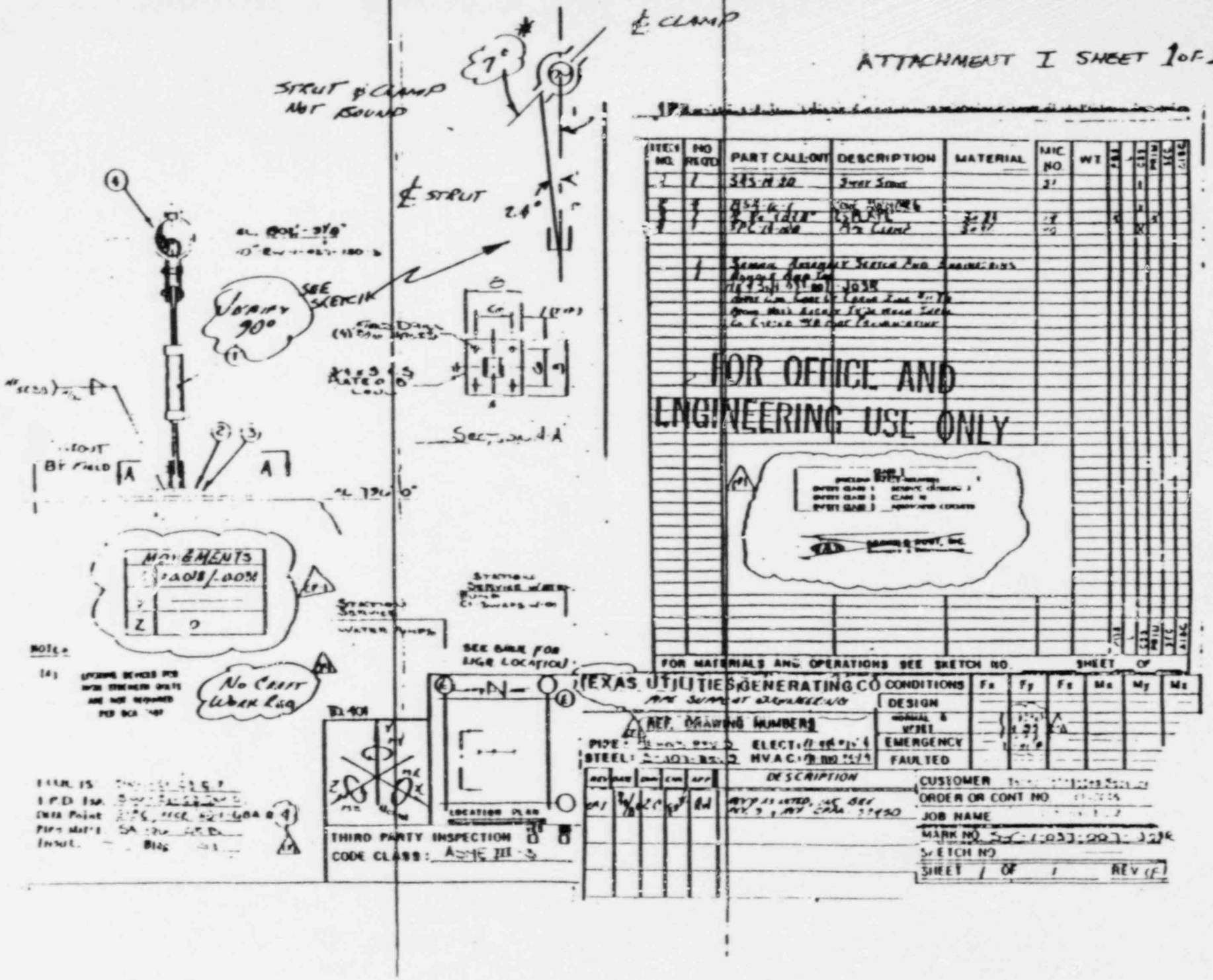
SHEET 2 OF 2 REV. 2

THIRD PARTY INSPECTION

CODE CLASS: ASME III / 2

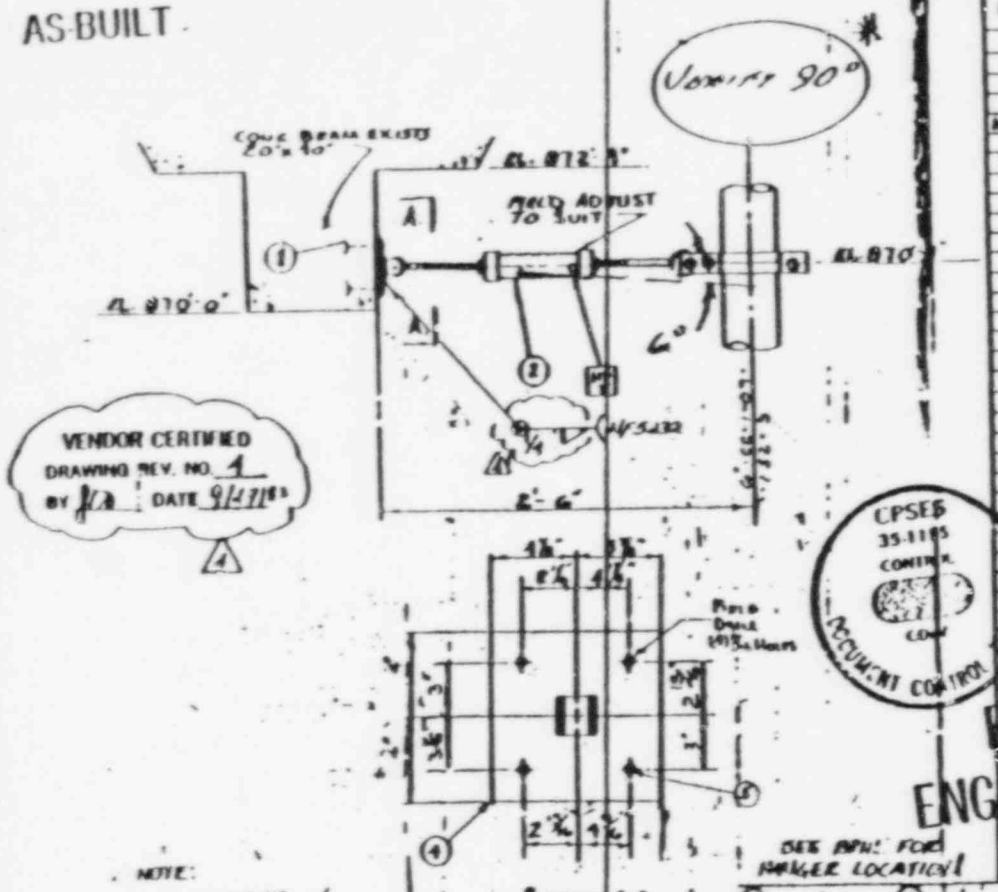
7/07 4802

ATTACHMENT I SHEET 1 OF 1



ATTACHMENT 3 SHEET 1 OF 1

AS-BUILT



VENDOR CERTIFIED
DRAWING REV. NO. 1
BY [illegible] DATE 9/27/83

CPSES 35-1105 CONTROL COPY DOCUMENT CONTROL

ITEM NO.	MATERIALS & OPERATIONS	QUAN	SHIP
	SEISMIC SNAP STRUT ASSEMBLY CONSISTING OF:	ONE	
1	1/2"-13 1/2" Milsi-Bolt Rolln. Concrete Anchors (1105-1)	3	
2	Fig. 2110, "C", Snap Strut Assembly, 3 3/8" O.D. Pipe, Carbon Steel, V-B, 3 3/4", Load: 2900#	1	
3	3/8"-16 x 8" Carbon Steel (SA307 GR B) HX HD Bolt	1	
	Elbow, 0°48" VRG, 2"-222		
	SEISMIC ASSEMBLY SKETCH & ENGINEERING	1	
	BUNDLE & TAG	1	
	MARK# CC-1-087-043-A63R		
	PAINT [illegible]		
	Apply one coat of Carbo Zinc #11 to shim mat'l except those which shall be coated w/a rust preventative.		
4	3/8" SQ x 1 1/2" C.S.B. SA307 GR B/SA36	1	
5	3/8"-16 x 1" MILSI-BOLT ANCHOR BOLT	1	

DESCRIPTION
REVISED AS CONSTRUCTED PER FIELD VERIFICATION SKETCH REF. CTR # 38443

FOR OFFICE AND ENGINEERING USE ONLY

Approved By: C.P.C.
Date: 3-22-79

FOR MATERIALS AND OPERATIONS SEE SKETCH NO. SHEET OF

TO H101

BOM 150 CC-1-AB-46 R 3
P.D. No. CC-1-AB-46-Pipe
Data Point A37 / AB-1-628 R.O
Pipe Mat'l SA 106m GRB
Insul. 1½" Bldg

Brown & Root, Inc.

REF. DRAWING NUMBERS
PIPE: M1-0701 sht 1 ELECT: Sht 1
STEEL: S-0733 sht 1 H.V.A.C: M1-2157 sht 1

REV	DATE	DRWN	CHK	APP	DESCRIPTION
					ISSUE FOR CONST. Field Sketch 1 - Hanger #46
					REV AS NOTED, REF CMC 39093 & CMC 39093
					REVISED AS NOTED PER DCP# [illegible] NOTE 3 - DELETED
					AS BUILT

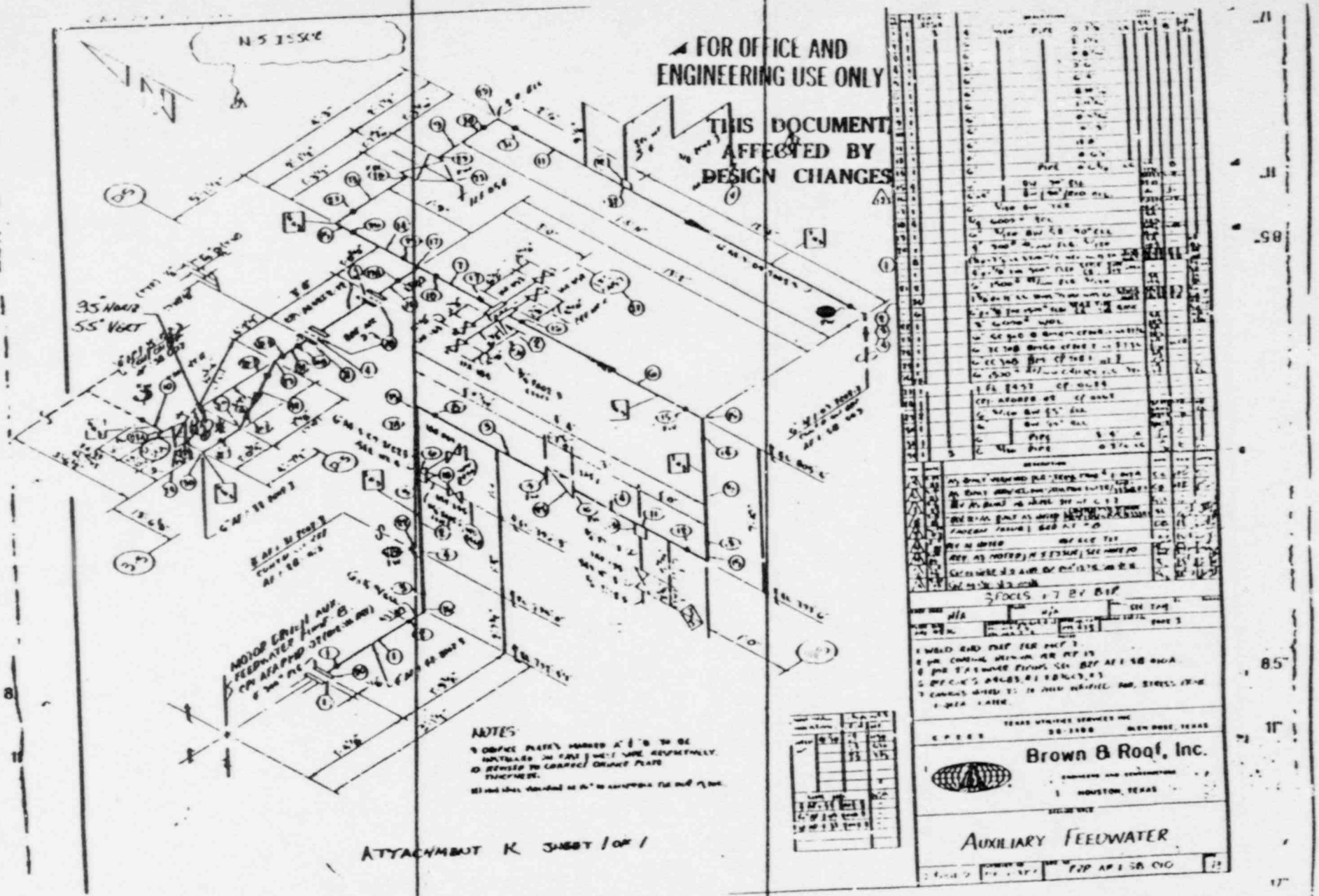
THIRD PARTY INSPECTION
CODE CLASS: ASME III-3

CONDITIONS	Fx	Fy	Fz	Mx	My
DESIGN					
NORMAL & UPSET					
EMERGENCY					
FAULTED					

CUSTOMER Texas Utilities Service
ORDER OR CONT NO CP-6026
JOB NAME Comanche Peak S.E.S.
MARK NO. CC-1-087-043-A63R
SKETCH NO
SHEET 1 OF 1 REV

FOR OFFICE AND ENGINEERING USE ONLY

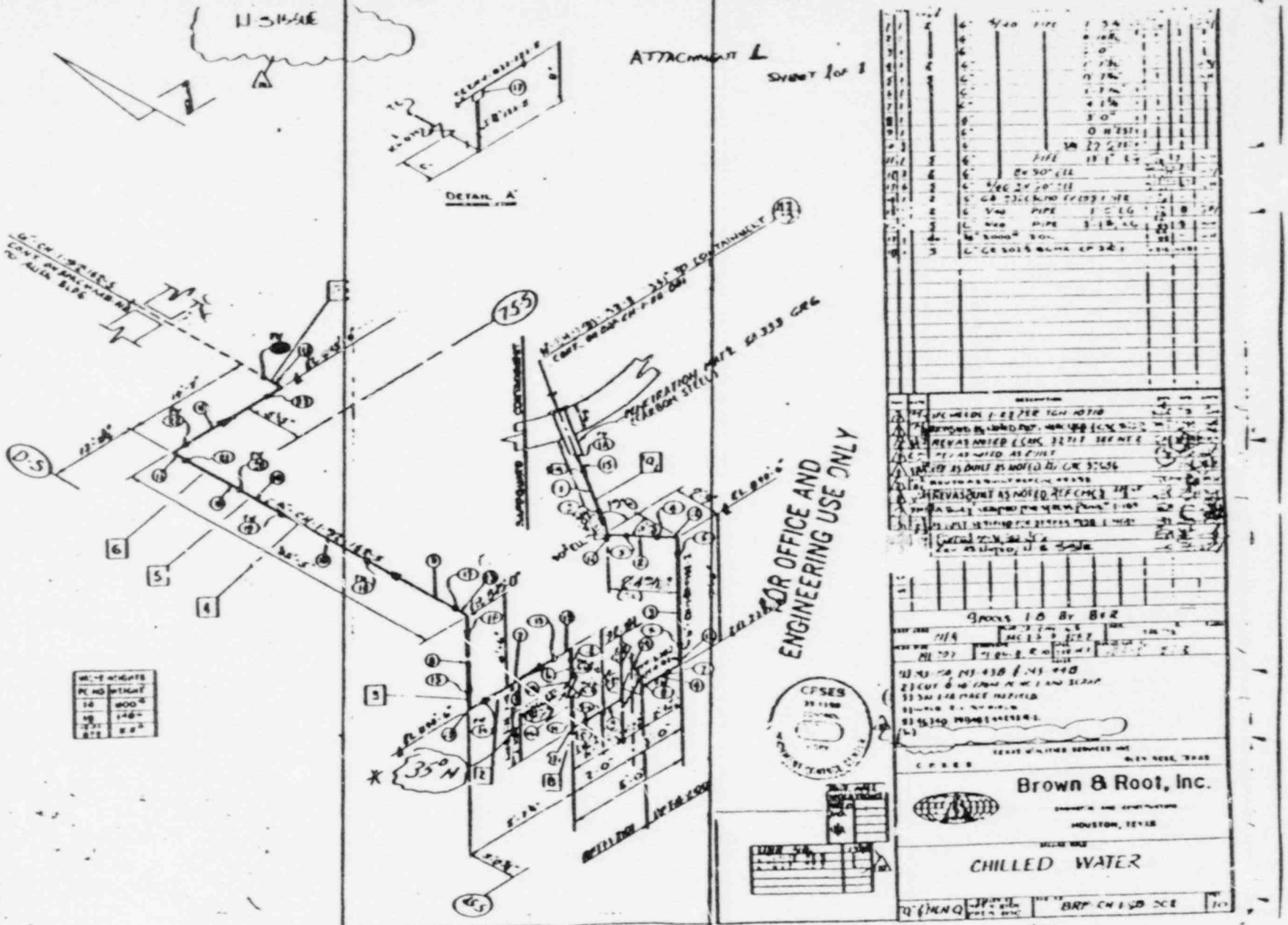
THIS DOCUMENT AFFECTED BY DESIGN CHANGES



ATTACHMENT K SHEET 1 OF 1

ATTACHMENT L

SHEET 1 OF 1



MISCELLANEOUS OBSERVATIONS FROM LARGE BORE WALKDOWN

The following conditions outside the scope of CPPP-5 were observed during the walkdown effort.

1. Pipe support CC-X-109-016-A65R is a voided support but is still installed in the field. This support does not appear on the hanger location drawing BRHL-CC-X-AB-041. Upon investigation, this support was requested to be removed via a memo dated May 22, 1979. SWEC walked down 8 of the 32 supports listed on this memo and all were found to be removed as requested.

2. The strut for support CC-1-116-002-F33R is stamped as CC-1-159-017-S53R. Reference BRHL-CC-1-FB-001.

3. Support SW-1-129-046-A43R is shown correct dimensionally but is incorrect pictorially on BRHL-SW-1-AB-005. The support is shown as being located east of the tee; actually, it is located west of the tee.

4. Support CC-1-033-005-S33K - The bottom two bolts on the south baseplate are not in full contact with the baseplate.

5. Support CC-1-204-019-C53R - A 3/4" Ø stainless steel line appears to be in contact with the strut. A rod hanger for the 3/4" Ø line is disconnected from the pipe in this area.

6. Support CC-1-011-007-A53R - Loose jam nut on strut.

7. BRP-BR-X-AB-005B Rev. 11 - Valve is identified as 1-8564A on piping drawing but is tagged as 1-8564B. Valve 1-8564B is tagged as 1-8564A.

8. Support CT-1-011-005-S22K - Items 11 and 12 are tube steel per revision 2 of drawing; however, original items 2 and 10 (W8x20) are still installed.

9. Support CT-021-001-S22R - Bearing is loose in strut paddle on clamp end.

10. Drawing BRP-MS-1-SB-045, revision 1, incorrectly shows the elevation of valve MS-063 at 887'-4 5/16". The elevation should be 877'-4 5/16".

CPPP-5 #1
(large bore)

STONE & WEBSTER ENGINEERING CORPORATION

STONE & WEBSTER ENGINEERING CORPORATION - NEW YORK
ONE PENN PLAZA
250 WEST 34TH STREET
NEW YORK, NEW YORK
ADDRESS ALL CORRESPONDENCE TO P.O. BOX 2325, NEW YORK, NEW YORK 10116

BOSTON
NEW YORK
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DENVER
CHICAGO
HOUSTON
PORTLAND, OREGON
WASHINGTON, D.C.

TELEPHONE (212) 290-8000
TELEX 12-9231
CABLE ADDRESS STONEBENG NEWYORK

Mr. John W. Beck
Vice President
Texas Utilities Generating Company
400 North Olive, L.B. 81
Dallas, Texas 75201

October 10, 1985

J.O. No. 15454
CPO-52

PIPING AND SUPPORT REQUALIFICATION PROGRAM
COMANCHE PEAK STEAM ELECTRIC STATION, UNIT NO. 1

Enclosure 1 Large Bore Field Walkdown Report
Enclosure 2 Miscellaneous Construction Discrepancies Observed

Enclosure 1 describes the results of the walkdown of large bore piping conducted by SWEC in accordance with Project Procedure CPPP-5. The conclusions of this report indicate that generic concerns exist that require consideration by the Comanche Peak Response Team (CPRT) and TUGCO Quality Assurance (QA). These concerns are summarized as follows:

- The orientation of valves and supports in piping systems are not correctly documented in the as-built documents. Expeditious resolution of this concern is necessary to preclude negative impact on SWEC's stress requalification schedule.

- Some items requiring correction which were identified during the as-built program have not been resolved.

We believe, with the commitment to resolve the above issues, the as-built program documentation is adequate to initiate stress requalification.

Enclosure 2 describes some construction discrepancies (e.g., loose bolts, strut/pipe lack of clearance) observed by the walkdown team. These discrepancies were not evaluated as part of the walkdown effort, and therefore should be resolved by CPRT and QA.

R P Klause

R. P. Klause
Project Manager

RPK:bjf
attachment

cc: J. B. George (TUGCO) - 1/1
J. C. Finneran (TUGCO) - 1/1
R. L. Cloud (RCLA) - 1/1
T. Snyder (TERA) - 1/1

#5

TEXAS UTILITIES GENERATING CO.
COMANCHE PEAK STEAM ELECTRIC STATION

IMPACT OF CONSTRUCTION DEVIATIONS ON STRESS REQUALIFICATION PROGRAM

STONE & WEBSTER

J.O.Nos. 15454/15616
Report No. 15454-N(C)-010

Job Book R4.8

IMPACT OF CONSTRUCTION DEVIATIONS ON STRESS REQUALIFICATION PROGRAM

COMANCHE PEAK STEAM ELECTRIC STATION
UNITS 1 AND 2

Prepared for

Texas Utilities Generating Company

by

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SUMMARY

Deviation reports (DRs) generated by the Evaluation Research Corporation (ERC) were evaluated by Stone & Webster Engineering Corporation (SWEC) for potential impact on SWEC's Stress Requalification Program (SRP) (Reference 7.1). Approximately 800 DRs related to the piping systems and supports were reviewed for this effort. The review confirmed the need to address clearances between piping and adjacent components/structures on a plantwide basis, as committed to in Section 7.2 of CPPP-6, Revision 2 (Reference 7.2). It also indicated the need to conduct a Hardware Validation Program (HVP), as recommended in Section 8 of L. S. Wigley's July 1986 report on Assessment of TUGCO's As-Built Documentation for Piping and Pipe Supports (Reference 7.3).

It was concluded that the concerns on clearances and other hardware problems do not impact the SWEC requalification program directly, and there is no need to change the stress requalification program or procedures to address the ERC-generated deviation reports on a specific or generic basis.

1.0 INTRODUCTION

The Construction Adequacy Program (CAP) is sponsored by the Comanche Peak Response Team (CPRT) of Texas Utilities Generating Company (TUGCO) to perform an independent reinspection of safety systems. Evaluation Research Corporation (ERC) has been contracted to perform this reinspection of the safety-related components on a sampling basis (Section 2.2 of Reference 7.4).

Each apparent construction deviation from the design drawing is identified by ERC and documented as a Deviation Report (DR).

The safety significance of these DRs in relation to reportability in accordance with 10CFR50.55(e) is continuously being evaluated by TUGCO. To determine the trends and adequacy of the sample size, ERC is also reviewing the DRs.

Concurrent with SWEC's Stress Requalification Program (SRP), TUGCO requested SWEC to evaluate independently the effects of the piping and pipe supports-related DRs on the SRP. SWEC was requested to develop a program to identify trends, if any, and make changes in the procedures, if necessary, to minimize the impact of these DRs when they are incorporated later into the as-built packages. Details of the SWEC program are as outlined in CPPP-18 (Reference 7.1).

2.0 PURPOSE

The purpose of this report is to describe the results, methods, and conclusions of SWEC's evaluation of the DRs for possible impact on the SRP. Deviations are categorized and discussed to identify the actions proposed. The review was limited to the ERC-DRs which were generated using following procedures:

QI-019	Reinspection of Small Bore Pipe Supports (SBPS)
QI-021	Reinspection of Piping System Bolted Joints/Material (PBOM)
QI-025	Reinspection of Large Bore Pipe Configuration (LBCO)
QI-026	Reinspection of Small Bore Pipe Configuration (SBCO)
QI-027	Inspection Procedures for Large Bore Supports Rigid (LBSR)
QI-029	Inspection Procedures for Large Bore Pipe Supports Nonrigid (LBSN)
QI-048	Reinspection of Small Bore Welds/Material (SBWM)
QI-049	Reinspection of Large Bore Piping Weld/Material (LBWM)
QI-051	Reinspection of Whip Restraints (PWRE)
QI-070	Reinspection of Tubing Welds/Material (TUWM)

3.0 REVIEW METHODS

This section describes details of the review methods used to evaluate the DRs for possible impact on the SRP. Section 3.1 addresses generation of the DRs by ERC, while Section 3.2 discusses the details of the review and the manner in which the review results were documented.

3.1 DEVIATION REPORTS (DRs)

The inspection procedures listed in Section 2.0 provide a set of criteria for inspection of various components of construction, defined as population groups. Inspections were performed on each of the population groups on a sampling basis and DRs were generated when the as-built condition deviated from the requirements of design drawings and specifications.

A typical DR is shown as Attachment 1 to this report. DRs from the following population groups were reviewed to determine the impact on the SRP:

LBCO:	Large Bore Piping Configuration
SBCO:	Small Bore Piping Configuration
LBSR:	Large Bore Pipe Supports - Rigid
LBSN:	Large Bore Pipe Supports - Nonrigid
PWRE:	Pipe Whip Restraints
SBPS:	Small Bore Pipe Supports
PBOM:	Piping System Bolted Joints/Materials
TUWM:	Tubing Welds/Materials
SBWM:	Small Bore Piping Welds/Materials
LBWM:	Large Bore Piping Welds/Materials

3.2 DETAILS OF THE REVIEW

The DRs for each of the population codes were obtained from ERC and a file was created. A log of all DRs (filed in Job Book R4.25, SWEC Evaluation of ERC Deviation Reports) in a population code also was prepared (Attachment 2). Table 1 provides the number of DRs that were reviewed for each population code.

Each DR was reviewed and classified as Category A, B, or C. Category A DRs include the deviations that have a potential impact on the design of the piping system and/or pipe supports. Category B DRs are hardware-related and thus will not affect the qualification methodology for the piping/pipe supports analysis. Category C DRs are neither design- nor hardware-related and do not require further evaluation for impact on the SRP. A categorization of DRs for each population code is given in Table 1.

4.0 RESULTS OF THE REVIEW

Results of the review for each DR were documented in a form shown in Attachment 3. Types of issues identified as a result of the review of DRs for each population code are summarized in Attachment 4. Table 2 provides a summary of issues and the number of DRs for each population code.

5.0 DISCUSSION OF RESULTS

It can be seen from Table 1 that approximately two-thirds of the deviations are Category A, while approximately one-third of the deviations are Category B. The number of Category C deviations is insignificant. As explained earlier, Category B deviations are hardward-related and do not affect the input to the SRP. The majority of Category B deviations are Items 7 through 11 in Table 2 and include missing locking devices, missing washers, paint on spherical bearings, clamp halves not parallel, and gaps greater than the smallest shim in rear brackets of snubbers. Significance of these deviations on the construction adequacy of the piping and pipe support systems has been assessed by the NRC under its Construction Adequacy Program and recommendations have been made or will be made by NRC to correct these deviations identified as construction deficiencies. L. S. Wigley also has recommended a program called Hardware Validation Program (HVP) as a part of the assessment of TUGCO as-built documentation for piping and pipe supports (Reference 7.3). Therefore, Category B deviations are not addressed further in this report.

Category A deviations identified in Table 2 as Items 1 through 6 and Item 12 are discussed below in detail.

Item 1 Locations/Dimensions Out-of-Tolerance

These deviations relate to the linear dimensions of piping/pipe supports and locations of pipe supports. Linear dimensions relate to the configuration/geometry of piping systems and supports and, if significant, may affect the stress analysis results. Of 136 total deviations for this item, 109 deviations are in the area of linear dimensions, while 21 deviations are related to the support locations. The remaining 6 deviations are in the area of elevation and bend radii of piping systems.

Details of the number of deviations for linear dimensions, support/restraint locations, and miscellaneous areas for various population groups are given in Table 3. Tables 4 and 5 provide details on the magnitudes of these deviations. Potential impact of these deviations on the stress analysis of piping systems is discussed below.

Linear Dimensions

In the piping configuration groups of LBCO and SBCO, 47 deviations out of a total of 50 deviations are less than 12 inches. These deviations in configuration of the piping represent small percentage changes in dimensions. Effects of these small changes on the stresses in piping systems and support loads would be small. Therefore, no further action is required to address these deviations.

The remaining 3 deviations (1 ft - 4 1/2 in. and 4 ft - 8 3/4 in. and 1 ft - 0 1/2 in.) are isolated cases and will be evaluated in the SRP.

In the pipe support/restraint population groups of LBSR, LBSM, SBPS, and PWRE, 50 out of a total of 59 deviations have linear dimension deviations of less than 3 in., six deviations (6 out of 59) are in the 3- to 6-in. range, and the remaining three deviations are between 7 in., 8 in., and

and 1 ft - 0 1/16 in. Fifty-six deviations less than 6 in. are related to bolt hole locations, base plate dimensions, pin-to-pin dimensions of struts, and geometry of support frame members being out of tolerances. These deviations represent small percentage changes in dimensions with no appreciable effects on the stress analysis results.

The other three deviations are as follows: 0 ft - 7 in. deviation is related to support I-beam located 7 in. above the required elevation. This changes the required rod length only and does not affect the design capacity of support components. The 8-in. deviation is in the required distance of 7 ft - 8 11/16 in. between the centerline of pipe and top of rear bracket of strut. This does not affect the capacity of support components adversely and thus is not significant. The remaining deviation of 1 ft - 0 1/16 in. is in the dimension between the centerline of tube steel support member and the the centerline of base plate. The ERC-SSE Group has reanalyzed the support with the revised geometry and found the support to be acceptable. Based on the above discussion, it is concluded that these deviations are insignificant and changes in the SRP are not required.

Support/Restraint Locations

Nine of the 21 DRs in this group are in the area of rupture restraints and thus do not affect the SRP. The remaining 12 DRs relate to the deviations in support locations. Ten of these deviations are less than 6 in., and two deviations are 9 in. and 9 1/8 in. These deviations are small and thus have no appreciable effect on the stress analysis of a piping system.

The remaining six deviations were in the areas of pipe elevations and bend radii with no adverse trend. Therefore, no impact on SRP is expected.

Item 2 Welds Missing, Undersized, or Underlength

A total of 113 deviations in this item were in the area of supports and restraints as shown in Table 2 and were related to the missing, undersized, or underlength welds.

The majority of these deviations were in the area of undersized welds (1/16 in. to 1/8 in.) over a small portion of the total welds length and thus would not reduce the overall strengths of the connections. It should be noted that the recent changes in the acceptance criteria of welds (Reference 7.6) allow 1/16 in. undersized weld for one-fourth of the weld length. This is based on computation of the reduced shear area due to undersized welds and limiting the reduction in the shear area percentage to reasonable values. Moreover, ERC has performed structural adequacy evaluation of the deviations for as-built weld configurations of individual supports/restraints and has concluded that support/restraint capacity is not affected significantly. Therefore, these deviations do not require further evaluation for impact on the stress requalification program.

Item 3 Clearance Violations

There were 82 deviations where small bore and large bore piping clearances were less than those required by the piping erection specification. The clearances are among pipe-to-pipe, pipe with wall penetration sleeves, and pipe with hangers, walls, handrails, etc. A final walkdown will be performed by SWEC at the completion of the stress requalification effort to verify that sufficient clearance exists between the piping systems and the adjacent structures (Section 7.2 of Reference 7.2). Therefore, no additional action is required.

Item 4 Anchor Bolt Violations

Of a total of 33 deviations in this item, 10 deviations were related to the depth of embedments being smaller than required, 9 deviations were in the area of minimum spacing requirements, and the remaining 14 were miscellaneous deviations. Embedment depths were shorter by a minimum of 0.125 in. for a required embedment of 6 1/2 in. to a maximum of 1.81 in. for a required embedment of 7 1/2 in. Spacing violations ranged from 0.125 in. of a required minimum of 5 5/8 in. to 4.75 in. for a required minimum spacing of 14 3/4 in. These violations have been evaluated by ERC on an individual basis using the reduced strengths of these bolts for smaller and overlapping shear cone capacities and found to be acceptable. Additionally, the number of cases is less than 5 percent with no adverse trend. Therefore, additional effort is not required in this area.

Item 5 Gaps in Connections and Supports

There were 25 deviations in pipe supports and 36 deviations in rupture restraints where either supports and piping had gaps which did not meet the design requirements or connections were not tight and mating surfaces did not bear at all locations.

A total of 25 DRs in pipe support population groups of LBSR and SBPS have gaps between piping and support frames/restraints which deviate from the required gaps by a minimum of ±1/32 in. to a maximum gap of +1/16 and -1/4 in. As a part of the SRP, the project has redefined the gap requirements for box frames and is reshimming the gaps to meet the revised requirements of Attachment 4-11 of CPPP-7 (Reference 7.5). Therefore, no further action is required to address these deviations.

The remaining 36 deviations are in the population group PWRE of rupture restraints. Since these deviations do not relate to the efforts of the SRP, they are not addressed further in this report.

Item 6 Richmond Inserts - Thread Engagement Less Than Minimum

There were a total of 28 deviations for pipe supports and restraints where thread engagement in Richmond inserts or of bolts into nuts was less than minimum. A total of 18 deviations in pipe support population groups of LBSR and LBSN and 2 deviations for pipe rupture restraint (PWRE) are for the Richmond inserts where thread engagement for 1 1/2-in.-diameter inserts are less than minimum of 3 1/8 in. The deviations range from 1/16 in. to 1 7/8 in. The remaining 8 deviations in

pipe rupture restraint population group PWRE have nuts which do not engage bolts fully. Capacities of these connections with thread engagement less than the minimum need to be established through analysis and/or testing. This issue is being addressed under the CPRT program for Issue ISAP V.b - Improper Shortening of Anchor Bolts in Steam Generator Upper Lateral Supports, and testing is planned. After the allowable capacities of these and other similar inserts are established through analysis/testing, structural adequacy of these connections should be evaluated to determine the need for any required modifications. No action is required at this time.

Item 12 Miscellaneous Deviations

Thirty-one out of 89 deviations in this category were related to either wrong items installed or missing items. These deviations are hardware-related and thus would be addressed under the HVP. The remaining 58 deviations relate to miscellaneous areas such as gap behind base plates (5), gouges due to grinding (4), angularity out of tolerance (4), gap between pipe and supports greater than tolerance (14), thread engagement in strut rods (9), and other miscellaneous items of specific nature. These deviations are small in number and do not have any generic implications on the stress requalification program. They also have been addressed by ERC on a specific basis and thus do not require any further action for the SRP.

6.0 CONCLUSIONS

Based on the discussion in Section 5.0, it is concluded that approximately one-third of the construction deviations are hardware related and should be corrected under the Hardware Validation Program. The other two-thirds of the deviations are related to six different items.

Item 1 is related to deviations in locations of supports and/or restraints and piping/supports linear dimensions out of specified tolerances. Magnitudes of deviations were evaluated, and it was concluded that the deviations do not show any trend and are not significant. Therefore, generic changes in the SRP are not required.

Item 2 is related to missing, undersized, and underlength welds where the majority of deviations were related to welds being undersized from 1/16 in. to 1/8 in. over a small portion of weld length. The overall strengths of these welds are not reduced significantly and therefore do not require a generic change in the SRP.

Item 3 is related to clearances between piping to piping and other components. A final walkdown will be performed by SWEC to resolve this item.

Item 4 is related to anchor bolts where the depth of embedments and the spacing did not meet the design requirements. These deviations have been evaluated and accepted by ERC using reduced strengths of the anchor bolts. There was also no adverse trend. Thus, no change in the SRP is required.

Item 5 relates to gaps in connections and gaps between piping and supports, and is being addressed by TUGCO as a part of the Hardware Validation Program.

Item 6 relates to inadequate thread engagement for Richmond inserts and is addressed as a part of the CPRT Issue Specific Action Plan (ISAP) V.b, where testing is planned to determine the capacities of inserts with inadequate thread engagement. No further action can be taken in the SRP at this time.

It is concluded, therefore, that there is no need to change the stress requalification program or procedures to address the ERC-generated deviation reports on a specific or generic basis.

7.0 REFERENCES

7.1 Comanche Peak Project Procedure CPPP-18, Procedure for Evaluation of ERC Deviation Reports, Revision 1, dated November 7, 1986

7.2 Comanche Peak Project Procedure CPPP-6, Pipe Stress/Support Requalification Procedure, Revision 2, dated April 18, 1986

7.3 Assessment of TUGCO As-Built Documentation for Piping and Pipe Supports, Final Report, dated July 2, 1986, L. S. Wigley

7.4 Safety Evaluation Report Related to the Operation of Comanche Peak Steam Electric Station, Units 1 and 2, NUREG-0797 Supplement No. 13, U.S. Nuclear Regulatory Commission, dated May 1986

7.5 Comanche Peak Project Procedure CPPP-7, Design Criteria for Pipe Stress and Pipe Supports, Revision 2, dated April 25, 1986

7.6 Visual Weld Acceptance Criteria for Structural Welding at Nuclear Power Plants, Revision 2, May 7, 1985, Nuclear Construction Issues Group, Southern Company Services, Birmingham, Alabama

TABLE 1

SUMMARY OF DEVIATION REPORTS

Population Code	No. of DRs Reviewed	No. of Deviations	Category		
			A	B	C
LBCO	61	74	64	10	0
SBCO	71	79	76	1	2
LBSR	154	174	96	67	11
LBSN	205	208	98	103	7
PWRE	212	225	136	88	1
SBPS	66	70	43	15	12
PBOM	11	11	4	6	1
TUWM	8	8	6	0	2
SBWM	1	1	1	0	0
LBWM	3	3	3	0	0
Total	792	853	527	290	36
Percent		100	61.8	34.0	4.2

TABLE 2

SUMMARY OF ISSUES

Deviation Issue	Category	No. of DRs in Population										Total	Percent
		LBCO	SBCO	LBSR	LBSN	PWRE	SBPS	PBOM	TUWM	SBWM	LBWM		
1. Locations/dimensions out of tolerance	A	23	33	20	20	30	10	0	0	0	0	136	16.0
2. Welds missing, undersized, or underlength	A	0	0	26	34	36	11	0	5	1	0	113	13.2
3. Clearance violations	A	39	43	0	0	0	0	0	0	0	0	82	9.6
4. Anchor bolt violations	A	-	-	8	13	2	6	0	0	0	0	29	
	B	-	-	1	-	2	0	0	0	0	0	3	3.9
	C	-	-	0	-	1	0	0	0	0	0	1	
5. Gaps in connections and supports	A	-	-	11	0	36	14	0	0	0	0	61	7.1
6. Richmond inserts -	A	-	-	13	5	9	0	0	0	0	0	27	
Thread engagement less than the minimum	B	-	-	-	-	1	0	-	-	-	-	1	3.3
7. Locking devices missing	B	-	-	3	14	12	6	0	0	0	0	35	4.1
8. Washers missing or not covering boltholes	B	-	-	0	0	26	0	0	0	0	0	26	3.0
9. Paint in spherical bearings for snubbers	B	-	-	16	25	0	2	0	0	0	0	43	5.0
10. Clamp halves not parallel	B	-	-	14	18	0	3	0	0	0	0	35	4.1

Deviation Issue	Category	No. of DRs in Population										Total	Percent
		LBCO	SBCO	LBSR	LBSN	PWRE	SBPS	PBOM	TUWM	SBWM	LBWM		
11. Gaps > smallest shim for snubber	B	-	-	14	16	0	0	0	0	0	0	30	3.6
	C	-	-	-	1	0	0	0	0	0	0	1	
12. Miscellaneous deviations	A	2	0	18	26	33	2	4	1	0	3	89	26.9
	B	10	1	19	30	37	4	6	0	0	0	107	
	C	0	2	11	6	0	12	1	2	0	0	34	
TOTAL		74	79	174	208	225	70	11	8	1	3	853	

TABLE 3

LINEAR DIMENSION/LOCATION DEVIATIONS

Population Group	No. of Deviations in the Area of: Linear Dimensions	Support/Restraint Locations	Pipe Elevation/ Bend Radius	Total DRs
LBCO	21	0	2	23
SBCO	29	0	4	33
LBSR	16	4	0	20
LBSN	15	5	0	20
PWRE	21	9	0	30
SBPS	7	3	0	10
Subtotal	109	21	6	136

Total: 136

TABLE 4

MAGNITUDES OF PIPING/SUPPORTS LINEAR DIMENSION DEVIATIONS

Population Group	Total DRs	Magnitudes of Deviations (Inches) 0-3	3-6	6-9	Greater Than 9
LBCO	21	15	5	1	0
SBCO	29	8	16	0	5 (Deviations of 1 ft - 4 1/2 in., 1 ft - 0 1/2 in., 0 ft - 10 in., 4 ft - 8 3/4 in. 1 ft - 0 in.)
LBSR	16	12	3	1	0
LBSN	15	11	2	1	1 (Deviation of 1 ft - 0 1/16 in.)
PWRE	21	20	1	0	0
SBPS	7	7	0	0	0
TOTAL	109	73	27	3	6

TABLE 5

MAGNITUDES OF SUPPORTS/RESTRAINT LOCATION DEVIATIONS

Population Group	Total DRs	Magnitudes of Deviations (Inches) 0-3	3-6	6-9	Greater Than 9
LBCO	0	0	0	0	0
SBCO	0	0	0	0	0
LBSR	4	3	1	0	0
LBSN	5	1	2	2 (0'-9" 0'-9 1/8")	0
PWRE	9	8	1	0	0
SBPS	3	3	0	0	0
TOTAL	21	15	4	2	0

ATTACHMENT 1

A TYPICAL DEVIATION REPORT

Page 1 of 1

Comanche Peak Response Team
ERC Deviation Report (DR)

DR NUMBER	ORIGINATOR	DATE
I-M-SBCD-026-1	David O. Hoss	8-29-85

IDENTIFICATION OF ITEM
LINE #2"-GH-X-136-62R-3
ISO # RRP. GH-X-AR-051

UNIT
☐ ONE ☐ TWO ☒ COMMON

SYSTEM AND LOCATION
WASTE PROCESSING GAS
AUX BLDG
ROOM 239
ELEV. 852'-6"

N/A REF NEW RT 306
TUGCO INSPECTOR
N/A REF NEW RT 306
TUGCO INSPECTION DATE

REQUIREMENT (INCLUDE CHECKLIST ITEM NO.)
QI-026 REV 0 SECTION 5.2.1a2 STATES IF THE LINE IS LESS THAN 200° OPERATING TEMP. A ONE INCH MINIMUM CLEARANCE INCLUDING INSULATION MAY BE MAINTAINED.

DEVIATION CONTRARY TO THE ABOVE REQUIREMENT, THERE IS A CLEARANCE OF ¼ TO ½ INCH BETWEEN THIS LINE AND ANOTHER 2 IN. LINE, INSULATION TO INSULATION. IT STARTS AT THE NORTH END OF THE LINE 2'-7" FROM THE TEE AND RUNS FOR 6'-7". IT STARTS AGAIN AT THE SOUTHERN MOST 45° ELBOW AND RUNS FOR 5'-2".

☒ YES ☐ NO ☐ PENDING (INCLUDE JUSTIFICATION AS REQUIRED)

W. S. Sheely — 8-29-85
FIRST REVIEWER — DATE

ORIGINATOR — DATE

VALID DR ☒ YES ☐ NO (INCLUDE JUSTIFICATION AS REQUIRED):
QI-026 Rev 0 requires a min. clearance of 1 in. including insulation. Since this clearance was not maintained this DR is valid

for J. Felts — 9-6-85
SECOND REVIEWER — DATE

ORIGINATOR — DATE

ATTACHMENT 2

LOG OF DRs

COMANCHE PEAK
REVIEW OF ERC - DRs FOR SRP

POPULATION CODE: ____________

DR. NO.	CATEGORY			TYPE OF DEVIATION		GENERIC RESOLUTION ITEM	REMARKS
	A	B	C	CODE	DESCRIPTION		

ATTACHMENT 3

COMANCHE PEAK STEAM ELECTRIC STATION
PIPING - PIPE SUPPORTS ERC DEVIATION REPORT (DR)
EVALUATION SHEET

DR No. _____ System _____

Reference:

BRP _____ BRH _____

BRHL _____ GHH _____

SWEC SRP Stress Problem No. _____

☐ Unit 1 ☐ Unit 2 ☐ Common

Deviation Type: M- S- C-

Deviation Summary:

Categorization: (1) Deviation Requires Drawing Change? Yes ☐ No ☐

(2) Deviation Affects SRP Calculation? Yes ☐ No ☐

Yes on Questions (1) and (2) Category A ☐

Yes on Question (2) Only Category B ☐

No on Questions (1) and (2) Category C ☐

Evaluation (include justification as required)

Evaluated by: _____ _____ (Date)

Reviewed by: _____ _____ (Date)

ATTACHMENT 4

RESULTS OF THE REVIEW

I. Population Code IM-LBCO

II. Number and Category of DRs Reviewed 61

Category A 64 Category B 10 Category C 0 Total 74

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Pipe to pipe clearance	18	A	3
2.	Linear dimension out of tolerance	10	A	1
3.	Out-of-location tolerance	11	A	1
4.	Pipe-to-support clearance	10	A	3
5.	Pipe-to-conduit or cable tray clearance	5	A	3
6.	Pipe-to-sleeve clearance	4	A	3
7.	Valve installed backwards	3	B	12
8.	Material installed wrong or missing	2	A	12
9.	Elevation out of tolerance	2	A	1
10.	Flow element installed backwards	3	B	12
11.	ID problems	1	B	12
12.	Expansion joint out of tolerance	1	B	12
13.	Missing jam nut on tie bar	1	B	12
14.	Flow arrow on valve missing	1	B	12
15.	Pipe-to-wall clearance	2	A	3

ATTACHMENT 4 (Cont)

RESULTS OF THE REVIEW

I. Population Code IM-SBCO

II. Number and Category of DRs Reviewed 71

Category A 76 Category B 1 Category C 2 Total 79

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Pipe-to-pipe clearance	27	A	3
2.	Linear piping dimension out of tolerance	18	A	1
3.	Out-of-location tolerance	11	A	1
4.	Pipe-to-support clearance	7	A	3
5.	Valve clearance	4	A	3
6.	Pipe-to-sleeve clearance	3	A	3
7.	Elevation out of tolerance	3	A	1
8.	Pipe-to-cable tray clearance	2	A	3
9.	Valve installed with flow arrow reversed	1	B	12
10.	Pipe bend greater than tolerance	1	A	1
11.	Conflict in valve identification	1	C	12
12.	Missing identification	1	C	12

ATTACHMENT 4 (Cont)

I. Population Code IS-LBSR

II. Number and Category of DRs Reviewed 154

Category A 96 Category B 67 Category C 11 Total 174

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Weld missing, undersized, or under-length	26	A	2
2.	Anchor bolt violations	8	A	4
			B	
3.	Member or plate out of tolerance	16	A	1
4.	Paint on spherical bearings	16	B	9
5.	Clamp halves out of parallelism	14	B	10
6.	Miscellaneous deviations	6	A	12
		5	B	
		1	C	
7.	Gaps between pipe and supports	11	A	5
8.	Thread engagement problems (strut assemblies) and nut threrads	1	A	12
		7	B	
9.	Gap on brackets $\geq$ smallest shim	14	B	11
10.	Mark identification problems	8	C	12
11.	Wrong item installed	4	A	12
		2	B	
		2	C	
12.	Gap behind base plate	4	A	12
13.	Locking devices missing or broken	3	B	7
14.	Angularity out of tolerance	3	A	12
15.	Support locations out of tolerance	4	A	1
16.	Cotter pin broken, missing, etc	4	B	12
17.	Missing items	1	B	12
18.	Thread engagement - Richmond inserts	13	A	6

ATTACHMENT 4 (Cont)

I. Population Code IS-LBSN

II. Number and Category of DRs Reviewed 205

Category A 98 Category B 103 Category C 7 Total 208

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Weld missing, undersized, or underlength	34	A	2
2.	Paint on spherical bearings	25	B	9
3.	Clamp halves out of parallelism	18	B	10
4.	Gaps on bracket of snubber ≥ smallest shim	16	B	11
		1	C	
5.	Anchor bolt violations	13	A	4
		1	B	12
		1	C	12
6.	Member or plate out of tolerance	15	A	1
7.	Miscellaneous deviations	7	A	12
		6	B	12
8.	Mark identification problems	9	B	12
		3	C	
9.	Wrong item installed	8	A	12
		5	B	12
		2	C	12
10.	Locking devices missing	10	B	7
11.	Thread engagement problems - Richmond inserts	5	A	6
12.	Missing items	4	A	12
		2	B	12
13.	Beveled washer missing (slope >1:20)	4	B	7
14.	Angularity out of tolerance	1	A	12
		3	B	
15.	Support location out of tolerance	5	A	1
16.	Cotter pin broken, missing, etc	4	B	12
17.	Thread engagement problems - threaded rods	6	A	12

ATTACHMENT 4 (Cont)

I. Population Code IS-PWRE

II. Number and Category of DRs Reviewed 212

Category A 137 Category B 88 Category C 1 Total 226

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Welds missing, undersized, or underlength, wrong type or location	36	A	2
2.	Gaps in bolted connections	26	A	5
3.	Members or plate out of tolerance	21	A	1
4.	Identification missing	18	B	12
5.	Wrong or extra material installed, or missing materials	11 6	A B	12
6.	Washers missing or do not cover hole	15	B	8
7.	Locking devices missing	12	B	7
8.	Gap between pipes and supports > tolerance	14	A	12
9.	Beveled washers missing	11	B	8
10.	Lack of full thread engagement	9 1	A B	6
11.	Shims do not cover 100 percent of mating surfaces	10	B	5
12.	Location out of tolerance	10	A	1
13.	Miscellaneous deviations	5 5	A B	12
14.	Cotter pin problems	5	B	12
15.	Anchor bolt violations	2 2 1	A B [illegible]	4
16.	Shim stacks not welded	3	B	12
17.	Gauges due to grinding	2	A	12
18.	Gap behind base plate	1	A	12

ATTACHMENT 4 (Cont)

I. Population Code IM-SBPS

II. Number and Category of DRs Reviewed 66

Category A 43 Category B 15 Category C 12 Total 70

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Gaps at deadweight supports	14	A	5
2.	Weld missing, undersized, or underlength	11	A	2
3.	Identification problems	8	C	12
4.	Anchor bolt violations	6	A	4
5.	Support dimensions > tolerance	6	A	1
6.	Material missing or wrong	1 2 2	A B C	12
7.	Locking devices missing	6	B	7
8.	Location of support > tolerance	4	A	1
9.	clamp halves out of parallelism	3	B	10
10.	Base plate has 1/4 in.-diameter x 1/4 in. holes	2	C	12
11.	Spherical bearing is painted	2	B	9
12.	Miscellaneous deviations	1 1	A B	12
13.	Thread engagement less than the minimum required (strut assembly)	1	B	12

ATTACHMENT 4 (Cont)

I. Population Code IM-PBOM

II. Number and Category of DRs Reviewed 11

Category A 4 Category B 6 Category C 1 Total 11

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Nuts are not tight	5	B	12
2.	Stud is not one thread higher than nut	2	A	12
3.	Capscrews installed instead of stud	1	A	12
4.	Gasket wrong color code	1	A	12
5.	No identification on flange	1	C	12
6.	Gasket does not cover flange	1	B	12

ATTACHMENT 4 (Cont)

I. Population Code SBWM

II. Number and Category of DRs Reviewed 1

Category A 1 Category B 0 Category C 0 Total 1

III. Issues Identified

Description	Numbers	Category	Item in Table 2
Undersized weld	1	A	2

ATTACHMENT 4 (Cont)

I. Population Code IM-TUWM

II. Number and Category of DRs Reviewed 8

Category A 6 Category B 0 Category C 2 Total 8

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Undercut on welds	3	A	2
2.	Wrong identification of weld	2	C	12
3.	Undersized welds	2	A	2
4.	Gouges due to grinding	1	A	12

ATTACHMENT 4 (Cont)

I. Population Code IM-LBWM

II. Number and Category of DRs Reviewed 3

Category A 3 Category B 0 Category C 0 Total 3

III. Issues Identified

	Description	Numbers	Category	Item in Table 2
1.	Rust on stainless steel pipe	1	A	12
2.	Gouging due to grinding	1	A	12
3.	Weld shrinkage	1	A	12

TABLE 1

SUMMARY OF DEVIATION REPORTS

Population Code	No. of DRs Reviewed	No. of Deviations	Category A	Category B	Category C
LBCO	61	74	64	10	0
SBCO	71	79	76	1	2
LBSR	134	174	96	67	11
LBSN	205	208	98	103	7
PWRE	212	225	136	88	1
SBPS	66	70	43	15	12
PBOM	11	11	4	6	1
TUWM	8	8	6	0	2
SBWM	1	1	1	0	0
LBWM	3	3	3	0	0
Total	792	853	527	290	36
Percent		100	61.8	34.0	4.2

#6

STONE & WEBSTER ENGINEERING CORPORATION

245 SUMMER STREET, BOSTON, MASSACHUSETTS

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W U TE: EX 94-0001
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DESIGN
CONSTRUCTION
REPORTS
EVALUATIONS
CONSULTING
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Re: Filing per Gen 79-14 and SWEC Walkdown Reports

Mr. Larry D. Nace
Vice-President, Engineering/Construction
Texas Utilities Generating Company
Comanche Peak Steam Electric Station
Farm Road 56
Glen Rose, Texas 76043

July 2, 1986

Dear Larry:

ASSESSMENT OF TUGCO AS-BUILT
DOCUMENTATION FOR PIPING AND PIPE SUPPORTS
COMANCHE PEAK STEAM ELECTRIC STATION

During the Nuclear Regulatory Commission (NRC)/Texas Utilities Generating Company (TUGCO) public meeting held on October 2 and 3, 1985, in Granbury, Texas, the NRC Staff raised questions about the TUGCO program and the organizations involved in addressing the requirements in NRC IE Bulletin 79-14, Seismic Analysis for As-Built Safety-Related Piping Systems. Subsequent to the above meeting, questions regarding the adequacy of the as-built documentation have been raised during NRC Staff audits of the Stone & Webster Engineering Corporation (SWEC) stress requalification program effort.

In April 1986, TUGCO commissioned a task group to conduct an overall assessment of relevant activities associated with piping and pipe supports at Comanche Peak Steam Electric Station - Unit 1. The purpose of this assessment was to determine whether the existing programs are effective to ensure the adequacy and completeness of the as-built documents used in the stress requalification program being performed by SWEC.

Attachment (1) provides the final report of this assessment.

Please call me at (617) 589-8170 (Boston) if you have any questions.

Very truly yours,

L. S. Wigley
Task Group Leader

Attachment: "Assessment of TUGCO As-Built Documentation for Piping and Pipe Supports," repor dated July 2, 1986.

cc: J.C. Finneran
J.E. Krechting
O.W. Lowe
T.G. Tyler

SWEC Internal CC:

W.A. Matson
E.J. Sisken
P. Dunlop
R.K. Westfahl
V.A. Hoffman
E.J. Brabazon
D.C. Foster
A.W. Chan
R.P. Klause
C.E. Watters
S. Feldman
R. Ackley

ASSESSMENT OF TUGCO AS-BUILT DOCUMENTATION FOR PIPING AND PIPE SUPPORTS

FINAL REPORT

TEXAS UTILITIES GENERATING COMPANY (TUGCO)
COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
UNIT 1

July 2, 1986

Prepared by: _____
M. P. Polachek - Principal Engr - Engr Mechanics

Prepared by: _____
R. A. Bain - Lead Engr - Engr Mechanics

Approved by: _____
L. S. Wigley - Group Leader

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KEY ABBREVIATIONS/DEFINITIONS

ASME III - Section III of the American Society of Mechanical Engineers Code

BRH - Brown & Root Pipe Hanger Drawing

BRHL - Brown & Root Pipe Hanger Location Drawing

BRP - Brown & Root Piping Isometrics

CAR - TUGCO Corrective Action Report

CPRT - Comanche Peak Response Team

CPSES - Comanche Peak Steam Electric Station

DR - Deviation Report

ERC - Evaluation Research Corporation

GHH - Gibbs & Hill Small Bore Pipe Hanger Location Drawing

HVP - Hardware Validation Program. Recommended as part of this assessment to be performed by TUGCO to ensure hardware adequacy of safety-related piping systems.

LDL - Line Designation List

NCR - Nonconformance Report issued by TUGCO

QA/QC - Quality Assurance/Quality Control

SWEC - Stone & Webster Engineering Corporation

SRP - Stress Requalification Program performed by SWEC

SVP - Supplemental Verification Programs. Recommended as part of this assessment to be performed by TUGCO to verify attributes related to safety-related piping systems.

TUGCO - Texas Utilities Generating Company

79-14 - NRC IE Bulletin 79-14 for the Seismic Analysis for As-Built Safety-Related Piping Systems

CPPP-5 - Comanche Peak Project Procedure for SWEC field walkdowns

CPPP-8 - Comanche Peak Project Procedure for piping and pipe support system engineering walkdown by SWEC

CPPP-6 - Comanche Peak Project Procedure for the pipe stress/support requalification effort

Safety Significant - As used in this report (and the ERC program), an identified discrepancy which, if uncorrected, could result in loss of capability of the affected system, structure, or component to perform its intended safety function (no credit is taken for redundancy).

10CFR50 - Title 10, Part 50 of the Code of Federal Regulations

10CFR50.55e - Section in the Code of Federal Regulations which contains the requirements for the reporting of potential issues which could adversely affect the safe operation of the plant.

Normal Inspection Process - QA/QC Inspection program originally performed by the installer contracted by TUGCO to meet the requirements of the Erection Specification, Appendix B to 10CFR50 and/or ASME III.

Safety-Related Piping System - As used in this report, an all-inclusive term which includes all ASME III piping and pipe supports. Also includes continuations of the code piping after the code class break up to the end of the pipe stress analytical model.

Computer-Analyzed - As used in this report, a term associated with small bore piping which reflects the type of detailed computer analysis used to analytically qualify the piping.

Noncomputer-Analyzed - As used in this report, a term associated with small bore piping which reflects the type of standard 'cookbook' or hand-calculated analysis used to qualify the piping.

Attribute - As used in this report, a term which refers to the qualitative characteristics of safety-related piping systems.

Large Bore Piping - Piping systems which are 2.5-inches nominal pipe diameter and greater.

Small Bore Piping - Piping systems which are less than 2.5-inches nominal pipe diameter.

Stress Requalification Program (SRP) - Requalification of safety-related piping and pipe supports being performed by SWEC.

Deviation - As used in this report, a verified failure to meet a licensing commitment, to meet a regulatory requirement, or to properly install hardware. Although this is a term defined by ERC, it also is used to represent SWEC observations for simplicity.

SUMMARY

During the Nuclear Regulatory Commission (NRC)/Texas Utilities Generating Company (TUGCO) public meeting held on October 2 and 3, 1985, in Granbury, Texas, the NRC Staff raised questions about the TUGCO program and the organizations involved in addressing the requirements of NRC IE Bulletin 79-14, Seismic Analysis for As-Built Safety-Related Piping Systems. TUGCO commissioned a task group to conduct an overall assessment of relevant activities associated with piping and pipe supports at Comanche Peak Steam Electric Station - Unit 1.

The purpose of this assessment was to determine whether the existing programs are effective to ensure the adequacy and completeness of the as-built documents used in the stress requalification program (SRP) being performed by Stone & Webster Engineering Corporation (SWEC).

The assessment process involved the identification of attributes that are required for input to pipe stress analysis and pipe support design. This included the attributes identified in NRC IE Bulletin 79-14 and other as-built documentation related to the SRP.

The existing programs of TUGCO, SWEC, and Evaluation Research Corporation (ERC) were reviewed to determine which key attributes were addressed. The procedures that evaluated the adequacy of these attributes and the organizational interfaces were also evaluated for completeness and effectiveness.

The assessment identified the following:

- There are existing procedures to ensure that all attributes identified in IE Bulletin 79-14 are verified. The assessment further identified that these procedures apply to other as-built documentation used in the SRP.

- There are programs in place to ensure that adverse as-built conditions are identified, evaluated for generic implications, and corrected; however, some improvements are recommended.

- Modifications of the programmatic interfaces are recommended to improve communication between the involved organizations.

Recommendations are presented by the Task Group that will enhance the overall program.

1.0 INTRODUCTION

During the Nuclear Regulatory Commission (NRC)/Texas Utilities Generating Company (TUGCO) public meeting held on October 2 and 3, 1985, in Granbury, Texas, the NRC Staff raised questions germane to the attributes in IE Bulletin 79-14, Seismic Analysis for As-Built Safety-Related Piping Systems, how they were being addressed and verified, and the relationship and interfaces between the organizations involved (TUGCO, Evaluation Research Corporation (ERC), and Stone & Webster Engineering Corporation (SWEC)). Subsequent to the above meeting, questions regarding the adequacy of the as-built documentation have been raised during NRC Staff audits of the SWEC effort.

TUGCO commissioned a Task Group of L. S. Wigley (SWEC - Group Leader), R. A. Bain (SWEC - Lead Engineer - Engineering Mechanics) and M. P. Polachek (SWEC - Principal Engineer - Engineering Mechanics) to conduct an overall assessment of activities associated with safety-related piping systems to address the above concerns.

2.0 PURPOSE

The purpose of this assessment was to determine whether the existing programs are effective to ensure the adequacy and completeness of the as-built documents used in the stress requalification program (SRP) being performed by SWEC.

3.0 SCOPE

The scope of this assessment includes:

1. An identification of as-built attributes critical to the SRP, including those in IE Bulletin 79-14, and the organizations responsible for verification of the attributes.

2. An evaluation of the programs currently in place at Comanche Peak Steam Electric Station (CPSES) - Unit 1 to verify the attributes.

3. An evaluation of the process followed by ERC, TUGCO, and SWEC for the evaluation of as-built discrepancies critical to the SRP, including the interface among the ERC, SWEC, and TUGCO programs and the applicable procedures used in the process.

Attachment 1 provides the action plan used by the Task Group for gathering and evaluating the information necessary to conduct this assessment.

4.0 ATTRIBUTES

Attributes associated with SWEC's SRP are listed in Table 1. All attributes identified in IE Bulletin 79-14 are included in this list.

Documents which are used to record the attributes also are identified in Table 1. The primary documents are American Society of Mechanical Engineers (ASME) control drawings for piping (BRPs) and hangers (BRHs), and

hanger locations (BRHLs for large bore piping and GHHs or BRHLs for small bore piping). Other drawings or documents used include the line designation list (LDL) for insulation, structural drawings for fire walls, and penetration schedule for penetration seals.

It is important to reinforce at the outset that the purpose of this assessment was not to inspect the attributes directly, but to determine: whether programs are in place to inspect the attributes; that the programs are effective; that the results are included in the stress requalification program (SRP); that root cause, trends, and generic implications are addressed; and that corrective action is taken, if appropriate.

Section 5.0 describes the programs of the involved organizations, while Section 6.0 discusses the adequacy and completeness of the programs and the attributes each verifies.

5.0 EXISTING PROGRAMS

5.1 TEXAS UTILITIES GENERATING COMPANY (TUGCO)

TUGCO developed a program for as-built piping verification to meet the general intent of IE Bulletin 79-14 requirements. Specifically, the TUGCO procedure (CP-EI-4.5-1) required a physical walkdown of piping systems in addition to the normal inspection process (described below). This as-built program verified the following:

1. Piping dimensions, elevations, and directional changes
2. Support and valve orientation
3. Sleeve clearance
4. Equipment orientation
5. Support mark numbers
6. Support and valve location
7. Support type
8. General support configuration
9. Clearance between the pipe and support

The above TUGCO procedure applied to all safety-related large bore and computer-analyzed small bore piping and pipe supports.

Other attributes not included in the above TUGCO as-built procedure were addressed in accordance with the normal inspection process. The normal inspection process, as used in this report, consists of the activities required to meet the ASME III code, Appendix B to Title 10, Part 50 of the Code of Federal Regulations (10CFR50), and/or the contractor specification. Also included in this term are the quality control procedures and construction procedures developed to meet these requirements. For

example, embedments were designed and installed in accordance with Comanche Peak Specification No. 2323-SS-30, Structural Embedments. The specification provided for a normal inspection program. No special walkdown was required.

Valve weights were addressed in accordance with the Valve Weighing Program, Comanche Peak Procedure No. CP-EI-2.2-1. The procedure provided for physical weighing of a representative sample of generic types of valves and operators. The procedure further provided for an engineering evaluation if the valve was not available for weighing or if additional information was required.

Pipe attachments are typically shown on the BRH for lugs or trunnions. Verification of this attribute was also dependent on the normal inspection process.

Table 1 lists other attributes related to safety-related piping systems which were not addressed in the TUGCO As-Built Program. Typically, these attributes were verified in accordance with the normal inspection process. Comanche Peak Specification No. 2323-MS-100 identified the requirements for piping and support erection. This normal inspection process was also used for the noncomputer-analyzed small bore piping excluded from the TUGCO As-Built Program.

In addition to the above programs, TUGCO is responsible for the processing of Comanche Peak Response Team (CPRT) Deviation Reports/Out-of-Scope Observations in accordance with Comanche Peak Procedure No. CP-QP-16.3. This procedure provides TUGCO with a mechanism to document, on nonconformance reports (NCRs), relevant ERC findings (discussed below) or any other organizations' (e.g., SWEC) relevant findings.

Additionally, TUGCO evaluates NCRs for potential reportability under 10CFR50.55e in accordance with Comanche Peak Procedure Nos. CP-QAP-16.1, Control of Nonconforming Items, and NEO-CS-1, Evaluation of and Reporting of items/events under 10CFR21 and 10CFR50.55(e). NCRs dispositioned use-as-is are evaluated by SWEC to verify the acceptability of the change to the design document. Generic corrective action and root cause are addressed in accordance with Comanche Peak Procedure No. CP-QP-17.0, Corrective Action.

5.2 STONE & WEBSTER ENGINEERING CORPORATION (SWEC)

TUGCO has contracted SWEC to perform a stress requalification effort for the safety-related piping and pipe supports on CPSES. As part of this effort, SWEC has performed three walkdowns to review existing TUGCO documents being used in the SRP. Two walkdowns were performed in accordance with Comanche Peak Project Procedure CPPP-5 and one in accordance with CPPP-8. Any deviations identified during these walkdowns have been or are being forwarded to TUGCO.

The two CPPP-5 walkdowns were sample inspections performed to verify that the existing documentation was adequate to initiate the SRP with an acceptable risk such that the analysis would not have to be redone upon completion of the ERC Program. Valve location, hanger location, hanger

function, and valve and support orientation were the attributes verified. These attributes were selected since they have the greatest potential for impact on pipe stress analysis. The first walkdown examined a sample of large bore Class 2 and 3 piping systems. A sample of the small bore noncomputer-analyzed piping systems which were not included in the TUGCO As-Built Program was addressed in the second walkdown.

The CPPP-8 walkdown was performed by experienced pipe stress and support engineers on a sample of large bore stress problems to review physical relationships and critical configurations which could impact conclusions regarding overall piping system design and acceptance. The objectives of this walkdown were as follows:

1. To determine whether there were technical configuration issues, other than existing technical findings from previous reviews, which should be evaluated relative to the functional behavior of the system, and

2. For experienced SWEC personnel to become familiar with the physical aspects of the design and determine whether additional refinements of design inputs, guidelines, or procedures were necessary for the SRP.

The walkdowns were based on a sample size of stress problems consistent with the ERC program (see below).

In addition to these walkdowns, SWEC has committed, in the Pipe Stress/Support Requalification Procedure (CPPP-6), to a final walkdown for clearances. This walkdown will ensure that any clearance violations exist between piping systems and nearby structures will be satisfactorily resolved based on the movements from the SRP.

5.3 EVALUATION RESEARCH CORPORATION (ERC)

ERC has developed a program to determine the adequacy of the CPSES construction Quality Assurance/Quality Control (QA/QC) program and the adequacy of the installed hardware. ERC was assigned this responsibility by the Comanche Peak Response Team (CPRT). The CPRT has been charged with responding to and resolving concerns raised by external sources (i.e., NRC Staff's Technical Review Team, NRC Staff's Construction Assessment Team, Cygna Independent Assessment Program) regarding the adequacy of safety-related hardware. Additionally, the CPRT is charged with advising TUGCO Management as to whether there is reasonable assurance that CPSES has been designed and constructed such that it is capable of being operated safely.

To this end, ERC has formulated a program with three main components. The first two address the issues raised by the external sources. The third component addresses the quality of construction as it relates to all safety-related aspects of the plant. This effort involves a sample reinspection of hardware that is representative of activities and processes used in the construction of safety-related aspects of the plant. Also included is the investigation and determination, where possible, of

the root cause of each identified safety-significant deficiency or adverse trend of nonsafety-significant deviations. The implications from the root cause are analyzed to determine the extent that other construction activities could be deficient for similar reasons. Generic implications, an overview of corrective action, and a collective evaluation of the deviations are also within the scope of the ERC program.

Pertinent to the SRP are the quality instructions (QIs), listed below, developed by ERC to address the construction adequacy of safety-related piping systems:

QI-19 Reinspection of Small Bore Pipe Supports
QI-21 Reinspection of Piping System Bolted Joint/Materials
QI-25 Reinspection of Large Bore Piping Configuration
QI-26 Reinspection of Small Bore Piping Configuration
QI-27 Reinspection of Large Bore Pipe Supports - Rigid
QI-29 Reinspection of Large Bore Pipe Supports - Nonrigid
QI-43 Reinspection of Concrete Placement
QI-49 Reinspection of Large Bore Piping - Welds/Materials
QI-51 Reinspection of Pipe Whip Restraints

Checklists were developed by ERC in accordance with the procedure for Preparation of Checklists and Data Base Reports (Comanche Project Procedure CPP-7) to identify the attributes to be inspected. The list of attributes and corresponding QI is prepared by the responsible ERC QA/QC discipline and reviewed and approved by the Lead Discipline Engineer and the QA/QC Engineering Supervisor. Inspections are then performed by personnel certified to Level II or III in accordance with American National Standards Institute (ANSI) N45.2.6, Qualifications of Inspection, Examination and Testing Personnel for the Construction Phase of Nuclear Power Plants; United States Nuclear Regulatory Commission Regulatory Guide 1.58, Qualification of Nuclear Power Plant Inspection, Examination and Testing Personnel; and additional requirements set forth in the ERC procedure for Indoctrination, Training and Certification of Personnel (CPP-3).

The inspections are based on a sampling plan described in detail in Appendix D of the CPRT Program Plan. Items not in conformance are recorded on Deviation Reports (DRs). The DRs are evaluated by the ERC's Safety Significance Evaluation Group for safety-significance in accordance with the ERC procedure for Safety-Significant Evaluations of Deviation Reports (CPP-16). Any item determined to have a potential safety-significant impact results in expanding the inspection sample potentially up to a 100-percent effort for the affected attribute.

Other pertinent procedures applicable to the ERC program include the following:

CPP-1 - Preparation of Project Procedures and Quality Instructions

CPP-5 - Establishing Population

CPP-6 - Sample Selection

CPP-11 - Evaluations of Adverse Trend Analysis, Safety-Significant Deficiencies, and QA/QC Program Deficiencies

CPP-13 - Collective Evaluation of the Quality of Construction

CPP-14 - Collective Evaluation of Construction QA/QC Program

CPP-21 - CPSES Project Corrective Action

All DRs are also forwarded to TUGCO QA in accordance with CPP-10 (Preparation of DRs) for generation of an NCR, if applicable.

5.4 SUMMARY OF EXISTING PROGRAMS

As discussed in further detail in Section 6.0, the attributes applicable to the SRP are being addressed by TUGCO, ERC, or SWEC; however, each organization has different purposes when reviewing the attributes as shown by the following:

1. TUGCO Normal Inspection process - performed by Brown & Root Quality Control personnel to meet the requirements of 10CFR50, Appendix B, and the ASME III Code.

2. TUGCO As-Built Program - performed to supplement the normal inspection process and to meet certain requirements of IE Bulletin 79-14.

3. TUGCO Specific Quality Control Backfit Type Inspections - performed due to design changes or generic corrective action programs.

4. ERC Program - performed to determine the quality of construction.

5. SWEC CPPP-5 Walkdowns - performed to assess the adequacy of key field inputs to the SRP.

6. SWEC CPPP-8 Walkdown - performed to determine the adequacy of the SRP procedures.

In general, the TUGCO normal inspection process was supplemented in part by the TUGCO as-built program. More recently, ERC sample inspections were also performed to determine the quality of construction. The SWEC sample inspections are also recent efforts which were performed to determine the adequacy of the requirements of the SRP procedures.

The interface and flow of work between the three organizations, shown in Figure 1, can be divided into six categories:

1. Initial information developed by TUGCO which is provided to SWEC and ERC.

2. Sample inspections by SWEC and ERC.

3. Evaluations and recommendations by SWEC and ERC (identification of individual deviations and generic concerns).

4. Corrective action by TUGCO (disposition of individual deviations and resolution of generic concerns).

5. Revision of documents by TUGCO and transmittal to SWEC for the SRP.

6. Completion of the SRP by SWEC.

The required documents are obtained from TUGCO by SWEC and ERC for their verification programs. These documents are also used by SWEC for the SRP. SWEC and ERC use sample techniques to evaluate the TUGCO documents. ERC identified deviations are evaluated by ERC for safety significance and adverse trends and, if necessary, are also forwarded to TUGCO for generic corrective action. SWEC deviations are evaluated by SWEC for impact on the SRP. SWEC generic concerns are addressed by revising the SRP procedures or by TUGCO generic corrective action. All ERC and SWEC individual deviations are forwarded to TUGCO to initiate an NCR.

All TUGCO NCRs related to safety-related piping systems and dispositioned "use-as-is" are distributed to SWEC and incorporated into the as-built documents to ensure that they are included in the SRP.

Figure 2 shows the interface between ERC and SWEC inspections and evaluations and TUGCO corrective action in more detail. Note that Figure 2 includes proposed programs recommended in Section 8.0.

6.0 DISCUSSION

A discussion of the attributes and the adequacy of various programs and procedures is presented in this section. In cases where the final conclusions of the ERC sample inspection programs and SWEC walkdown efforts have not been completed, the adequacy as discussed in this report is assessed based on draft reports and in-process data. In cases where ERC or SWEC concerns already have been identified, TUGCO corrective action is addressed as future work even though all or part may be in progress or complete.

6.1 ADEQUACY OF ATTRIBUTES

6.1.1 Adequacy of Attributes Included in the TUGCO As-Built Program

As shown in Table 2, the original TUGCO As-Built Program (described in Section 5.1) addressed several attributes. Table 2 also identifies the ERC and SWEC procedures that inspect the attributes and the procedures which have currently identified any generic concerns.

Support location and support function are attributes which were included in both the ERC and SWEC CPPP-5 programs. Pipe run geometry was indirectly included by virtue of checking support locations. No generic concerns that could result in TUGCO generic corrective action have been identified to date.

Support design was included in the ERC program and the SWEC CPPP-8 program for general configuration. Although deviations have been identified by both programs, it does not appear that this will result in a generic concern that requires TUGCO generic corrective action.

Although clearance between piping and supports (gaps) was included in the ERC and SWEC CPPP-8 programs, the specified tolerances have been revised as part of the SRP. The adequacy of this attribute will be addressed by TUGCO generic corrective action.

Valve identification and orientation were included in the ERC program and SWEC CPPP-5 program. No generic concern has been identified for the valve identification; however, the orientation has been identified as a generic concern which requires a TUGCO 100-percent reinspection. This is also the case for support orientation.

Clearances between piping and sleeves were included in the ERC and SWEC CPPP-8 programs; however, the ERC program only addressed this as a general clearance attribute. Sleeve clearance and type were not included as specific attributes. The CPPP-8 program did identify this to be a generic concern. As a result, all safety-related piping penetrations (including fire walls) will require TUGCO generic corrective action for clearance and type of seal.

In general, there are generic concerns regarding specific attributes included in the TUGCO As-Built Program. A root cause evaluation (discussed in Section 6.3, Corrective Action) and generic corrective action are necessary to resolve the concerns.

6.1.2 Adequacy of Other Attributes

As shown in Table 2, TUGCO also utilized the normal inspection process to address attributes related to the SRP. The ERC and SWEC procedures which inspected the attribute and the procedures which have identified any generic concerns also are tabulated. Some examples follow.

Embedments were included in the ERC program. Since they are not within the scope of the SRP, they were excluded from the SWEC programs. No generic concerns have been identified by ERC to date; however, while conducting a third-party design assessment, CYGNA Engineering Services determined that the normal inspection requirements were incomplete. Specifically, the minimum separation requirements for welded attachments to embedded plates and the minimum spacing criteria between loaded Richmond inserts and embedded plates were not specified. These requirements were not included in the ERC program. Generic corrective action by TUGCO is therefore necessary.

Pipe attachments were included in the ERC and SWEC CPPP-8 programs. No generic concerns have been identified.

Valve weights were reviewed as part of the SWEC CPPP-8 program. Since this attribute is not really related to the quality of construction, it was not included in the ERC program. The SWEC CPPP-8 program identified

a concern regarding the documentation of additional mass as a result of remote operators. TUGCO corrective action is necessary.

As listed in Table 2, other attributes related to safety-related piping systems were assessed. The majority of these attributes were addressed by TUGCO as part of the normal inspection process. Table 2 also shows the ERC and SWEC programs that address the attribute. Included also are the programs which have identified concerns to date (e.g., expansion joints, tie-back support location, Class 5 continuations, insulation, clamp and support orientation, and loose, missing, or damaged hardware).

6.1.3 Summary of Attributes

In general, the verification of each attribute falls into one of the following categories:

1. The attribute was originally included in a TUGCO inspection program (normal or as-built) and is verified in both the ERC and SWEC programs.

2. The attribute was originally included in a TUGCO inspection program and is verified in either the ERC program or the SWEC program.

3. The attribute was not originally included in a TUGCO inspection program and is verified as part of TUGCO generic corrective action.

In the first two cases, the SWEC and/or the ERC programs identify any individual deviation or generic concerns to TUGCO for corrective action. In the third case, missed attributes (i.e., embedments) are identified as part of design adequacy reviews which are conducted by SWEC and other organizations. These attributes are identified to TUGCO for generic corrective action.

Also, the adequacy of each attribute falls into one of the following:

1. The SWEC and/or ERC program(s) identified no deviations.

2. The SWEC and/or ERC program(s) identified deviations which require disposition on an NCR but which do not require generic corrective action.

3. SWEC and/or ERC and/or other organizations identified deviations and concerns which require disposition on an NCR and which also require generic corrective action.

In summary, there are programs in place to ensure that all attributes related to the SRP, including those identified in IE Bulletin 79-14, are included in a verification program and evaluated for adequacy. The adequacy of the SWEC and ERC evaluation process and TUGCO corrective action process is discussed in the following sections.

6.2 ADEQUACY OF EVALUATION PROCESS

Each individual deviation is dispositioned as part of the NCR program. The NCR process ensures that the particular deviation is corrected either by rework or by technical justification to use-as-is. Although the process also includes an evaluation for potential reportability under 10CFR50.55(e), it is unlikely that any one deviation considered by itself would be reportable. More important is the cumulation of similar deviations which could result in a generic concern. An evaluation for potential reportability of a generic conern is addressed in Section 6.3 as part of corrective action. The adequacy of the process by which the deviations are considered together is discussed in this section.

The ERC program is designed to verify the adequacy of construction as described in detail in the Comanche Peak Response Team Program. This program has been evaluated by the NRC (Safety Evaluation Report for CPSES, NUREG-0797, Supplement 13). The Staff concluded that the program provides an overall structure for addressing all existing and future issues and, if properly implemented, will provide important evidence of the construction quality of CPSES and will identify any needed corrective action. The Staff also identified items to be addressed during the implementation phase.

The quality of construction of piping and pipe supports is therefore addressed under the ERC program for those attributes in the program. As such, ERC is considered to be adequately verifying the as-built information being used by SWEC in the SRP. For those attributes not addressed in the ERC program, other programs are verifying their adequacy.

The SWEC CPPP-5 and 8 walkdowns address all field attributes that affect the adequacy of the SRP (embedments are not in the SRP scope). Although the SWEC deviations are not formally evaluated for trends, generic implications, and safety significance similar to the ERC deviations, SWEC does assess the deviations for generic impact on the SRP. Due to the nature of the SWEC programs, the assessment for impact on the SRP is essentially equivalent to a detailed trending, generic implication, and safety-significant evaluation. Specifically, the SWEC program does require that generic concerns which could impact the SRP are either corrected by TUGCO or corrected by refining or modifying the SRP procedures.

Since trending, generic implications, and safety significance for safety-related piping systems are being performed by ERC for construction quality and by SWEC for design adequacy, there is no need for TUGCO to repeat these efforts. It should be noted that this applies only to reinspections of work previously completed. For ongoing construction and current in-process inspections, TUGCO does have a program for trending, generic implications, and safety significance. This ensures that current trends are not improperly influenced by past trends.

In summary, each individual deviation is reviewed for potential reportability and dispositioned rework or use-as-is. The process by which individual deviations are evaluated is therefore considered adequate. The process by which deviations are evaluated for trends and generic implications is considered adequate based on acceptance of the ERC program by the NRC Staff and further supplemented by the SWEC program.

However, the effectiveness can be improved as described in Recommendations 8.3 and 8.4. Recommendation 8.3 suggests that SWEC also review the ERC DRs for impact on the SRP. Recommendation 8.4 suggests that ERC review the SWEC walkdown results to supplement ERC's collective evaluation.

6.3 ADEQUACY OF CORRECTIVE ACTION

Corrective action is addressed by TUGCO utilizing two main processes, NCRs and CARs. As stated above, the NCR process ensures that each individual deviation is processed to determine whether the deviation is valid. If the deviation is valid, an NCR is initiated and a determination is made as to whether the NCR should be reworked or used as is. Since SWEC evaluates all NCRs associated with safety-related piping systems, and the NCRs are further incorporated into the as-built documents, all valid individual deviations related to safety-related piping systems are considered in the SRP.

The corrective action report (CAR) is utilized by TUGCO to address the generic concerns identified by SWEC, ERC, or any other organization. This program ensures the concern is evaluated for extent, root cause, corrective action, and potential reportability under 10CFR50.55e. The CAR also is utilized to track the corrective action to closure.

Both ERC and SWEC identify generic concerns to TUGCO through independent programs. SWEC generic concerns are initially addressed through TUGCO Engineering, while ERC generic concerns are addressed through TUGCO Quality Control (QC). Although TUGCO QC and Engineering do interface, the process should be better defined to avoid a duplication of efforts.

Recommendations 8.1 and 8.2 suggest that TUGCO develop two types of programs to organize any generic corrective action which deals with verification of specific attributes. A hardware validation program (HVP - Section 8.1) would address items such as loose, missing, damaged, or misaligned hardware. A supplemental verification program (SVP - Section 8.2) would address other items such as penetration seal requirements, tie-back supports, and insulation thickness. The distinction between the two is that the HVP is geared towards tightening, replacing, or reworking the hardware so that there is no change to the as-built drawings, while the SVP is geared towards documenting changes to the current requirements that could affect the SRP. The two programs could directly refer to the NCR and CAR procedures to ensure that all TUGCO corrective action is appropriately addressed.

In summary, the process by which each individual deviation identified by SWEC or ERC is corrected is adequate. The process by which generic corrective action is addressed should be improved so that it will be better organized and efforts will not be duplicated.

7.0 CONCLUSIONS

The assessment identified the following:

- There are existing procedures to ensure that all attributes identified in IE Bulletin 79-14 are verified. The assessment further identified that there are existing procedures to ensure that other design inputs related to the SRP are verified.

- There are programs in place to ensure that adverse as-built conditions will be identified and corrected; however, some improvements should be implemented.

- Programmatic interfaces should be modified to improve communication between the involved organizations.

8.0 RECOMMENDATIONS

Figures 1 and 2 show the existing and recommended programs in flow chart form.

8.1 RECOMMENDATIONS REGARDING HARDWARE-RELATED CONCERNS

ERC and SWEC have and are in the process of identifying hardware-related concerns which normally will require rework to the specified requirements and have no impact on the SRP. Items such as missing cotter pins, loose jam nuts, damaged components, misaligned struts or snubbers, and nonparallel clamp ears are examples. These items should be grouped into a single verification program entitled hardware validation program (HVP) to improve the corrective action process. The following additional recommendations would then apply:

1. TUGCO should define the scope and establish the HVP program, since all concerns are identified to TUGCO.

2. Since the HVP will close ERC issues, ERC is required by program (CPP-21) to review the applicable HVP procedure and results. SWEC should also review the HVP procedure to ensure that SWEC concerns are adequately addressed.

3. The procedure should directly reference the procedures for corrective action and potential reportability addressed further in Recommendation 8.6. This will avoid duplication of efforts and organize the process.

4. Operations personnel should be involved to facilitate the transition from a final as-built system to an operating system. In addition, programs should be verified to be effective to ensure maintainability of as-built configurations. Modification of Procedures STA-802-5, Final Acceptance of Station Systems and Equipment, and STA-804-2, Control of Station Areas, should be considered to implement or interface with the HVP.

5. Scheduling of the HVP should consider the completion of modifications as a result of the SRP.

6. The HVP should be developed such that components can be corrected without having to generate individual NCRs. However, a system to identify corrected items should be provided. The followup report should include a quantitative analysis for historical record.

8.2 RECOMMENDATIONS REGARDING OTHER CONCERNS

ERC and SWEC have and are in the process of identifying other concerns which may or may not require rework to the specified requirements and therefore may affect the SRP. Items such as penetration type and clearance, fire wall clearance, insulation thickness and stand-off dimensions, tie-back supports, valve orientation, certain Class 5 continuation piping, embedments, and expansion joints are examples. Those items

evaluated by TUGCO to require a field verification should be grouped into a single program called the supplemental verification program (SVP) to improve the corrective action process. The following additional recommendations would then apply:

1. TUGCO should define the scope and establish the SVP program, since all concerns are identified to TUGCO.

2. Since the SVP will close ERC issues, ERC is required by program to review the applicable SVP procedure(s) and results. SWEC should also review the SVP procedure(s) to ensure that SWEC concerns are adequately addressed.

3. The procedure(s) should directly reference the procedures for corrective action and potential reportability addressed further in Recommendation 8.6. This will avoid duplication of efforts and organize the process.

4. Completion of the SVP and subsequent action should be expedited to minimize potential impacts to the SRP.

5. An accounting system to identify the corrected items should be provided for historical record.

6. The Protection and Analysis Group should participate in the resolution of penetration/sleeve concerns, since they have primary responsibility for the seals.

7. Resolution of concerns regarding embedments should consider identification of spacing violations and overloaded conditions as an initial objective. Since pipe supports may have to be modified to qualify the embedment, it is advantageous to identify these cases as early as possible.

8.3 RECOMMENDATIONS REGARDING REVIEW OF ERC DRs FOR IMPACT ON THE SRP

SWEC should review the ERC DRs related to safety-related piping systems to ensure that they are evaluated for potential impact on the SRP. This evaluation should be done to ensure that any potentially generic items are identified and evaluated to determine whether corrective action is required.

8.4 RECOMMENDATIONS REGARDING ERC REVIEW OF SWEC WALKDOWN RESULTS

ERC should review SWEC walkdown procedures and results to ensure that relevant information is utilized. Additionally, SWEC walkdowns may identify cases where TUGCO/SWEC have already evaluated or corrected a specific concern that overlaps an ERC concern.

8.5 RECOMMENDATIONS REGARDING DISTRIBUTION OF SWEC/ERC RESULTS

SWEC should provide ERC the walkdown reports. Conversely, ERC should provide the piping and pipe support DRs to SWEC.

8.6 RECOMMENDATIONS REGARDING ROOT CAUSE AND 10CFR50.55(e) EVALUATIONS

The root cause of the ERC/SWEC concerns should be addressed prior to initiating the HVP and SVP to prevent recurrence of the concern. Potential 10CFR50.55(e) evaluations should be grouped such that all deviations due to the same root cause are addressed once. This will provide for more meaningful preventive action and more efficient corrective action. For example, the evaluation of an insulation concern for root cause should consider the following:

1. Adequacy of original inspections

2. Adequacy of original criteria, such as minimum and maximum thickness requirements

3. Adequacy of QC inspection plan

4. Requirements to identify changes to the responsible stress analysis organization

After determining that one or more of these items represent the root cause, appropriate action can be taken to prevent recurrence of the concern. Corrective action should also consider that it may be expedient and less costly to proceed directly to a 100-percent verification.

8.7 RECOMMENDATIONS REGARDING PLANNING

A single TUGCO focal point (individual) should be responsible for monitoring all activities associated with completing the safety-related piping systems. The task should include the following:

1. Comprehensive scheduling of the SVP, HVP, and ongoing modifications or rework

2. NCR generation and disposition

3. Design change generation and disposition

4. Drawing updates and issue of revisions

9.0 REFERENCES

NRC IE Bulletin 79-14, Seismic Analysis for As-built Safety-Related Piping Systems

TUGCO Internal Guidelines for As-built Verification - Unit 1, Reverification of Strut, Snubber, Spring and Valve Orientation; Subsequent As-built Review; NCR/DN Tracking and Closure

TNE-AD-5-2, Processing Non-Conformance Results

TNE-DC-7-3, Preparation of Design Drawing by TSMD

TNE-DC-24-1, Program for As-built Piping Verification

TNE-DC-25, Control of Activities for the PSE HFT Results Groups

CP-EI-2.2-1, Valve Weighing Program

CP-EI-4.0-39, Performance Instruction for PSI HFT Design Change Control Group

CP-EI-4.5-1, General Program for As-built Piping Verification

CP-QAP-16.1, Control of Non-Conforming Items

CP-QP-16.3, Processing CPRT Deviation Reports/Out of Scope Observation

CP-QP-17.0, Corrective Action

STA-802-5, Final Acceptance of Station Systems and Equipment

STA-804-2, Control of Station Areas

NED-CS-1, Evaluation of the Reporting of Items/Events under 10CFR27 and 10CFR50.55(e)

CPP-001 through 023, Comanche Peak Response Team QA/QC Review Team Project Procedure

CPPP-5, Comanche Peak Project Procedure for Field Walkdown - Unit 1

CPPP-6, Comanche Peak Project Procedure for Pipe Stress/Support Requalification Effort - Unit 1

CPPP-7, Comanche Peak Project Procedure for Design Criteria for Pipe Stress and Pipe Supports

CPPP-8, Comanche Peak Project Procedure for Piping and Support System Engineering Walkdown - Unit 1

CPPP-18, Comanche Peak Project Procedure for the Evaluation by SWEC of Deviation Reports Generated by the ERC

Specification No. 2323-SS-30, Structural Embedments

Specification No. 2323-MS-21, Valve Extension Stems

Specification No. 2323-MS-46A, Nuclear Safety Class Pipe Hangers and Supports

Specification No. 2323-MS-100, Piping Erection

Specification No. 2323-MS-200, Design Specification for all ASME III Code Class 2 and 3 Piping

QI-019, Reinspection of Small Bore Pipe Supports

QI-021, Reinspection of Piping System Bolted Joints/Material

QI-025, Reinspection of Large Bore Piping Configuration

QI-026, Reinspection of Small Bore Piping Configuration

QI-027, Inspection Procedures for Large Bore Pipe Supports - Rigid

QI-029, Inspection Procedures for Large Bore Pipe Supports - Non-Rigid

QI-043, Reinspection of Concrete Placement

QI-049, Reinspection of Large Bore Piping - Welds/Material

QI-051, Reinspection of Pipe Whip Restraints

TUGCO Letter No. TXX-3597 (to NRC), IE Bulletin 79-14, dated December 3, 1982

TUGCO Letter No. TXX-4729 (to NRC), Status of As-built Verification Program, dated April 6, 1986

NUREG-0797, Supplement No. 13, Safety Evaluation Report Related to the Operation of Comanche Peak Steam and Electric Station, Units 1 and 2 (Docket Nos. 50-445 and 50-446) dated May 1986

TABLE 1

ATTRIBUTES

1. Pipe run geometry is shown on Brown & Root Piping Drawings (BRP).

2. Support design is shown on support hanger drawings (BRH).

3. Support location is shown on large and small bore hanger location drawings (BRHLs and GHHs).

4. Support function is shown on BRHs.

5. Support clearances/gaps are shown on BRHs.

6. Embedments are shown on structural drawings.

7. Pipe attachments are shown on BRPs.

8. Valve and Valve Operator Location

   a. Identification is shown on BRPs.

   b. Orientation is shown on BRPs.

9. Valve and valve operator weights are controlled by the valve list.

10. Clearance between pipe and sleeves are shown on BRPs. Fire walls are shown on structural drawings, and penetrations are shown on the penetration schedule.

11. Component type and identification (valves, strainers, expansion joints, flanges, reducers, flex hoses) are shown on BRPs.

12. Bends/elbows (standard, short radius, 5D, etc) are shown on BRPs.

13. Branch connection types (ANSI tee, unreinforced tee, reinforced tee, sockolet, weldolet, boss, coupling, half coupling, swagelock) are shown on BRPs.

14. Branches/intersections (small bore, vents and drains, instrumentation taps) are shown on BRPs.

15. Equipment locations and identification are shown on BRPs.

16. Material type/size/class (including substitutions and specification violations) are shown on BRPs and specification NCRs.

17. Tie-back supports are shown on small bore hanger drawings (BRHs) and small bore hanger location drawings (GHHs).

18. Identifications and type of supports are shown on BRHs.

19. Support welds are shown on BRHs.

20. Base plates are shown on BRHs.

21. Integral/nonintegral attachments to pipe are shown on BRHs, except for those abandoned which are shown on the BRPs.

22. Attachments to support structures are shown on BRHs.

23. Bill of materials is shown on BRHs.

24. Class 5 piping installation analyzed with Class 1, 2, and 3 piping is shown on BRHs, BRHLs, and GHHs.

25. Insulation thickness and type is shown on the LDL.

26. Whip restraints/moment restraints are shown on structural drawings and Brown & Root installation drawings.

27. Support/clamp orientation is shown on BRHs.

TABLE 2

ATTRIBUTE MATRIX

INSPECTION/VERIFICATION PROGRAMS

	Items	TUGCO	ERC	SWEC (Note 1)	Remarks
1.	Pipe run geometry	A/B Program	QI-25,26	CPPP-5	CPPP-5 indirectly verifies geome /
2.	Support design (configuration)	A/B Program	QI-19,27,29	CPPP-8	
3.	Support location	A/B Program	QI-19,27,29	CPPP-5	
4.	Support function	A/B Program	QI-19,27,29	CPPP-5	
5.	Support clearances/gaps	A/B Program	QI-19,27,29	CPPP-5, 8	Being Verified to Revised Criteria
6.	Embedments				
	a. Spacing of attachments	No	No	No	CYGNA Concern (Note 2)
	b. Other embedment attributes	Normal Insp	QI-43	No	
7.	Pipe attachments	Normal Insp	QI-25,26	CPPP-8	
8.	Valves				
	Identification	A/B Program	QI-25,26	CPPP-8	
	Orientation	A/B Program	QI-25,26	CPPP-5	CPPP-5 Concern (Note 2)
9.	Valve weights	Normal Insp	No	CPPP-8	CPPP-8 Concern (Note 2)
10.	Clearance				
	Sleeve type	A/B Program	No	CPPP-8	CPPP-8 Concern (Note 2)

TAB (C

Items	TUGCO	ERC	SWEC	Remarks
Sleeve clearance	A/B Program	No	CPPP-6, 8	CPPP-8 Concern (Note 2)
Fire walls	A/B Program	No	CPPP-8	CPPP-8 Concern (Note 2)
11. Piping components	A/B Program	QI-25,26	CPPP-5, 8	ERC and CPPP-8 Concern for Expansion Joints Only (Note 2)
12. Piping bends	Normal Insp	QI-25,26	CPPP-5	
13. Branch type	Normal Insp	QI-25,26	CPPP-8	
14. Branch locations	Normal Insp	QI-25,26	CPPP-5	
15. Equipment location/id	A/B Program	QI-25,26	CPPP-5, 8	
16. Piping material	Normal Insp	QI-25,26	CPPP-18	
17. Tie-back supports	Normal Insp	No	CPPP-8	CPPP-8 Concern (Note 2)
18. Support identification/type	A/B Program	QI-19,27,29	CPPP-5, 8	
19. Support welds	Normal Insp	QI-19,27,29	No	
20. Base plates	Normal Insp	QI-19,27,29	CPPP-8	
21. Integral/nonintegral attachments	Normal Insp	QI-19,27,29	CPPP-8	
22. Support attachments	Normal Insp	QI-19,27,29	CPPP-8	
23. Bill of materials	Normal Insp	QI-19,27,29	CPPP-8	
24. Class 5 continuations	Normal Insp	No	CPPP-8	CPPP-8 Concern (Note 2)
25. Insulation	Normal Insp	No	CPPP-8	CPPP-8 Concern (Note 2)

Items	TUGCO	ERC	SWEC (Note 1)	Remarks
26. Moment restraints	Normal Insp	QI-51	CPPP-8	
27. Hardware	Normal Insp	All	CPPP-8	ERC and CPPP-8 Concern (Note 3)
28. Clamp/support orientation	Normal Insp	QI-26,27,29	CPPP-5, 8	ERC and CPPP-8 Concern (Note 2)
29. Clearances	Normal Insp	All	CPPP-6	

INSPECTION DESCRIPTION

TUGCO	ERC	SWEC
Normal Insp - Covered by Brown & Root Inspection Program for ASME piping and pipe supports	QI-19 - small bore pipe supports	CPPP-5 - initial SWEC walkdown for key attributes only
	QI-21 - bolted joints	CPPP-8 - SWEC walkdown for general attributes
	QI-25 - large bore piping	
A/B Program - Covered by Brown & Root Inspection Program CP-EI-4.5-1 for large bore and small bore computer-analyzed piping	QI-26 - small bore piping	CPPP-6 - final walkdown for clear e
	QI-27 & 29 - large bore pipe support	
	QI-43 - concrete placement	
	QI-51 - whip restraints	

Note 1 A SWEC procedure is recommended (8.3) to review deviations identified by ERC.

Note 2 Resolution of the concern is a candidate for the SVP (8.2).

Note 3 Resolution of the concern is a candidate for the HVP (8.1).

FIGURE 1

ORGANIZATIONAL INTERRELATIONSHIPS

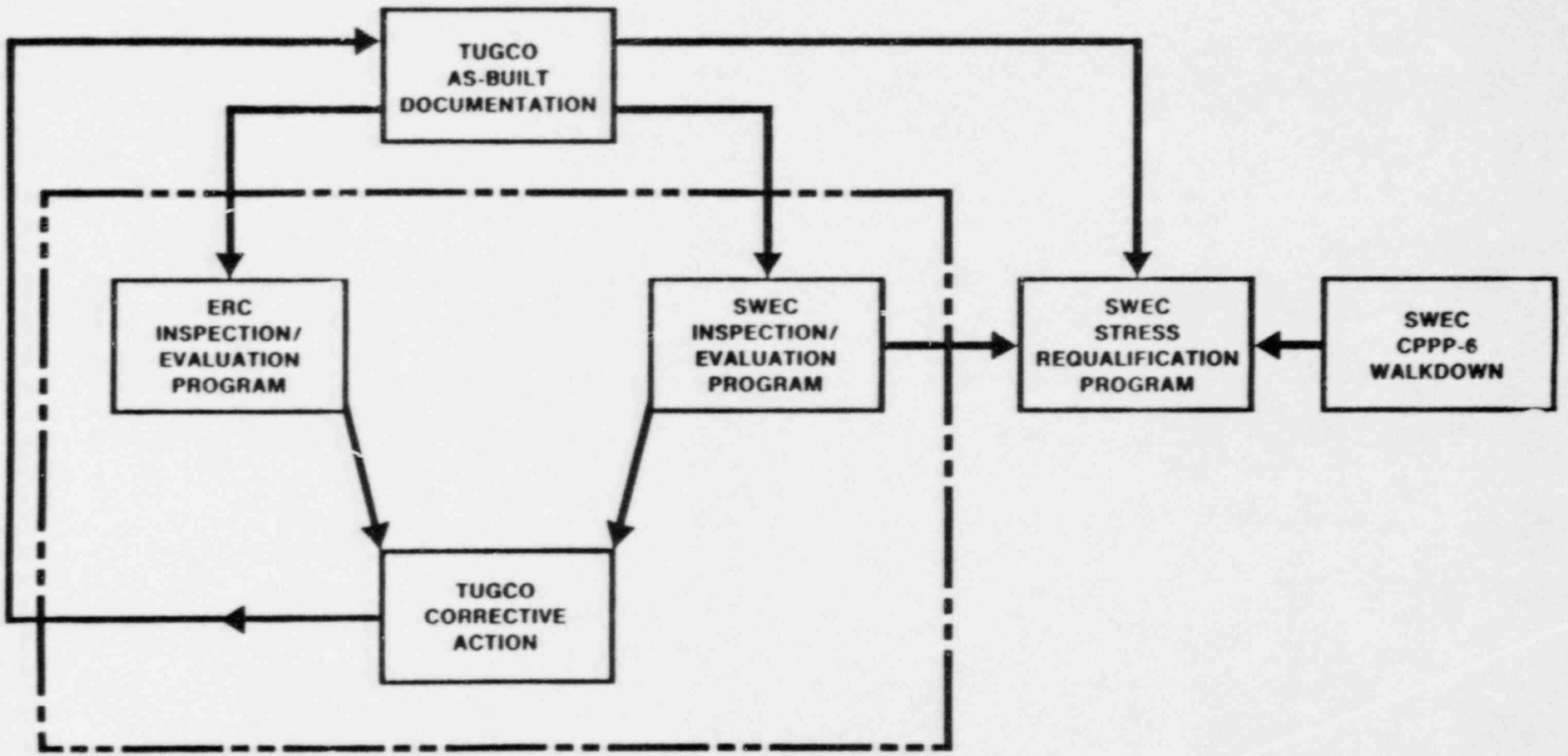
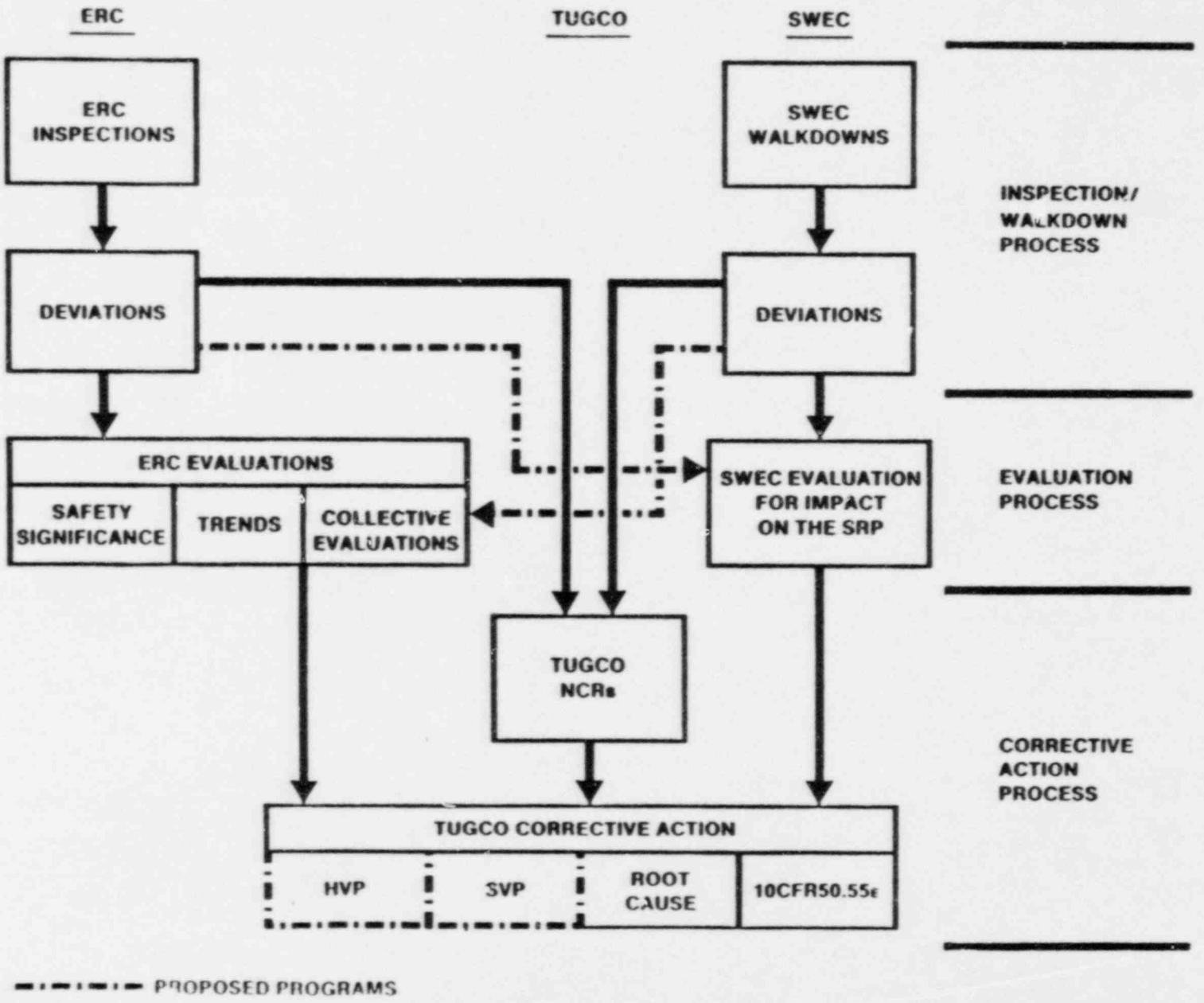


FIGURE 2

ORGANIZATIONAL INTERRELATIONSHIPS — DETAILED FLOWCHART



ATTACHMENT 1

ACTION PLAN

1. List all attributes required to fulfill the requirements of NRC IE Bulletin 79-14 and Supplements.

2. Identify attributes covered under TUGCO IE Bulletin 79-14 walkdown program which are to include, but not be limited to, the following:

   a. Procedures used for project (copy of each, plus description).
   b. Report(s) of original effort.
   c. Final documents resulting from TUGCO program.
   d. Procedures to ensure that the documentation is kept up to date.

      1) Examples from current SWEC effort.
      2) Include discussion of how current modifications are controlled/verified.

3. Verify that attributes required by Item 1 above are included in program. If not all-inclusive, discuss action taken to verify/complete.

4. Describe the ERC process associated with Issue-Specific Action Plan VII.c (Construction Reinspection/Documentation Review Plan). Description is to include, but not be limited to, the following:

   a. List procedures associated with IE Bulletin 79-14 attributes and process directives associated with pipe stress, pipe supports, piping configuration, and concrete population, if applicable.

   b. Identify the attributes in the ERC program that are applicable to the SWEC Stress Requalification Program (SRP).

   c. Describe ERC DR program, root cause/generic implication, and trend analysis.

   d. Determine whether ERC should provide a copy of all DRs associated with the SRP to SWEC.

   e. Determine whether ERC, as part of the program, should analyze all DRs that are associated with SWEC.

   f. Compare ERC and IE Bulletin 79-14 required attributes.

   g. Determine whether ERC should change/develop a procedure (formalize process) for d. above.

5. Describe the SWEC (SRP) Discipline-Specific Action Plan (DSAP IX). Description is to include, but not be limited to, the following:

   a. List procedures associated with IE Bulletin 79-14 attributes and process directives related to pipe stress, pipe supports, and piping configuration.

   b. Identify all attributes (documents):

      1) That are associated with pipe stress.
      2) That are associated with pipe supports.

   c. Identify what attributes SWEC is using for the SRP.

      1) Identify sources of the above documents.
      2) Evaluate adequacy of the above information.

   d. Evaluate document control procedure for TUGCO.

      1) Determine whether ERC is looking at this under a separate ERC Action Plan and review the preliminary results.

      2) Evaluate whether the documents being sent to SWEC are current.

   e. Describe walkdowns conducted by SWEC (SRP), to include:

      1) CPPP-5 (2)
      2) CPPP-8 (1)
      3) CPPP-6 (to be done)

      and results and implications for as-built data from these walkdowns.

   f. Determine if a formalized program should be developed by SWEC to evaluate all DRs received from ERC and NCRs from TUGCO.

      1) Include consideration of generic implication, a trend analysis program, and SWEC's need to develop a procedure.

6. Compare attributes of ERC and SWEC programs to ensure that all attributes associated with the SRP are examined.

   If not all covered, identify verification program to examine.

7. Describe the overall integration of the TUGCO, ERC, and SWEC programs associated with the piping and pipe support stress program. Description is to include, but not be limited to, the following:

   a. All SWEC walkdowns.

      - What has TUGCO done as a result of the walkdown data?

Enclosure 2

15454-N(C)-007
File R4.8
Revision 2

#7

DOCUMENTATION OF ASME III NA-1140 REVIEW FOR PIPING AND SUPPORTS

Prepared for

TEXAS UTILITIES ELECTRIC COMPANY (TU ELECTRIC)
COMANCHE PEAK STEAM ELECTRIC STATION
UNITS 1 AND 2

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Discussion	Item 9. Editorial corrections in first paragraph.
Discussion	Item 10. Complete revision of discussion to reflect the effect of pre-1974 requirements in accordance with Code interpretation III-1-83-96.
Discussion	Item 11. Second paragraph was revised to indicate that the design margin may be reduced to that inherent in the code design methods and allowables.

BACKGROUND

Safety-related piping and pipe supports on the Comanche Peak Steam Electric Station (CPSES) Units 1 and 2 are designed and constructed to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Section III, Division I, Rules for Construction of Nuclear Power Plant Components (Code) (Reference 1). Paragraph NA-1140(f) of the Code provides rules for the use of specific provisions within an edition or addendum, provided all related requirements are met. For CPSES piping, the Code effective date (Code of record) is the 1974 Edition, including the Summer 1974 Addenda. For pipe supports, the Code of record is the 1974 Edition, including the Winter 1974 Addenda.

Many code requirements for piping and pipe supports, at the time of and as specified within the Code of record in 1974, were either not explicitly addressed or were still under development. For example, since the first issuance of Subsection NF for component supports in the 1974 Code Edition, the requirement of intervening elements in relation to jurisdictional boundaries was not specified until the later 1980 Code Edition (see Item 6 in Discussion). In order to provide more definitive design requirements and additional Code guidance developed subsequent to the issuance of the Code of record, the design criteria for requalification of CPSES piping and pipe supports, CPPP-7 (Reference 2) invoked specific provisions of later Code editions/addenda, as permitted by NA-1140(f) of the Code of record. Review of all related requirements for these alternatives to the Code of record was performed to justify their implementation.

OBJECTIVE

This report documents the results of the review performed in order to assure that the use of specific Code provisions in CPPP-7 (Reference 2) is in conformance with Paragraph NA-1140(f) of the Code, which states:

> "Code Editions, Addenda, and Cases which have not become mandatory on the contract date for a component may be used by mutual consent of the Owner or his agent and Manufacturer or Installer on or after the dates permitted by (a) through (d) above. It is permitted to use specific provisions within an Edition or Addenda provided that all related requirements are met."

The report will document compliance with the above paragraph for the alternates to the code of record, which are listed in Sections 2.1 and 2.2 of CPPP-7 and Project Memorandum PM-163 (Reference 3). Related requirements (if any) will be defined and identified, and the method of compliance to them will be explained.

REFERENCES

1. American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, 1974 Edition

2. Project Procedure CPPP-7, Design Criteria for Pipe Stress and Pipe Supports, Revision 3, February 23, 1987

3. Project Memorandum PM-163, CPPP-7 Piping and Pipe Support Code Applicability Changes, May 27, 1987

4. Report No. SEM-001-001, ASME Code Stress Intensification Factors for Comanche Peak Steam Electric Station - Units 1 and 2, by S. E. Moore, May 21, 1987

5. Project Memorandum PM-155, Stress Intensification Factors Evaluation of Branch Connections, June 8, 1987

6. Project Procedure CPPP-6, Pipe Stress/Support Requalification Procedure - Unit 1, Revision 4, April 8, 1987

7. Project Procedure CPPP-9, Pipe Stress/Support As-Built Procedure - Unit 2, Revision 4, April 8, 1987

8. Piping Erection Specification No. 2323-MS-100, Revision 9, July 9, 1987

CONCLUSIONS

The related requirements for the invoked special paragraphs from the later Code editions/addenda have been identified, reviewed, and addressed in Items 1 through 12 of the Discussion section. CPPP-7 incorporated these special paragraphs to provide additional and more rigorous Code guidance. These alternates represent the mandatory design requirements (with the exception of nonmandatory Appendix O in Item 1) of later Code editions, but were not explicitly addressed by the Code of record.

All applicable requirements related to these alternates have been implemented and incorporated in the CPSES piping and pipe support requalification project procedures. As a result, application of all the alternates invoked in Sections 2.1 and 2.2 of CPPP-7 and PM-163 are in compliance with of Paragraph NA-1140(f) of the Code of record.

DISCUSSION

GENERAL

For the purpose of this report, the related requirements specified in Paragraph NA-1140(f) are considered to be those contained in the Subsections NC/ND for Piping, NF for supports, NA (or NCA) for general requirements, and the appendixes of the alternatives of later Code Editions/Addenda Section III. They will be reviewed and addressed with respect to the corresponding requirements in the Code of record in the following order:

- Article 1000 - Introduction
- Article 2000 - Materials
- Article 3000 - Design
- Article 4000 - Fabrication and Installation
- Article 5000 - Inspection
- Article 6000 - Testing (NC only)
- Article 7000 - Overpressurization Protection (NC only)
- Article 8000 - Nameplates
- Subsection NA (or NCA)
- Appendixes

Each of the above areas of the code will be discussed for the alternates with respect to the Code of record identified below. If there are any related requirements in Section II, Material Specifications, or Appendix I, Materials, they will be discussed under Article 2000.

ALTERNATES TO THE CODE OF RECORD

1. 1977 Edition - Winter 1978 Addenda
   Appendix O -- Rules for Design of Safety Valve Installations

   Appendix O first appeared in the Winter 1978 Addenda, and it provides guidance for the design and analysis of the piping components containing safety valves, which was not available in the Code of record. It provides the safety valve load computation, the stress acceptance criteria, and general design considerations for both open and closed safety valve discharge systems. Related requirements in NC/ND-3652 and NC/ND-3643.3(c)(6) of the alternate are consistent with the corresponding paragraphs in the Code of record.

Related Requirements

Article NC/ND-1000 - Introduction

There are no related requirements affected by this change.

Article NC/ND-2000 - Materials

There are no related requirements affected by this change.

Article NC/ND-3000 - Derign

Appendix O is used to develop the SRV fluid transient forces. This appendix refers to Equation (9) of paragraphs NC/ND-3652 for the evaluation of the reaction force moment (Mb) and sub-paragraphs NC/ND-3643.3(c)(6) for the reinforcement of multiple openings. The Code of record is used to evaluate the above criteria, and the corresponding paragraphs were not less restrictive than the Winter 1978 Addenda criteria; therefore, the related requirements are met.

Article NC/ND-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NC/ND-5000 - Examination

There are no related requirements affected by this change.

Article NC/ND-6000 - Testing

There are no related requirements affected by this change.

Article NC/ND-7000 - Overpressure Protection

There are no related requirements affected by this change.

Article NC/ND-8000 - Nameplates, Stamping, and Reports

There are no related requirements affected by this change.

Subsection NA - General Requirements

There are no related requirements affected by this change.

Appendixes

There are no related requirements affected by this change.

2. 1983 Edition

Paragraph NC-3658.2 - Standard Flange Joints at Moderate Pressures and Temperatures

Paragraph NC-3658.3 - ANSI B16.5 Flanged Joints with High-Strength Bolting

Paragraph ND-3658.2 - Standard Flange Joints at Moderate Pressures and Temperatures

Paragraph ND-3658.3 - ANSI B16.5 Flanged Joints with High-Strength Bolting

The above paragraphs in the 1983 Edition were invoked for this topic because guidance was not provided by the Code of record. These paragraphs are intended for the simplified analysis of standard flanges (e.g., ANSI B16.5).

Related Requirements:

Article NC/ND-1000 - Introduction

There are no related requirements affected by this change.

Article NC/ND-2000 - Materials

Paragraphs NC/ND-3658.3 require the use of 1983 S (bolt allowable stress, psi) values, since S must be > 20,000 psi. All selected bolt materials have been checked and in fact satisfy the criteria in the 1983 Code thus allowing use of this procedure.

Article NC/ND-3000 - Design

Paragraphs NC/ND-3658.3 refer to Tables NC/ND-3673.2(b)-1 for the evaluation of the stress intensification factors of pipe to flange welds. The weld stress intensification factor used in the design is discussed in Item 3. Therefore, the related requirements have been met.

Article NC/ND-4000 - Fabrication and Installation

This section has no related requirements to NC/ND-3658.3. Bolting requirements discussed in NC/ND-4720 are identical in both years 1983 and 1974.

Article NC/ND-5000 - Examination

There are no related requirements affected by this change.

Article NC/ND-6000 - Testing

There are no related requirements affected by this change.

Article NC/ND-7000 - Overpressure Protection

There are no related requirements affected by this change.

Article NC/ND-8000 - Nameplates, Stamping, and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

Subparagraphs NC/ND-3658.2 and NC/ND-3658.3, which apply to simplified analysis of standard flanges, do not require the implementation of Appendix XI. Appendix XI is required for detailed (nonsimplified) analysis of all types of flanges (standard and nonstandard). The code of reference can be used for an Appendix XI evaluation.

3. 1983 Edition - Winter 1984 Addenda
   Subparagraphs NC/ND-3673.2(b) - Flexibility and Stress Intensification Factors
   Figure NC-3673.2(b)-1 - Flexibility and Stress Intensification Factors ($D_o/t_m \leq 100$)(For Branch Connections, Buttwelds, and Fillet Welds)
   Figure NC-3673.2(b)-2 - Branch Dimensions
   Figure ND-3673.2(b)-1 - Flexibility and Stress Intensification Factors ($D_o/t_m \leq 100$)(For Branch Connections, Buttwelds, and Fillet Welds)
   Figure ND-3673.2(b)-2 - Branch Dimensions

The 1983 Edition/1984 Winter Addenda (1983-W84) stress intensification factors (SIFs) formulation for run pipe/branch connections was invoked because SIF for the run pipe end moment loads was not specified in the 1974 Code of record.

An independent review (Reference 4) performed by S. E. Moore, concluded that the 1983-W84 SIF formulation for branch connections, butt welds, and fillet welds is acceptable for CPSES piping requalification with one exception. That exception is that the use of General Note 2, Figures NC/ND-3673.2(b)-2 will be less restrictive than the Code of record. Consequently, Project Memorandum PM-155 (Reference 5) was issued, which specified the use of adjustment factors to provide sufficient margin in the calculated stresses and obviate this concern.

Related Requirements:

Article NC/ND-1000 - Introduction

There are no related requirements affected by this change.

Article NC/ND-2000 - Materials

There are no related requirements affected by this change.

Article NC/ND-3000 - Design

The branch connection stress intensification formulation of the 1974 code was not specified; hence it was necessary to use the later editions. S. E. Moore reviewed the related requirements for the 1983-W84 SIF formulations for branch connections and additionally for girth butt welds and circumferential fillet welds. The review results, documented in Reference 4, concluded that the use of 1983-W84 formulation is acceptable, with the exception of General Note (2), Figures NC/ND-3673.2(b)-2 for the branch connection. Consequently, PM-155 (Reference 5) was issued to address the related requirements for the branch connection. The other items, girth butt welds and circumferential fillet welds, are addressed in CPPP-7.

Article NC/ND-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NC/ND-5000 - Examination

There are no related requirements affected by this change.

Article NC/ND-6000 - Testing

There are no related requirements affected by this change.

Article NC/ND-7000 - Overpressure Protection

There are no related requirements affected by this change.

Article NC/ND-8000 - Nameplates, Stamping, and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

There are no related requirements affected by this change.

4. 1977 Edition - Winter 1978 Addenda
Paragraph XVII-2211 - Stress in Tension
Figure XVII-2211(c)-1 - Illustrations of Maximum Design Stress in Through-Thickness Direction of Plates and Elements of Rolled Shapes (Figure Deleted)
Paragraph NF-3226 - Through-Plate Thickness Tensile Limit

Figure NF-3226.5-1 - Illustrations of Maximum Design Stress in Through-Thickness Direction of Plates and Elements of Rolled Shapes (Figure Deleted)

Paragraph NF-3321.1 - Design Loadings

Invoking these paragraphs deletes the original code requirement to use reduced allowables with through-thickness tensile stress in plates or rolled sections. The original code concern was that high applied through-thickness stress in plates and rolled sections might increase the possibility of lamellar tearing (subsurface splitting of the material parallel to its rolled surfaces). The original Code-imposed limits on the through-thickness allowable tensile stress had the effect of requiring the designer to increase the weld size to achieve the lower allowable stress. Later, the Code committee recognized that excessive weld size increases the joint's susceptibility to lamellar tearing due to increased weld residual stresses.

The 1977 Edition, Winter 1978 Addenda (1977-W78) code edition for these paragraphs deleted the requirement to reduce the allowable stress in the through-thickness direction. This, in effect, reduces the weld size. It recognizes that smaller welds induce less residual stress, which can cause lamellar tearing, and that this has a more beneficial effect than a larger weld with lower calculated applied strerses.

The above alternates to the Code of record address Class 1 plate and shell and Class 1 linear supports. Through thickness stresses for Class 2 and MC and for Class 3 are addressed in subparagraph NF-3391.1 for plate and shell designs, and subparagraph NF-3392.1 for linear designs (see next Item 5).

Related Requirements

Article NF-1000 - Introduction

This article addresses scope, owner's responsibility, boundaries, and types of supports and attachments and is not affected by the deletion of a rule for a calculation of a specific type of stress. Therefore, there are no related requirements affected by this change.

Article NF-2000 - Materials

No materials have been added or deleted, nor have there been any changes to the requirements for test coupons, fracture toughness, welding, or examination, which are directly related to through-thickness properties. Therefore, there are no related requirements affected by this change.

Article NF-3000 - Design

No other stress criteria has been added or deleted in the Winter 1978 addenda or later to compensate for this change. Therefore, there are no related requirements in this article affected by this change.

Article NF-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NF-5000 - Examination

The Winter 1978 Addenda of this article is more restrictive for welds with a groove or throat dimension of 1 in. or greater, requiring surface examination (magnetic particle or liquid penetrant) instead of visual examination. However, the Code committee position for the removal of reduced allowables for through-thickness stress is related to lamellar tearing. Surface examination methods are effective only for detecting flaws which come to the surface. The addition of surface examination requirements to the Code is not related to the deletion of the reduced allowables. Considering this, there are no related requirements.

Article NF-8000 - Nameplates, Stamping, and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

The related requirements in Appendix XVII are addressed automatically by reference in Subsection NF. There are no other requirements in the appendices related to this change.

5. 1977 Edition - Winter 1979 Addenda
Subparagraph NF-3391.1 - Allowable Stress Limits
Subparagraph NF-3392.1 - Allowable Stress Limits

See prior discussion on through-thickness stresses. These paragraphs apply to Class 2 and MC plate and shell (NF-3391.1) and linear (NF-3392.1) support designs.

6. 1980 Edition
Paragraph NF-1133 - Intervening Elements in Relation to Jurisdictional Boundaries
Subparagraph NF-1131.6 - Portion F

Intervening elements were introduced into Section III of the ASME Code through Code Case N-199 and the Summer 1978 Addenda to allow items in the load path to be used when these items met other standards or were not appropriate for Section III. Items such as non-pressure retaining portions of ASME III control valves to which ASME III NF supports are attached are considered intervening elements. The appropriate paragraphs of the 1980 Edition were invoked in order to apply this criteria to the project, which was not available in the Code of record.

Related Requirements

Article NF-1000 - Introduction

There are related requirements. They are contained in paragraph NF-1111, Owner's Responsibility for Component Supports, which requires that the Owner 1) ensure that the intervening elements are adequately designed and 2) provide specific information in the design specification, and in paragraph NF-1112, Owner's Review, which requires that a design verification report be provided.

The method for satisfying these related requirements is contained in CPPP-6 and CPPP-9 (References 6 and 7).

Article NF-2000 - Materials

No materials have been added or deleted nor have there been any changes to the subsections on test coupons, fracture toughness, welding, or examination, which are directly related to intervening elements. Therefore, there are no related requirements affected by this change.

Article NF-3000 - Design

No other stress criteria has been added or deleted to compensate for this change. Therefore, there are no related requirements affected by this change.

Article NF-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NF-5000 - Examination

There are no related requirements affected by this change.

Article NF-8000 - Nameplates, Stamping, and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

There are no related requirements affected by this change.

7. 1980 Edition
Paragraph XVII-2462 - Minimum Edge Distance

The paragraph in 1980 Code Edition provides the minimum edge distance criteria with requirements imposed on the ultimate strength, material thickness, and bearing stress of the plate holes. The 1974 Code of record empirically prescribed the tabular values, based on the traditional practice of limiting the ratio of edge distance to the bolt diameter between 1.25 to 1.8. The 1980 Code provision was invoked to incorporate the alternates for minimum edge distance, which provides a more rigorous, complete, and precise rule to prevent the tear-out failure or excessive deformation of the plate.

Related Requirements

Article NF-1000 - Introduction

There are no related requirements affected by this change.

Article NF-2000 - Materials

No materials have been added or deleted nor have there been any changes to the subsections on test coupons, fracture toughness, welding, or examination, which are directly related to minimum edge distance criteria. Therefore, there are no requirements directly related to this change.

Article NF-3000 - Design

No other stress criteria has been added or deleted to compensate for this change. Therefore, there are no requirements directly related to this change.

Article NF-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NF-5000 - Examination

There are no related requirements affected by this change.

Article NF-8000 - Nameplates, Stamping, and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

This change is in Appendix XVII and there are no related requirements in this or any other appendix affected by this change.

8. 1983 Edition - Summer 1983 Addenda
Subparagraph NF-3225 - Design of Bolting
Subparagraph NF-3324.6 - Design Requirements for Bolted Joints

The Summer 1983 Addenda is invoked for the design of bolting to enable the updated allowable stresses in the 1983 Edition to be used in support designs. In particul· Appendix F was upgraded by the addition of explicit tension · ·ar requirements for bolting design for the faulted condition. Also, for bolts loaded in combined tension and shear, the three straight-line interaction curves of the Winter 1974 Addenda have been replaced by a more precise elliptical interaction curve of the second degree. The newer code provides a clearer treatment of the subject.

Related Requirements

Article NF-1000 - Introduction

There are no related requirements affected by this change.

Article NF-2000 - Materials

No materials have been added or deleted nor have there been any changes to the subsections on test coupons, fracture toughness, welding, or examination, which are related to the design of bolting. Therefore, there are no related requirements affected by this change.

Article NF-3000 - Design

No other stress criteria has been added or deleted to compensate for this change. Therefore, there are no related requirements affected by this change.

Article NF-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NF-5000 - Examination

There are no related requirements affected by this change.

Article NF-8000 - Nameplates, Stamping, and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

The related requirements in Appendix F are addressed automatically by specific direction in Table NF-3225.2-1 of the Code of record. There are no other related requirements affected by this change.

9. 1983 Edition - Summer 1985 Addenda
Paragraph NF-4721 - Bolt Holes

The Code of record in the Winter 1974 Addenda did not address holes for concrete anchor bolts. In the Winter 1974 Addenda, this paragraph addressed only oversized holes and a method of fabricating holes. The Summer 1985 criteria provides more detail on hole size requirements, provides new criteria for long-slotted and short-slotted holes, addresses holes for concrete anchors and holes for no-shear applications, and provides direction for use of washers. This newer criteria provides clearer direction and additional coverage in the support designs.

Related Requirements

Article NF-1000 - Introduction

There are no related requirements affected by this change.

Article NF-2000 - Materials

No materials have been added or deleted nor have there been any charges to the subsections on test coupons, fracture toughness, welding, or examination, which are directly related to bolt hole clearances. Therefore, there are no related requirements affected by this change.

Article NF-3000 - Design

No other stress criteria has been added or deleted to compensate for this change. Therefore, there are no related requirements affected by this change.

Article NF-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NF-5000 - Examination

There are no related requirements affected by this change.

Article NF-8000 - Nameplates, Stamping, and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

There are no related requirements affected by this change.

10. 1974 Edition - Winter 1975 Addenda
Paragraph NC-6221 - Minimum Required System Hydrostatic Test Pressure

The Winter 1975 Addendum revised the minimum completed system hydrostatic test pressure from 1.5 times to 1.25 times the design pressure. This, in effect, restored the pre-1974 code requirement of 1.25 times the design pressure as documented in Code Interpretation III-1-83-96.

This Code interpretation identifies the Code of Record requirement as an error, the correction of which should have been identified as Errata in the Summer 1975 Addenda. Therefore, there are no related requirements affected by this change.

11. 1974 Edition - Winter 1975 Addenda
Paragraph XVII-2410 - General Requirements (for the Design of Connections and Joints)

This paragraph addresses: types of connections permitted (XVII-2411), minimum design strength of connections (XVII-2412), provision for eccentric connections (XVII-2413), and placement of bolts and welds (XVII-2414). Only Subparagraph XVII-2412 was affected by the adoption of the Winter 1975 Addenda; it was deleted in its entirety. Subparagraph XVII-2412 stated, "Connections carrying calculated stresses, except for lacing, shall be designed to support not less than 6 kips."

The welds are designed on an as-loaded basis. There is sufficient inherent margin in the design using allowables of welds from the Code of record.

Related Requirements

Article NF-1000 - Introduction

There are no related requirements affected by this change.

Article NF-2000 - Materials

There are no related requirements affected by this change.

Article NF-3000 - Design

There are no related requirements affected by this change.

Article NF-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NF-5000 - Examination

There are no related requirements affected by this change.

Article NF-8000 - Nameplate Stamping and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

There are no related requirements affected by this change.

12. 1980 Edition - Winter 1982 Addenda
Paragraph NF-3324.5

Paragraph NF-3324.5 of the 1980 Edition, Winter 1982 Addenda, gives the design requirements for welds on Class 1, 2, 3, and MC linear type supports. Prior to this version, this information was given in Paragraphs NF-3292, NF-3293, NF-3392, NF-3393, and NF-3400; the general reorganization of Article NF-3000 in the 1980 Edition, Winter 1982 Addenda regrouped the design requirements by support type (i.e., plate and shell supports and linear supports) as opposed to Class 1, 2, 3, or MC in the Code of record.

This alternative to the Code of record was invoked because it contains a much greater degree of detail in its discussion of allowable stress limits which must be satisfied for design loadings and of rules and stress limits which must be satisfied for Level A through D service test loadings. In addition, this alternative to the Code of record recognizes several different permissible weld types absent from the Code of record.

Related Requirements

Article NC-1000 - Introduction

There are no related requirements affected by this change.

Article NC-2000 - Materials

There are no related requirements affected by this change.

Article NF-3000 - Design

There are no related requirements affected by this change.

Article NF-4000 - Fabrication and Installation

There are no related requirements affected by this change.

Article NF-5000 - Examination

There are no related requirements affected by this change.

Article NF-8000 - Nameplate Stamping and Reports

There are no related requirements affected by this change.

Subsection NA

There are no related requirements affected by this change.

Appendixes

There are no related requirements affected by this change.

#43

10-30-2

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

NOTED APR 09 1986 A. CONONS

SCTO 84 (FRONT)

CLIENT & PROJECT	PAGE 1 OF 27
EMD - GENERIC	

CALCULATION TITLE (Indicative of the Objective):

Stress Intensification Factors for Lateral Branches Fabricated from "Welded-In" Piping to be used in ASME Class 1 and ANSI B31.1 Pipe Stress Analysis

QA CATEGORY (✓)

☒ I - NUCLEAR SAFETY RELATED

☐ II ☐ III ☐ _____ OTHER

CALCULATION IDENTIFICATION NUMBER

J.O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
5997.470.1.01	NP (B)	75	X6	

NOTED APR 21 1982

* APPROVALS - SIGNATURE & DATE			REV. NO. OR NEW CALC NO.	SUPERSEDES * CALC. NO. OR REV. NO.	CONFIRMATION *REQUIRED (✓)	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
L. Raghavan L Raghavan Mar 16, 82	G ARENA G Arena 3.17.82	G ARENA G Arena 3.17.82	Rev. 0	N/A		X
L Raghavan May 5, 1982		G. Arena 5.5.82	REV 1	N/A		X

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Calculation No. 599.470.1-01-NP(B)-75-X6

Calculation Title Stress Intensification Factors for Lateral Branch Conn.

This calculation has been reviewed in accordance with EMTP 8.26 and was found to be adequate. The method of review utilized was (circle one):

a. Comparison with a similar previous Calculation No. _____.

(b.) Review of calculation.

c. Alternate Calculation No. _____.

Guy Arena
Signature of Reviewer

3-17-82
Date

_____
Signature of Independent Reviewer (where different from Reviewer)

_____
Date

REV 1

Guy Arena I/SE
SIGNATURE OF REVIEWER

5/5/82
DATE

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

A 9210 65

CALCULATION IDENTIFICATION NUMBER				PAGE 3
J.O. OR W.O. NO. 599.470.1.01	DIVISION & GROUP NP(B)	CALCULATION NO. 75	OPTIONAL TASK CODE X6	

REVISION STATUS

REVISION 0 — ORIGINAL ISSUE

REVISION 1

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REASON FOR CHANGE : DELETED CODE SUBPARAGRAPH REFERENCE IN CONCLUSION NOTE 2.b.

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

A 5010 65

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STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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599 470-1-01	NPLB)	75	X b	

Nomenclature

D and R	= mean diameter and mean radius, respectively of plane pipes and pipes of connections
d and r	= mean diameter and mean radius of branch, respectively
T	= thickness of pipe of connection
t	= thickness of branch
s/S	= elastic hoop stress ratio $(d/t)/(D/T)$
ρ and ρ_c	= constant fillet radius of external surface of intersection of tees and fillet radius at external crotch of tee
$A_f = \rho^2(1 - \frac{\pi}{4})$	= crossectional area of reinforcement due to fillet in horizontal plane
ρ_a and ρ_o	= external fillet radius of lateral where crotch makes an acute and obtuse angle, respectively
σ_Y	= average yield strength of connection in tension
e_{LB}, e_{LP}	= theoretical elastic axial strain due to internal pressure of a plane pipe with closed ends having dimensions of branch or pipe, respectively
e_L	= referring to e_{LB} or e_{LP}
e_a/σ_c	= elatic stress ratio in thin plane pipe exposed to axial force and bending
e_{aB}/σ_{LB}	= elastic stress ratio in thin branch due to F_E and C_{LE}
D_N	= nominal diameter of pipe of welded laterals
p_{LP} and p_L	= theoretical limit pressure of plane pipe with open ends and closed ends, respectively
p_E	= experimental limit pressure of connection or plane pipe
C_L and C_{BL}	= theoretical limit couple of plane pipe and plane branch respectively
p	= experimental pressure in connection
C_E	= experimental limit couple of plane pipe
C_{IE}	= stable experimental in-plane limit couple
C_{OE}	= stable experimental out-of-plane limit couple
IC_{OE}	= unstable experimental out-of-plane plastic couple
C_{pL}	= theoretical limit couple of plane pipe at constant internal pressure
$\sigma_Y(t)$	= yield strength averaged for various types of tensile tests and specimens
e_{hB}, e_{hP}	= theoretical elastic hoop strain due to internal pressure of a plane pipe with closed ends having dimensions of the branch or pipe, respectively
e_h	= referring to e_{hB} or e_{hP}
e_{hE}	= experimental elastic hoop strain due to internal pressure
F_E	= axial force acting on branch due to differences in magnitude of forces constituting the limit couple
e_{cB}, e_{cP}	= theoretical elastic extremum axial strain due to an external couple having dimensions of branch and pipe, respectively
e_c	= referring to e_{cB} or e_{cP}
e_{cE}	= experimental axial strain due to external couple measured at 90 deg to neutral axis
F_c	= average of magnitude of forces constituting limit couple

STRESS INTENSIFICATION FACTORS (SIF)

FOR UNREINFORCED LATERAL BRANCH CONNECTIONS

1.0 OBJECTIVE.

Paragraph NC 3650 of the ASME Section III, (12)*, code provides a method of analysis of class 2 and 3 piping products. The analysis utilizes Stress Intensification Factors (SIF) along with some simple equations to establish acceptable limits on stresses.

Figure NC 3673.2(b)-1, (12)*, provides SIF's for commonly used standard piping products. For non-standard piping products NC 3673.2(b), (12)*, states that SIF may be taken as $C_2K_2/2$ where C_2 and K_2 are class 1 stress indices given in Table NB 3682.2-1, (12)*. Lateral branch connections are not among the components for which SIF or C_2 and K_2 stress indices are available. Thus, code evaluation of lateral branch connection by simplified analysis is not possible.

The purpose of this calculation is to establish a method to derive an appropriate SIF for use in the evaluation of lateral "stub-in" branches using NC-3650 rules, (12)*, based upon the results of a published literature survey.

* Numbers in () indicate reference numbers listed in Section 3.

3. DIRECT - this indicates the step is to be analyzed in the increments given on the data card, breaking the step into fractions, e.g.,
   0.7, 0.8, 0.9, 0.95, 1.0
   indicates increments will be used applying to 70%, 80%, 90%, 95%, and 100% of the load history (as defined on the loading cards).
4. TIMEP is the period of this analysis step. Default value is one which means that normalized time is used.
   Note: this time period for static analysis is not accumulated over different steps. The time period must be non-zero.
5. NUMBER - this parameter is used to initiate the automatic load incrementation option and to suggest the increment size. For example, NUMBER = 5 will make the first increment equal to 0.2 of the total time. However, the program will now adjust the time increment based on the number of cycles needed in each increment with the limitation being that the time increments will not be larger than 0.2 of the total time.
   Note: NUMBER and DIRECT are mutually exclusive parameters.
6. CUTMAX - the maximum number to times the suggested uniform increment size may be subdivided.

OD3

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CALCULATION SHEET

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CALCULATION IDENTIFICATION NUMBER				PAGE 7
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
599.470-1-01	NP(B)	7S	X6	

2.0 ASSUMPTIONS

	CONFIRMATION REQUIRED (✓) YES	NO
1. It is reasonable to assume that unreinforced lateral branch connection behavior would also be indicative of reinforced lateral branch connection behavior.		X
2. Bending moment stress indices (c_2 and k_2) are same for tubular joints (no hole at the intersection) as well as pipe branch connections.		X
3. All other assumptions are noted in the body of the text.		X

3.0 References:

1. Markl A.R.C., "Fatigue Tests of Piping Components"- Transactions ASME, April 1952, pp. 287-303.

2. Schroeder, J., Srinvasaich, K.R., and Graham, P., " Analysis of test data on branch connections exposed to internal pressure and/or external couples", Bulletin No. 200, Welding Research Council, New York, 1974.

3. Kuang, J.G., Potvin, A.B., and Leick, R.D., "Stress concentrations in Tubular Joints", Paper No. OTC 2205, Off-Shore Technology conference, Houston 1975.

4. Hsiao C. and Kahn. A.S., "Stress intensification effects in unreinforced oblique branch intersections due to external moments" - PVP Volume 50 ASME, New York 1981.

5. Wichman, K.R., Hopper A.G., and Mershon, J.L., "Local Stresses in spherical and cylindrical shells due to External Loadings" Bulletin No. 107, Welding Research Council, New York.

6. Visser W. " On the structural design of tubular joints" OTC 2117 Proc. Sixth Annual Off-Shore Technology Conference, Houston (May 6-8, 1974) Volume II pp. 881-894

7. Reber, J.B. Jr. "Ultimate Strength Design of Tubular Joints" OTC 1664 Proc. Fourth Annual Off-Shore Technology Conference Houston (May 1-3, 1972) Volume I pp. 447-458

8. Beale L.A. and Toprac, A.A. "Analysis of in-plane T,Y, and K Welded Tubular Connections" Welding Research Council Bulletin 125 Oct. 1967 pp. 1-30.

9. Gurner, T.R., "Fatigue of Welded Structures" Second Edition 1979 Cambridge University Press.

10. Khan, A.S. and Hsiao C., "Strain Field in the intersection region of two obliquely inclined straight cylindrical shells, An Experimental Study". Submitted for publication in "Experimental Mechanics".

11. Mukhopadhyay A., Itoh, Y., Bouwkamp, J. G., "Fatigue Behavior of Tubular Joints in Offshore Structures", OTC 2207, Seventh Annual Offshore Technology Conference, Houston (May 5-8, 1975).

12. ASME Boiler and Pressure Vessel Code, Section III, 1980 Edition.

13. ANSI B31.1, American National Standard Code for Pressure Piping, Power Piping, 1977 Edition.

4.0 ANALYSIS

Stress intensification factors (i) for various piping components are, in large part, based upon Markl's (1)* approach and test data generated by his work.

The Markl cyclic moment fatigue tests did not cover lateral branch connections and code does not provide either 'i' factors or C_2, K_2 stress indicies for lateral branch connections. Several authors have investigated this problem and references (2)*, (3)*, and (4)* are some of the significant published reports.

WRC Bulletin 200 (2)* reports and analyzes test data on branch connections including unreinforced laterals exposed to internal pressure and/or external couples. Tests were conducted on plain pipes, tees (normal branch connections) and 45° laterals, to determine "limit loads" of the components when subject to internal pressure, in-plane and out-of-plane bending moments. No fatigue tests were conducted.

Figures 1 and 2,** (2)*, show results of in-plane couple tests on a 45° lateral and a 90° normal branch connection, both of identical dimensions except for the angle of branch connection. Table 1, (2)*, summarizes the data and test results as well. From these figures and table, it is clear that the limit load for the lateral is higher compared to that of 90° tee indicating that the laterals are plastically stronger than tees. The same conclusions are arrived at for out-of-plane couples as observed by test results shown in figures 3, 4, and 5 and Table 2, (2)*. However, as observed in the Pe/P_{lp} column in Table 1, (2)*, the following is concluded:

1. Laterals are plastically stronger than 90° branch connections when subjected to external bending moments.

2. Laterals are plastically weaker compared to tees when exposed to internal pressures.

Conclusion 2 is drawn as a point of interest since in class 2, 3, and B31.1 stress analysis, the pressure loading terms are not intensified. The branch construction need only meet the local pressure reinforcement requirements stated in the applicable codes.

While reference (2)* conducted tests on 45° lateral branch connections only reference (3)* reports results of tests conducted on tubular joints laterals with angle of branch connections ranging from 0° to 90°. Reference (3)* presents the finite element model analytical results as well as results of experimental investigations and provides stress concentration factor (SCF) for radial thrusts loads, in-plane, out-of-plane bending moments applied to both normal and lateral branch connections. The SCF value reported does not represent maximum or peak stress in the joint, but rather the equivalent of the maximum primary plus secondary membrane plus bending stresses as represented by the C_2 stress indices of NB 3650.

* Numbers in () indicate reference numbers listed in Section 3.

** FIGS. & TABLES FOLLOW CONCLUSION SECTION

J.G. Kuang, et al, (3)* performed a parametric study to best fit the experimental results to those arrived at by finite element analysis. The following parameters that govern the stress distribution in branch connections were chosen: the run thickness to diameter ratio T/D, the branch the run pipe thickness ration t/T, the branch to run diameter ratio d/D, and most significantly to our current investigation, the angle of branch connection. The T/D and t/T ratios govern the stress distribution by influencing the radial flexibility of the run pipe (Figure 6), (3)*, and by bending stress in the branch at the intersection. The d/D ratio and the angle of branch connection influence the stress distribution by the load transfer mechanism.

When a tee is subjected to axial branch loading, the load is transferred to the run primarily via local bending and punching shear. As a result if the branch is inclined at other than 90° only the component of the load normal to the run wall is of primary concern, as the horizontal component is transferred by compression or tension in the run.

Reference (3)* developes empirical equations to derive SCF's based on the parameters discussed above. The applicability and accuracy of the empirical equations developed were verified by comparing the test results to results obtained by the empirical equations. Figure 7(3)* shows good agreement between the experimental and analytical results. The empirical expression for radial loads, in-plane, and out-of-plane bending loads contain a multiplying term $\sin^a \theta$ where θ is the angle of branch connection, [see Table 3] and 'a' is a constant greater than zero. This indicates that the maximum stress for the branch connection and SCF increases as the angle θ increases, $0° \leq \theta \leq 90°$.

Several other researchers' investigations, (6)*, (7)*, and (8)* have resulted in empirical equations for SCF's that include a $\sin^a \theta$ term reinforcing the conclusion arrived at in reference (3)*. Table 4, (9)*, also indicates the agreement between the results arrived at by various authors.

Reference (3)* imposes a set of limitations on geometric parameters to minimize dispersion between experimental and analytical results. Most important of them are:

- $0.2 \leq t/T \leq 0.8$
- $0.3 \leq d/D \leq 0.8$
- $0° \leq \theta \leq 90°$

As mentioned earilier, the SCF derived in reference (3)* is akin to C_2 stress indices of the code. From reference (3)* it is clear that the SCF and therefore, C_2 for laterals are lower thean 90° branch connections. By considering the geometry, branch and lateral connections must have similar K_2 indices and thus the product of C_2K_2 for laterals will always be lower than that for branches. Therefore stress intensification factor 'i' which is equal to $C_2K_2/2$ (NC 3673.1(b)) for laterals will always be lower than that for 90° branches.

* Numbers in () indicate reference numbers listed in Section 3.

While it is true that Reference (3)* deals with tubular joints, (no hole at the run-branch intersection) the same conclusions are arrived at by C. Hsiao and A.S. Kahn (4)* for piping intersetions. C. Hsiao, et al, present the result of finite element investigation of 6 x 3 branch connections for three branch angles, namely 30°, 60°, and 90°, subjected to in-plane and out-of-plane loads.

The output of the finite element analysis in the form of membrane stresses and bending moments in the local coordinates are properly combined to obtain total stresses at the run/branch pipe intersection. These stresses are divided by "beam type stresses" (= M/Zr) for the known applied in-plane and out-of-plane moment to obtain a "stress ratio". Here M is the applied moment and Zr the elastic section - modules of the run pipe. The stress ratio thus obtained are compared to the experimental data, (10)*, for in-plane and out-of-plane loadings available for 30° and 60° branch connection angles. Figures 8, 9, 10, and 11, (4)*, exhibit good agreement between the experimental and analytical results. Reviewing figures 12 through 20, (4)*, indicate that the stress ratio increases with the increase in the angle of branch connection thus confirming results of reference (3)*.

Reference (11)* provides a basis to evaluate the fatigue capacities of a lateral in comparison to a 90° branch of equal size under equivalent loading conditions. Figure 21 results indicate a trend to initial failure (crack initiation) occurring at 90° branches sooner than at equivalent laterals and complete failure (through-wall crack) predominantly occurring in 90° branch connections. The tests were run using stress ranges above those allowed by the piping codes for a 7,000 cycle life. The laterals withstood greater than 7,000 cycles in all cases. These trends indicate that a lateral is less sensitive to cyclic damage than its equivalent 90° branch.

* Numbers in () indicate reference numbers listed in Section 3.

5.0 SUMMARY OF RESULTS

1. Under a single load to failure, the lateral branch connection is stronger plastically than the normal branch connection.

2. Under cyclic loading the lateral branch connection has greater fatigue strength than a normal branch connection.

3. Laterals are plastically weaker compared to tees when exposed to internal pressure.

4. While reference (3)* tests are on tubular joints the results are applicable to branch connections considering the similar conclusions arrived at in reference (1)* and (4)*.

5. Reference (3)* imposes geometric parameter limitations for the empirical expressions for SCF to be valid. However, it is reasonable to assume that the dispersion between experimental and analytical results for tees and laterals will be in the same direction so that the laterals SCF's will always be lower than that of tees even outside the geometric limitations.

* Numbers in () indicate reference numbers listed in Section 3.

6.0 CONCLUSIONS

1. In a piping analysis a lateral branch connection can be safely analyzed similar to a normal branch connection for class 2 and 3 and non-ASME pipes.

2. In general the results of this investigation indicates that unreinforced fabricated lateral connections are stronger than corresponding 90° connections. It is expected that this same conclusion could be drawn for reinfored lateral connections as well. However, until more data becomes available to confirm this it is recommended that a factor be applied for additional conservatism in the calculation of stress intensification factors (SIF) for lateral connections.

   The SIF for either an unreinforced or reinforced connections may be determined by calculating the SIF for an equivalent 90° connection and increasing it by 25 percent.

3. The above must be subjected to the following restrictions:

   a. The branch connections must meet all the pressure reinforcement requirements of NC 3643 of ASME Section III or ANSI B31.1 Paragraph 104.3.1.

   b. The branch connection angle (the angle between the run and branch pipe axes) is between 45° and 90° both inclusive

   REV 1

   c. ASME Section III code version is limited to the summer 1981 addenda and earlier. Winter 1981 addenda requires that pressure terms be modified by "B" indices.

4. The use of lateral branch connections would be restricted to ASME Class 2 and 3 and B31.1 systems; insufficient data exists to draw conclusions for Class 1 applications.

* Numbers in () indicate reference numbers listed in Section 3.

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CALCULATION SHEET

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J.O. OR W.O. NO. 590.470.1.01	DIVISION & GROUP NP(B)	CALCULATION NO. 75	OPTIONAL TASK CODE X6	PAGE 14

TABLE 1 : — REF : 2 Tables 1,

—Data on Limit Pressure Tests

Connect. or Pipe No.[1]	$\frac{d}{D}$	$\frac{D}{T}$	$\frac{s}{S}$	$\frac{Af}{rT}$	$\frac{p}{p_L}$ or p_L	σ_T (ksi)	p_{LP} (ksi)	p_E (ksi)	$\frac{p_E}{p_{LP}}$	No. of dial gages	Fig. No. for test data
T_1	1	33	1	...	...	33.3	2.02	1.45	(0.69)	1	20
T_2	0.63	35	0.9	...	...	31.4	1.80	1.40	(0.78)	3	21
T_3	0.83	26	1	0.32	4T	40.4	3.11	1.88	0.61	3	22
T_7	1	25	1	0.28	4T	36.5	2.92	1.8 ± 0.1	0.62	3	23
P_1	...	31	...	...	...	28.2	1.82	2.1	1.16	...	24
Y_1	1	34.5	1	...	8T	35.0	2.03	0.78	0.39	1	25
Y_2	1	26.8	1	...	8T	30.3	2.25	0.80	0.35	1	26, 27
Y_4	0.63	29	0.94	...	8T	31.6	2.18	1.15	0.51	4	28
Y_{16}	1	26.8	1	...	8T	30.3	2.26	0.87 ± 0.1	0.39	4	29
Y_{45}	1	14.6	1	...	...	35.7	4.89	3.4	0.7	4	30, 32
Y_{46}	1	17	1	...	...	38.9	4.57	2.1	0.46	4	31, 33
Y_{47}	0.77	17.2	0.8	...	...	33.9	3.94	2.6	0.69	4	34
Y_{48}	1	17.7	1	...	...	37.7	4.26	1.9	0.47	4	35

[1] The branch-pipe angle α of all laterals is 45 deg. The external reinforcement of T_1 and T_2 was more than a fillet. The limit pressure p_L of P_1 was 2.09 ksi.

TABLE 2 : REF 2 Tables 2 & 3

—Data on Limit Couple Tests of Plain Pipes and In-Plane Couple Tests

Connect. or Pipe No.[1]	$\frac{d}{D}$	$\frac{D}{T}$	$\frac{s}{S}$	$\frac{Af}{rt}$	$\frac{p}{p_L}$ or p_L	σ_T (ksi)	p_{LP} (ksi)	C_L or C_{SL} (in-kip)	p (ksi)	C_E or C_{IS} (in-kip)	$\frac{C_E}{C_L}$ or $\frac{C_{IS}}{C_{SL}}$	$\frac{p}{p_{LP}}$	No. of dial gages	Fig. No. for test data
P_1	...	21	...	...	...	28.7	...	43.0	...	36.9	0.86	...	2	37
P_2	...	41	...	...	...	28.2	1.38	31.8	0.75	26.5	0.83	0.55	2	38
P_4	...	51	...	...	...	27.7	...	24.6	...	23.5	0.96	...	2	39
T_{46}	0.52	24	1	0.14	2T	31.6	...	7.3	0	6.6 ± 0	0.91	0	2	40
$T_{1,2}$	0.75	25	1	0.37	3.5T	32.4	...	22.1	0	18.5 ± 0	0.84	0	2	41
T_{45}	1.0	25	1	0.28	4T	25.0	...	42.5	0	27.0 ± 2	0.64	0	4	42, 43, 44
Y_1	0.75	25	1	...	7T	35.4	...	24.2	0	23.0 ± 0	0.95	0	2	45
T_{48}	0.75	25	1	0.37	4T	37.5	3.1	25.4	1.0	12.0 ± 0	0.47	0.32	2	46
T_{49}	1.0	27	1	0.25	4T	25.2	1.9	39.6	0.5	19.2 ± 0	0.49	0.26	2	47

[1] The branch-pipe angle α of all laterals is 45 deg. C_{SL} of P_1 is 27.8 in.-kip.

TABLE 2

—Data on Out-of-Plane Limit Couple Tests and Plastically Unstable Out-of-Plane Couple Tests

Connect. or pipe No.[1]	$\frac{d}{D}$	$\frac{D}{T}$	$\frac{s}{S}$	$\frac{Af}{rT}$	$\frac{p}{p_L}$ or p_L	σ_T (ksi)	p_{LP} (ksi)	C_{SL} (in-kip)	p (ksi)	C_{OS} (in-kip)	$\frac{C_{OS}}{C_{SL}}$	IC_{OS} (in-kip)	$\frac{IC_{OS}}{C_{SL}}$	No of dial gages	Fig. No. for test data
T_1	0.5	25	1	0.14	2T	33.6	...	7.8	...	5.6	0.72	>7.8	...	2	50
T_{16}	0.7	34.5	0.55	0.22	3.5T	29.5	...	20.2	...	...	...	9.7	0.48	1	51
Y_1	0.63	22	1	...	6T	33.2	...	16.1	...	14.4	0.90	...	...	1	52
T_3	1	25	1	0.07	2T	31.4	...	54.0	...	...	...	32.0	0.59	1	54
T_{16}	1	42	1	0.34	6T	24.1	...	23.1	...	...	...	11.0	0.49	3	55, 57
T_{11}	0.7	34.5	0.55	0.044	5T	31.0	1.8	21.5	1.0	7.0	0.32	...	...	2	56

[1] The branch-pipe angle α of all laterals is 45 deg.

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TABLE 3 (REF 3 Table 3)

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CALCULATION IDENTIFICATION NUMBER				
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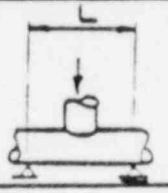
590.470.1.01	NPLB)	73	x6	

STRESS CONCENTRATION FACTORS FROM SPE 5472, OTC 2205 AUG, 1977

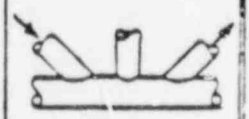


$$T,Y_{Chord} = 1.177\left(\frac{T}{D}\right)^{-0.808} e^{-1.2\left(\frac{d}{D}\right)^3}\left(\frac{t}{T}\right)^{1.333}\left(\frac{D}{L}\right)^{-0.057}\sin^{1.694}\theta \qquad T\text{-}1$$

$$T,Y_{Branch} = 2.784\left(\frac{T}{D}\right)^{-0.55} e^{-1.35\left(\frac{d}{D}\right)^3}\left(\frac{t}{T}\right)\left(\frac{D}{L}\right)^{-0.12}\sin^{1.94}\theta \qquad T\text{-}2$$

$$K_{Chord} = 0.949\left(\frac{T}{D}\right)^{-0.666}\left(\frac{d}{D}\right)^{-0.059}\left(\frac{t}{T}\right)^{1.104}\left(\frac{g}{D}\right)^{0.067}\sin^{1.521}\theta \qquad T\text{-}3$$

$$K_{Branch} = 0.825\left(\frac{T}{D}\right)^{-0.157}\left(\frac{d}{D}\right)^{-0.441}\left(\frac{t}{T}\right)^{0.560}\left(\frac{g}{D}\right)^{0.058} e^{1.440\sin\theta} \qquad T\text{-}5$$



$$T,K_{Chord} = 1.26\left(\frac{T}{D}\right)^{-0.54}\left(\frac{d}{D}\right)^{0.12}\left(\frac{t}{T}\right)^{1.068}\sin\theta \qquad T\text{-}7$$

$$T,K_{Branch} = 5.65\left(\frac{T}{D}\right)^{-0.1}\left(\frac{d}{D}\right)^{-2.36}\left(\frac{t}{T}\right)^{0.68}\left(\frac{g_1+g_2}{D}\right)^{0.126}\sin^{0.5}\theta \qquad T\text{-}8$$

$0 < \theta < 45°$

$$T,K_{Branch} = 12.88\left(\frac{T}{D}\right)^{-0.1}\left(\frac{d}{D}\right)^{-0.36}\left(\frac{t}{T}\right)^{0.68}\left(\frac{g_1+g_2}{D}\right)^{0.126}\sin^{2.88}\theta \qquad T\text{-}9$$

$45° < \theta < 90°$

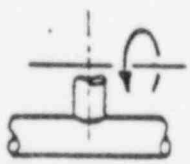
$$Tot\ T,K = 4.491\left(\frac{T}{D}\right)^{-0.123}\left(\frac{d}{D}\right)^{-0.396}\left(\frac{t}{T}\right)^{0.672}\left(\frac{g_1+g_2}{D}\right)^{0.159}\sin^{2.267}\theta \qquad T\text{-}10$$

$$T,Y_{Chord} = 0.463\left(\frac{T}{D}\right)^{-0.6}\left(\frac{d}{D}\right)^{-0.04}\left(\frac{t}{T}\right)^{0.86}\sin^{0.57}\theta \qquad T\text{-}11$$

$$T,Y_{Branch} = 1.109\left(\frac{T}{D}\right)^{-0.23}\left(\frac{d}{D}\right)^{-0.38}\left(\frac{t}{T}\right)^{0.38}\sin^{0.21}\theta \qquad T\text{-}12$$

$$K_{Chord} = 1.40\left(\frac{T}{D}\right)^{-0.38}\left(\frac{d}{D}\right)^{0.06}\left(\frac{t}{T}\right)^{0.94}\sin^{0.9}\theta \qquad T\text{-}13$$

$$K_{Branch} = 2.827\left(\frac{d}{D}\right)^{-0.35}\left(\frac{t}{T}\right)^{0.35}\sin^{0.5}\theta \qquad T\text{-}14$$



$$T,Y_{Chord} = 0.507\left(\frac{T}{D}\right)^{-1.014}\left(\frac{d}{D}\right)^{0.787}\left(\frac{t}{T}\right)^{0.889}\sin^{1.557}\theta \qquad T\text{-}15$$

$0.3 < d/D < 0.55$

$$T,Y_{Chord} = 0.229\left(\frac{T}{D}\right)^{-1.014}\left(\frac{d}{D}\right)^{-0.619}\left(\frac{t}{T}\right)^{0.889}\sin^{1.557}\theta \qquad T\text{-}16$$

$0.55 \leq d/D \leq 0.75$

$$T,Y_{Branch} = 0.843\left(\frac{T}{D}\right)^{-0.852}\left(\frac{d}{D}\right)^{0.801}\left(\frac{t}{T}\right)^{0.543}\sin^{2.033}\theta \qquad T\text{-}17$$

$0.3 < d/D < 0.55$

$$T,Y_{Branch} = 0.441\left(\frac{T}{D}\right)^{-0.852}\left(\frac{d}{D}\right)^{-0.281}\left(\frac{t}{T}\right)^{0.543}\sin^{2.033}\theta \qquad T\text{-}18$$

$0.55 \leq d/D \leq 0.75$

D = Chord Outside Dia. d = Branch Outside Dia

T = Chord Nominal Thickness t = Branch Nominal Thickness

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Table 7.2

Formula	SCF in chord			SCF in brace		
	$\beta = 0.3$	$\beta = 0.55$	$\beta = 0.8$	$\beta = 0.3$	$\beta = 0.55$	$\beta = 0.8$
Axial load on the brace						
Gibstein	5.25	5.58	4.08	5.79	6.20	5.24
Kuang	5.92	4.58	3.06	8.36	6.27	3.97
Wordsworth & Smedley	5.87	6.66	4.98	4.70	5.20	4.14
In-plane bending						
Gibstein	2.03	2.03	1.85	2.03	2.02	1.83
Kuang	1.59	1.55	1.53	2.59	2.06	1.78
Wordsworth & Smedley	2.14	2.23	2.04	2.35	2.40	2.29
Out-of-plane bending						
Gibstein	2.91	4.60	4.32	2.78	4.64	4.93
Kuang	2.44	3.94	3.10	3.15	5.12	4.60
Wordsworth & Smedley	2.87	5.09	5.87	2.81	4.21	4.70

TABLE : 4

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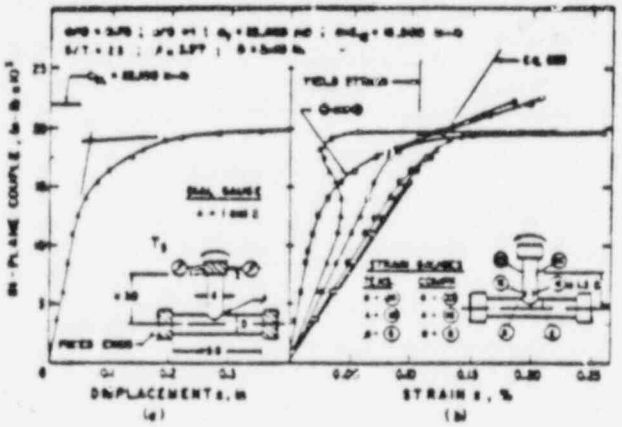
REFERENCE 2: Fig. 41



—in-plane limit couple tees on T_5

TEES

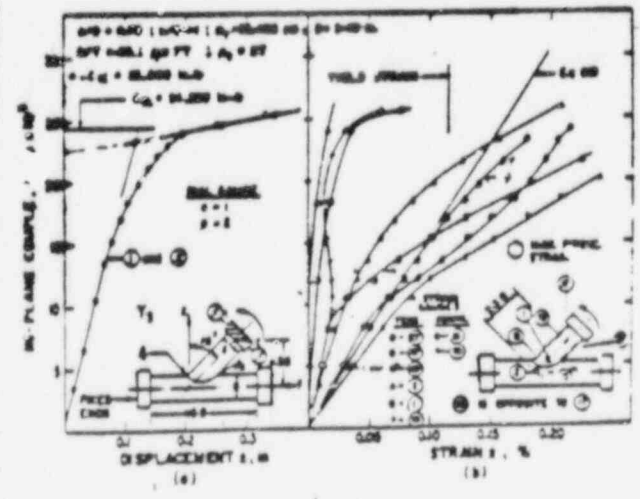
IN-PLANE LIMIT COUPLE

TEES:

EXPERIMENTAL: 18500 IN-LB

THEORETICAL: 22,100 IN-LB

FIGURE: 1



—in-plane limit couple case on Y_5

LATERALS

IN-PLANE LIMIT COUPLES

ON 45° LATERAL:

EXPERIMENTAL: 23,000 IN-LB

THEORETICAL: 24,200 IN-LB

FIGURE: 2 (REF 2 Fig 45)

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CALCULATION SHEET

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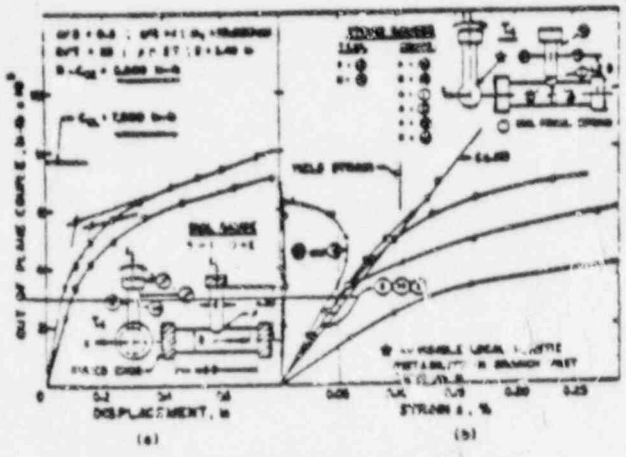
OUT. OF PLANE

LIMIT COUPLE

ON TEES AND

LATERALS

(REF: 2. Figs 50, 52, 56)



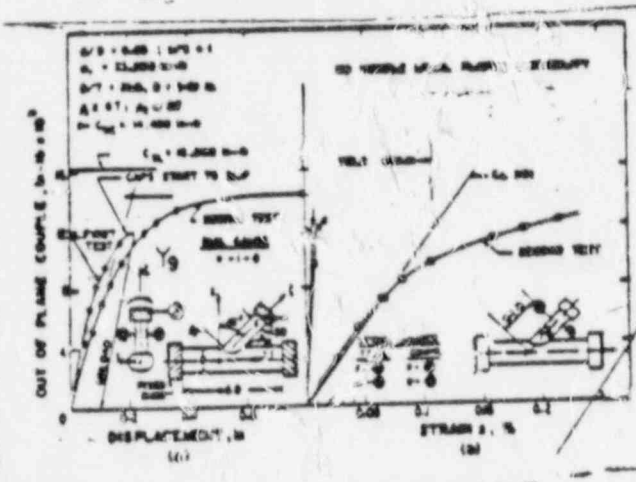
—Out-of-plane limit moment test on T_6

FIGURE: 3

LIMIT COUPLE:

EXPERIMENTAL : 5600 IN LB

THEORETICAL : 7800 IN LB

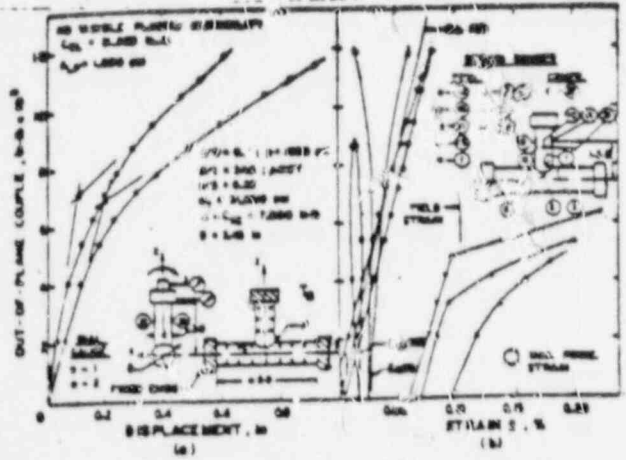


—Out-of-plane limit moment test on Y_9

EXPERIMENTAL : 14,400 IN LB

THEORETICAL : 16,060 IN LB

FIGURE : 4



—Out-of-plane limit moment test on T-s at constant internal pressure

EXPERIMENTAL : 7000 IN LB

THEORETICAL : 21 900 IN LB

FIGURE : 5

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J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
590-270-1-01	NP(B)	73	X6	

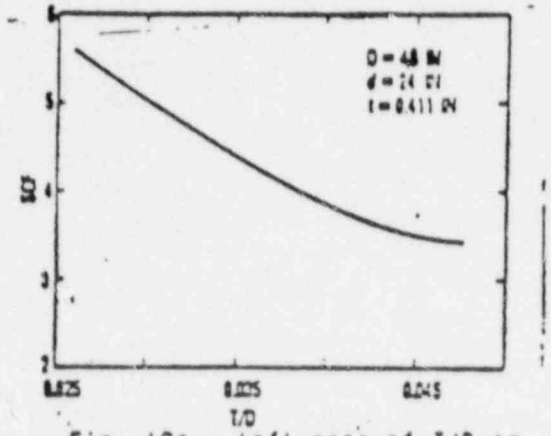

Fig. 10a - Influence of T/D on the SCF of a typical T-joint.

REF: 3
(Fig 10a)

FIGURE 6

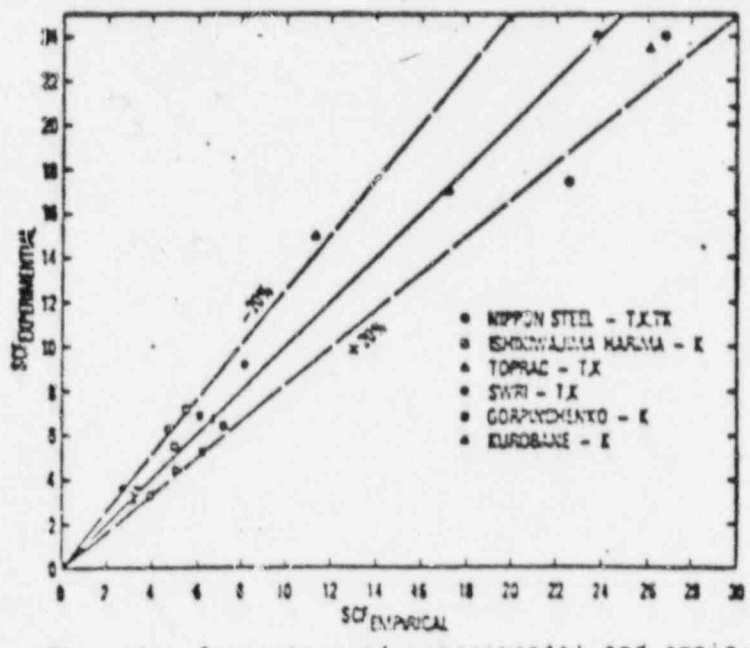

Fig. 11 - Comparison of experimental and empirical SCFs for various joints.

REF: 3
(Fig 11)

FIGURE 7

CALCULATION IDENTIFICATION NUMBER				PAGE 20
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	
590.47081.01	NPLB)	75	X.6	

REF: 4 (Fig 13)

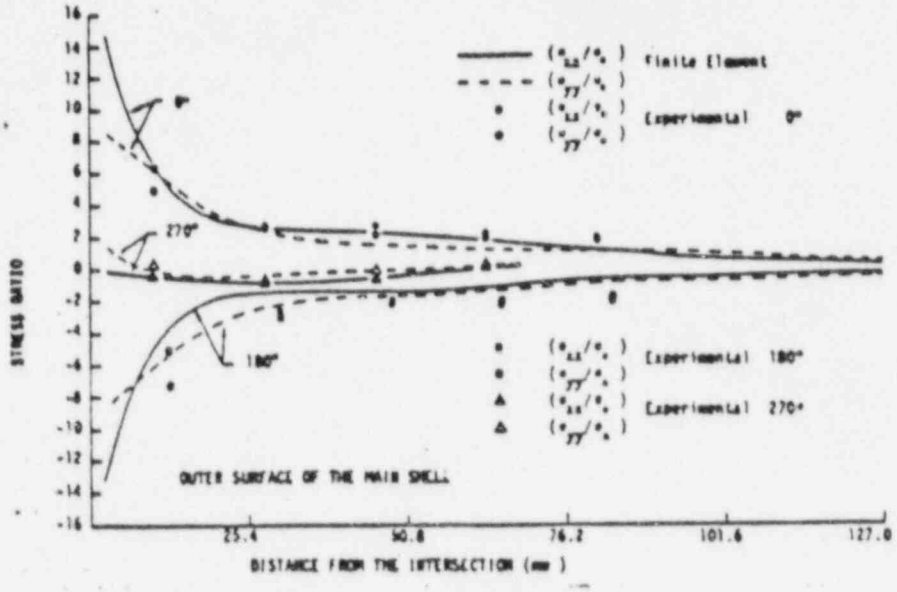

Figure 13. In-plane loading results for 60° intersection (outside surface).

FIGURE 8

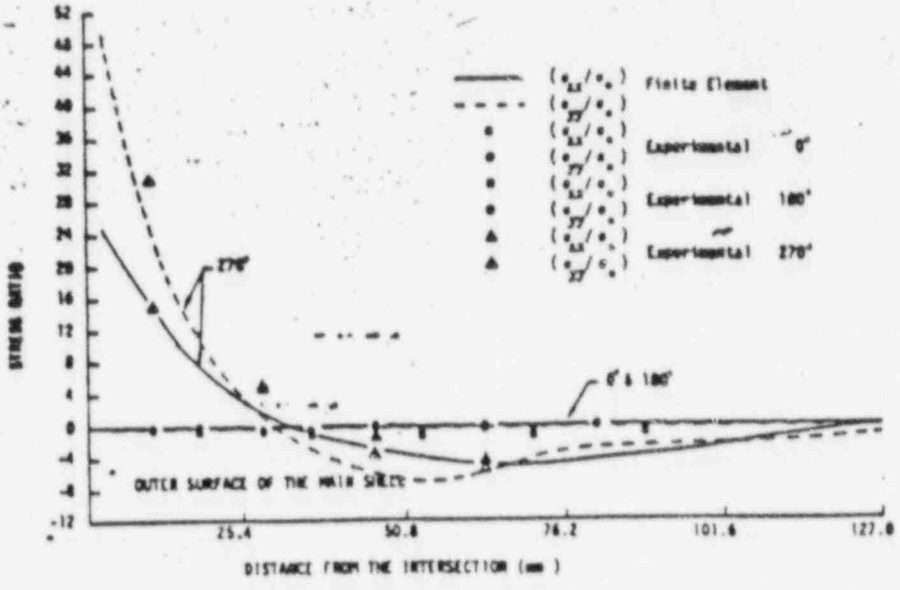

Figure 14. Out-of-plane loading results for 60° intersection (outside surface).

FIGURE 9 (Ref: 4 Fig 14)

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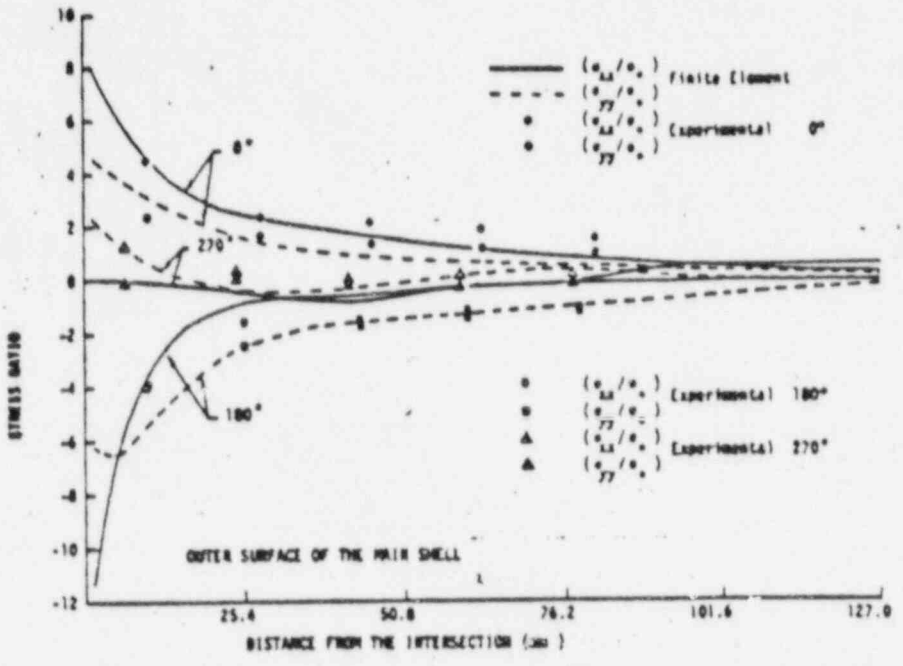
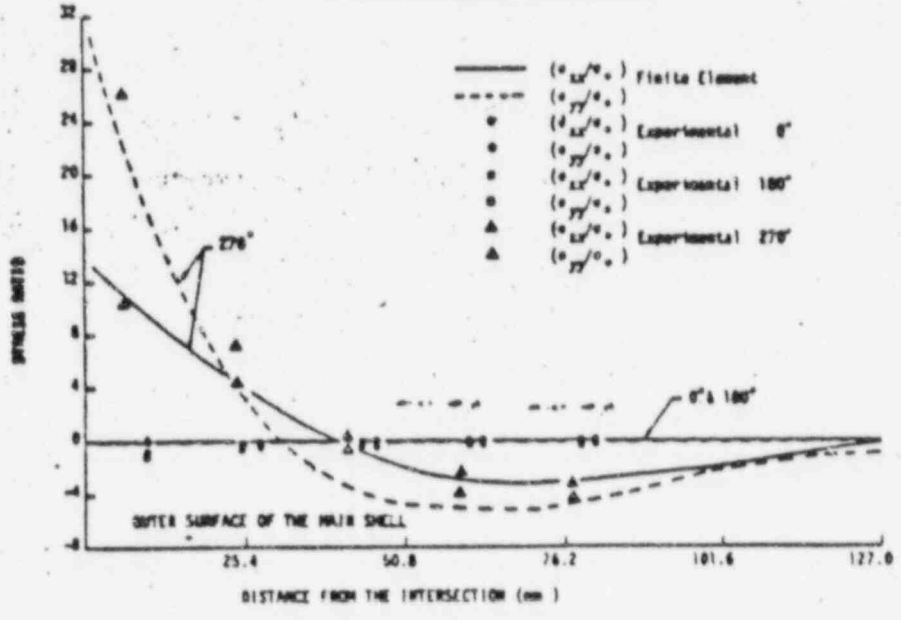
CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO. 590.470.1.01	DIVISION & GROUP NPLB)	CALCULATION NO. 75	OPTIONAL TASK CODE X6	PAGE 21



(REF: 4 Fig 15)

Figure 15. In-plane loading results for 30° intersection (outside surface).

FIGURE 10



(REF: 4 Fig 16)

Figure 16. Out-of-plane loading results for 30° intersection (outside surface).

FIGURE 11

▲ 5010 65

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J.O. OR W.O. NO. 59047C.1.01	DIVISION & GROUP NP(B)	CALCULATION NO. 75	OPTIONAL TASK CODE X6	

(REF: 4 Fig 11)

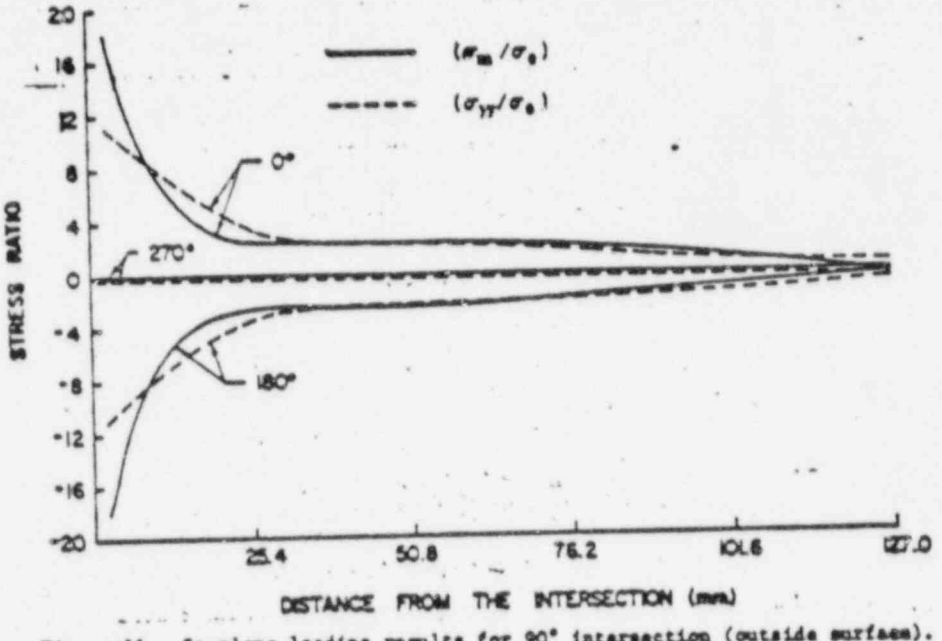
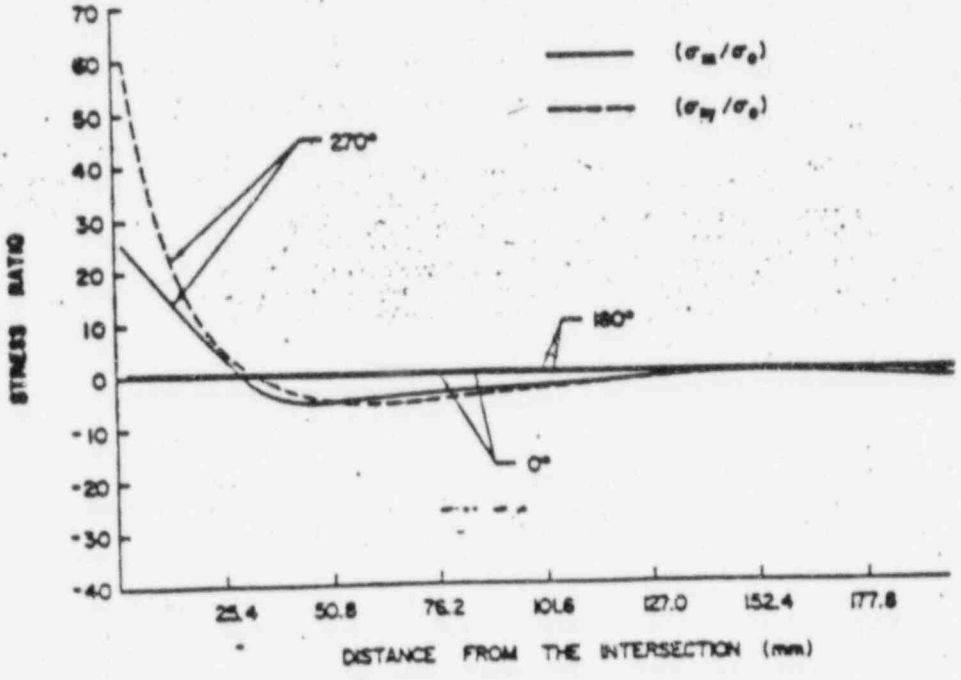


Figure 11. In-plane loading results for 90° intersection (outside surface).

FIGURE 12



(R44 Fig 12)

Figure 1. Out-of-plane loading results for 90° intersection (outside surface).

FIGURE 13

REF: 4
(Fig 17)

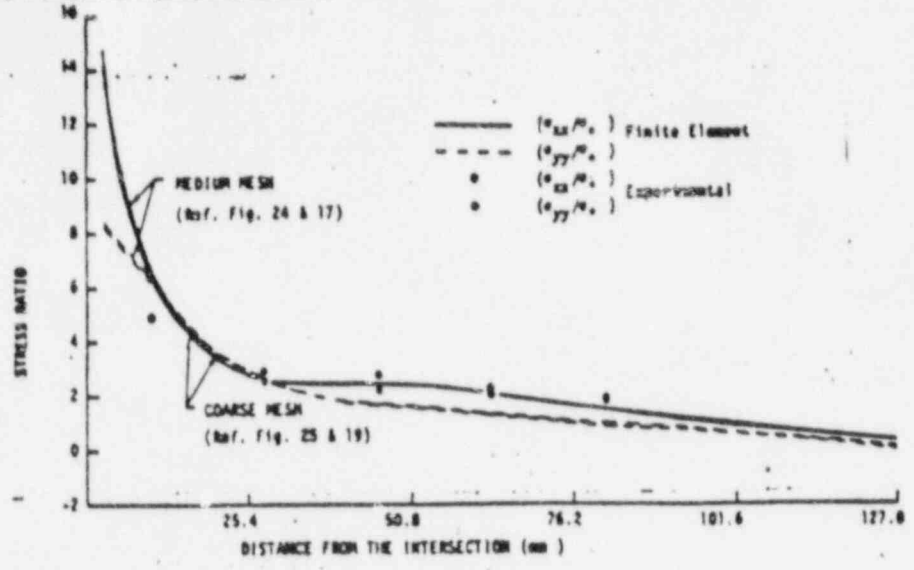


Figure 17. Comparison of the course and fine meshes for the case of in-plane loading at 0° line.

FIGURE 14

(Ref: 4
Fig. 18)

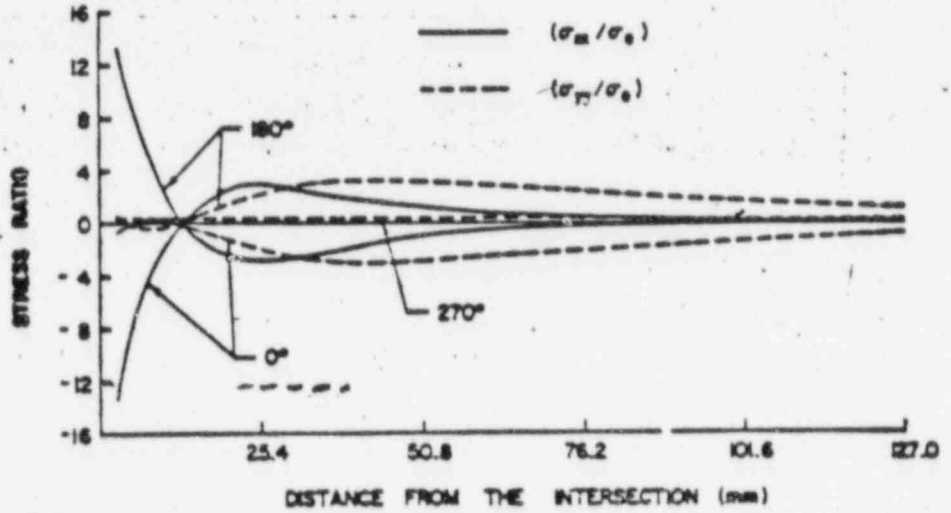


FIGURE 15

Figure 18. In-plane loading results for 90° intersection (inside surface).

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO. 590-470-1-01	DIVISION & GROUP NPGB	CALCULATION NO. 75	OPTIONAL TASK CODE X6	PAGE 24

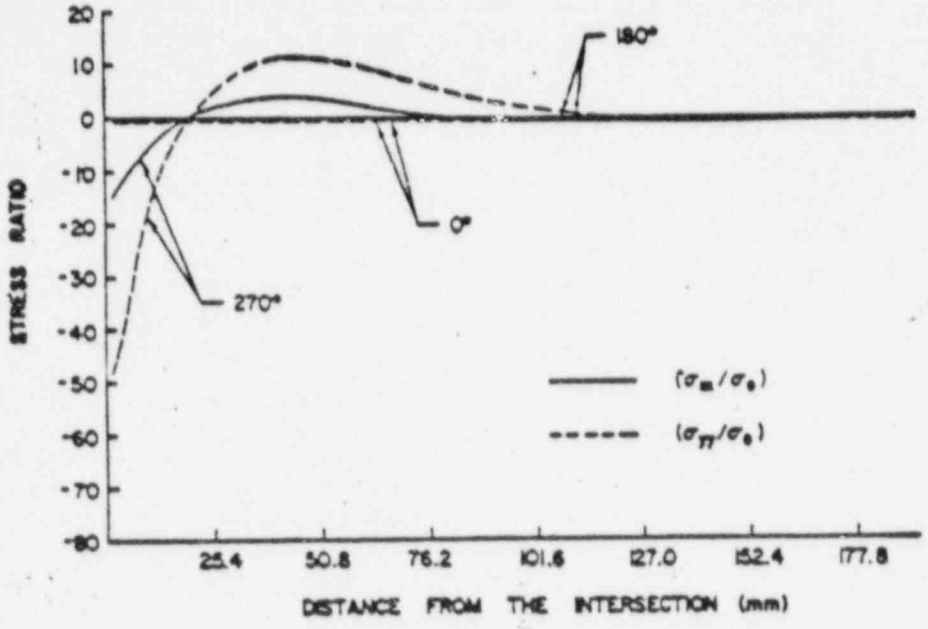

Figure 19. Out-of-plane loading results for 90° intersection (inside surface).

REF: 4
(Fig 19)

FIGURE 16

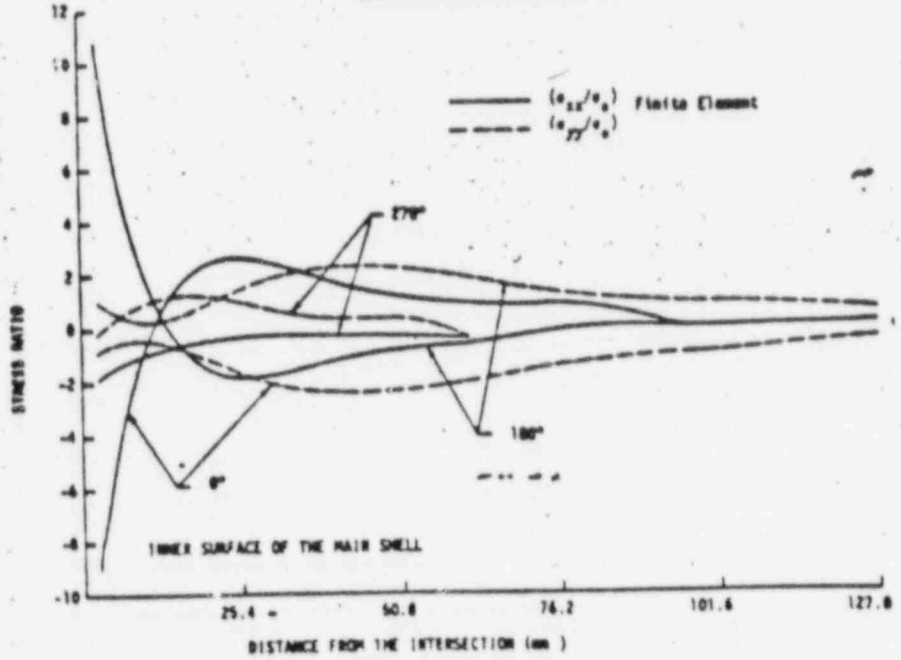

Figure 20. In-plane loading results for 60° intersection (inside surface).

(REF 4
Fig 20)

FIGURE 17

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CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CALCULATION NO.	OPTIONAL TASK CODE	PAGE 25
590·470·1·01	NP(B)	75	X6	

REF 4

(Fig 21)

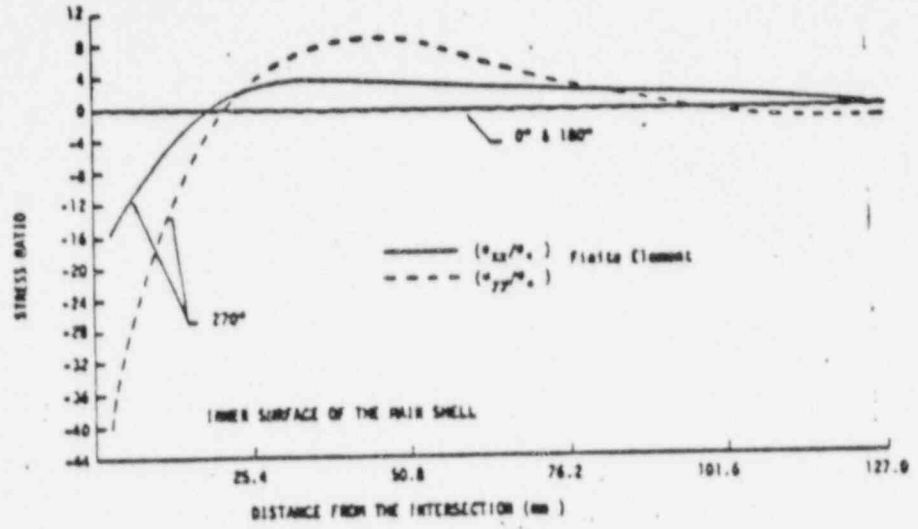

Figure 21. Out-of-plane loading results for 60° intersection (inside surface).

FIGURE 18

REF 4

Fig 22

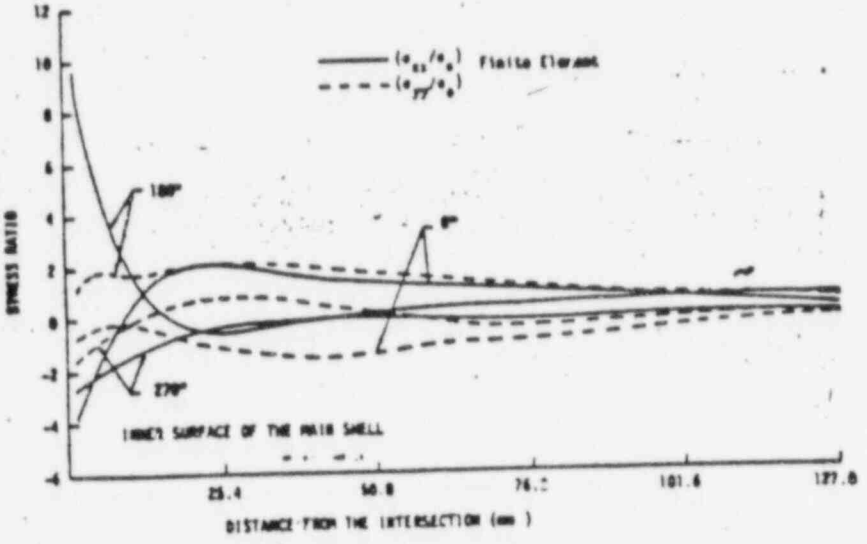

Figure 22. In-plane loading results for 30° intersection (inside surface).

FIGURE 19

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J.O. OR W.O. NO. 590 470 1 01	DIVISION & GROUP NP(B)	CALCULATION NO. 75	OPTIONAL TASK CODE X6	

FIGURE 20 (REF: 4 Fig 23)

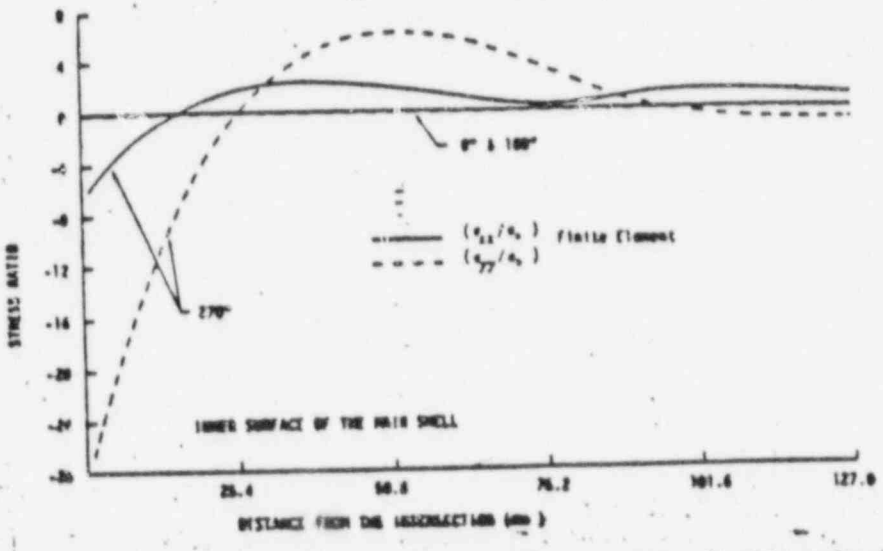

Figure 23. Out-of-plane loading results for 30° intersection (inside surface).

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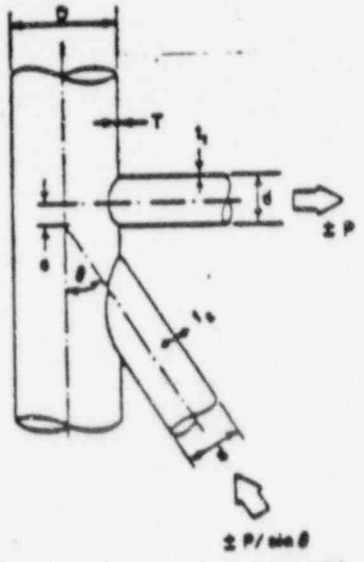
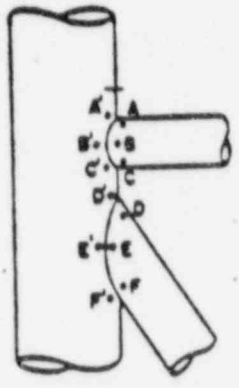
FIGURE 21 (REF: 14. Figs 2,3 & Table 2)



Tube specimen and loading condition.



Critical Locations.

- FATIGUE DATA OF K-TYPE TUBULAR JOINTS- C. FATIGUE LIFE AND CRITICAL LOCATIONS FOR FATIGUE FRACTURE

SPECIMEN DESIGNATION	CRACK INITIATION				CYCLES TO COMPLETE FAILURE	FAILURE OCCURRED AT
	HORIZONTAL		DIAGONAL			
	CYCLES	CRITICAL LOCATION	CYCLES	CRITICAL LOCATION		
A-1	14,500	C	20,300	B	34,600	Horiz.
A-2	49,000	C,B',C'	68,500	B	94,900	Horiz.
B-1	6,400	C,B'	12,300	B'	22,600	Horiz.
B-2	7,500	C,B'	None	-	19,000	Horiz.
B-3	48,700	C,B'	35,600	D'	106,500	Horiz.
B-4	160,000	C	150,000	D',D	217,900	Diag.
C-1	9,900	C,B,A	None	-	9,900	Horiz.
C-2	17,700	C	16,100	B	27,700	Horiz.
C-3	27,500	C	None	-	75,900	Horiz.
C-4	67,000	C	None	-	85,600	Horiz.
C-5	382,000	-	None	-	None	-
D-1	60	B',C',A'	None	-	450	Horiz.
D-2	2,580	C',B'	1,400	D'	6,300	Horiz.
B-3	1,297	C',B'	1,520	B',F	6,600	Diag.