May 15, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 50-445 and 50-446
TEXAS UTILITIES ELECTRIC COMPANY, ET AL.	)	
	)	(Application for Operating Licenses)
(Comanche Peak Steam Electric Station, Units 1 and 2)	)	

AFFIDAVIT OF J.C. FINNERAN, R.C. IOTTI AND J.D. STEVENSON REGARDING ALLEGATIONS INVOLVING AWS VS. ASME CODE PROVISIONS

We, J.C. Finneran, R.C. Iotti and J.D. Stevenson, being first duly sworn, hereby depose and state as follows[1]:

(Finneran) My name is John C. Finneran. I am the Pipe Support Engineer for the Pipe Support Engineering Group at Comanche Peak Steam Electric Station ("CPSES"). In this position, I oversee the design work of all pipe support design organizations for Comanche Peak. I have previously provided testimony in this proceeding. A statement of my professional and educational qualifications was received into evidence as Applicants' Exhibit 142B.

---

1 Except as otherwise indicated each affiant attests to all parts of this affidavit.

8405170434 840516
PDR ADOCK 05000455
G PDR

(Iotti) My name is Robert C. Iotti. I am Chief Engineer, Applied Physics for Ebasco Services, Inc. A statement of my professional and educational qualifications is attached to Applicants' letter of May 16, 1984, to the Licensing Board.

(Stevenson) My name is John D. Stevenson. I am the President and Managing Partner of Stevenson and Associates. My educational and professional qualifications are attached to Applicants' Motion for Summary Disposition of Certain CASE Allegations Regarding AWS and ASME Code Provisions Related to Welding (April 15, 1984).

Q. Are you familiar with CASE's allegations that there are several design related provisions included in the AWS Code which are not considered by the ASME Code nor used at CPSES, specifically "Multiplication factor and reduction factors for skewed "T" joints," "Limitations on angularity for skewed "T" joints," "Calculations for punching (actually a reduction factor for the weld) shear on step tube joints," and "Design procedure for joint of tube to tube with Beta equal to 1.0"?

A. Yes, we have evaluated these four design related items which CASE has characterized as AWS Code provisions not considered in ASME requirements or in CPSES design practices.

Q. In an overview fashion what did your evaluation entail?

A. We first examined the AWS D1.1 Code to determine if there were any AWS Code provisions related to the item. We also examined the AISC Specification for the Design, Fabrication

and Erection of Structural Steel for Buildings, since the AWS Code is intended to be complementary with a specification for design and construction of steel structures (see Section 1.1 of AWS D1.1). Next we examined applicable portions of the ASME Code, e.g., Section IX (Welding and Brazing Qualifications) and Subsection NF (Component Supports) and Appendix XVII (Design of Linear Type Supports by Linear Elastic and Plastic Analysis) of Section III. Finally, we examined design practices used at CPSES.

Q. Do the AWS and ASME Codes contain all the information necessary to design a weld joint?

A. No. Design of structural steel including welded connections or joints should consider not only the detailed welding provisions of applicable codes such as ASME Section IX or AWS D1.1, but also the complementary requirements of other Codes (e.g., ASME Section III in the case of ASME component supports). In addition, a properly designed welded connection also requires the training, experience and skill of the design engineer to provide structural design adequacy. See for example the Forward to the Commentary to the AWS D1.1 Code which states in pertinent part that "It should be recognized that the fundamental premise of the Code is to provide general stipulations applicable to any situation and to leave sufficient latitude for the exercise of engineering judgement." Considering the infinite variety and combination of welded joints or connection

configurations together with types of welds possible, no published standard can possibly cover all possibilities. In the final analysis, the engineer designing the weld joint must be relied upon to assure the structural adequacy of the design.

Q. Describe the results of your evaluation of the "multiplication factor and reduction factors for skewed "T" weld joints"?

A. AWS Code requirements regarding multiplication and reduction factors for skewed T-weld joints are contained in Appendix B of the AWS Code, which sets forth limitations on effective throat thickness for fillet welds in skewed T-joints designed in accordance with the AWS Code. This is but one of the parameters effecting the load capacity of the joint. While the ASME Code does not have explicit requirements governing this area, compensatory requirements have provided assurance of acceptable load carrying capacity.

For example, Appendix XVII (paragraph 221[illegible](c)) of Section III of the 1974 ASME Code required that T-joint basemetal thru thickness allowable tensile stresses be limited to half the normal tensile allowable. This assured that a welded skewed T-joint designed in accordance with this provision would be more conservative than a similar welded joint designed in accordance with the above noted provisions of the AWS Code. To illustrate the above, consider a 60° skewed T-joint of four inches in length with

a 1/4 inch heel and toe weld. To determine the load carrying capacity of the weld using the limitations on skewed T-joint effective throats contained in Appendix B of AWS D1.1, the following equation in Appendix B is used:

$F = w/k \times .707 \times l_w \times S_a$

where:

w = weld leg length

l_w = length of weld

S_a = allowable stress in the weld material

k = coefficient set forth in Appendix B, Table B

F = load carrying capacity of the weld

F for (60°) (limiting) = $\frac{1/4}{.71} \times .707 \times 4 \times 21{,}000 = 20{,}911$ lbs.

F for (135°*) (limiting) = $\frac{1/4}{1.31} \times .707 \times 4 \times 21{,}000 = 11{,}333$ lbs.

* (should use 120° to be consistent with 60° acute angle, but used 135° as the limiting more conservative case)

Total load = sum of two load capacities = 32,244 lbs.

To determine the load carrying capacity using the ASME Code provision noted above, and the bounding material used at CPSES (cold rolled tube steel, ASTM A-500), the following equation is used:

$F = w \times l_w \times S_{ct}$

where:

w = weld leg length

l_w = length of weld

S_{ct} = weld contact surface tensil allowable stress (.3 times the specified minimum yield strength of the plate, Appendix XVII (paragraph 2211(c)) of Section III of the ASME Code)

F = load carrying capacity of the weld

F = 1/4 x 4 x 0.3fy = 1/4 x 4 x 0.3 x 42 ksi = 12,593 lbs.

F for Obtuse side = F for acute side

Total load = sum of two load capacities = 25,186 lbs.

As can be seen, the load limitations using the ASME provisions are more restrictive than the AWS provisions.

The above discussion is not meant to imply that engineers at CPSES did not use considerations as set forth in the AWS Code. Documentation to the QA Group in August 1982 reflects that weld designers at CPSES were using considerations virtually identical to that noted in Appendix B of AWS D1.1. See the attached letter CPPA-22,616, which indicates the methods being used by all design organizations at that time (Attachment 1).

(Finneran) To verify the adequacy of these measures, we performed an evaluation of 13 skewed T-joint designs at CPSES selected at random, and in all cases these joints met or exceeded the load capacities required by AWS. The highest stressed weld was only stressed to 39 percent of AWS allowables (21 ksi). See Attachment 2 for a summary of these results as they applied to ASME allowables of 18 ksi.

It should be noted that the SIT Report at p. 51, after an analysis of skewed T-joints, also concluded that "the design procedures being utilized by the three pipe support design groups for skewed joints are based on sound engineering practice."

In conclusion, the allegations of CASE that design practices at CPSES regarding skewed T-joints is flawed because it does not consider AWS requirements regarding fillet weld throat thickness is without merit.

Q. Would you please describe the results of your evaluation of the limitation on angularity for skewed "T" joints.

A. The AWS Code requirement regarding this issue is set forth in Section 2.7.1.4 of AWS D1.1. This Section establishes angle limitations for fillet welds used in skewed T-joints. These limitations do not apply to welds qualified by test. See Appendix E, Table E-2, to AWS D1.1. Both the AWS D1.1 and ASME Codes permit weld procedures without such limitations provided the weld procedure used is qualified by test.

Applicants' practices, as set forth in CPPA-22,616 (Attachment 1), are virtually identical to those set forth in the AWS Code regarding this issue. In addition, as previously noted, ASME Code provisions provided compensatory measures to assure the adequacy of skewed T-joint welds. See e.g., Appendix XVII (paragraph 2211(c)) of Section III of the 1974 ASME Code. Evaluations of randomly selected

skewed T-joint welds (as noted above) provide assurance that AWS allowables were not exceeded. This conclusion is reinforced by the SIT Report at p. 51.

In sum, CASE's allegations that CPSES' design practice is flawed because it does not consider AWS requirements regarding angularity limitations on skewed joints are without merit.

Q. Would you please describe the results of your evaluation of calculations for punching shear on step tube joints.

A. The AWS Code provisions regarding punching shear are part of empirically derived equations which take into consideration numerous other factors (e.g., axial and bending stresses in the main member). See Section 10.5.1 of the AWS Code. These equations, in essence, combine punching shear analyses into a complete local failure assessment of the effected joint. It should be noted that AWS punching shear analysis requirements were introduced to deal with large tubular structures (e.g., offshore platform supports) with relatively large flange width to flange thickness ratios. These conditions do not apply to relatively small tubular members used in pipe supports at CPSES. Accordingly, punching shear is not a significant problem at CPSES. However, on a case by case basis, when the CPSES designer believes it may be appropriate, punching shear is calculated for a given weld joint.

(Finneran) To provide assurance that punching shear was not a problem, I had a punching shear evaluation performed on 12 tubular pipe supports (both stepped and matched connections) selected from the worst cases provided in Case Exhibit 669B. The evaluation reflected no instance where punching shear was a problem, and the highest ratio of actual stress from punching shear to the AWS allowable was .57. (See Attachment 3.)

It should be noted that Applicants' design process regarding local stress effects (e.g., punching shear) was evaluated by the SIT, and based on a sample of 100 vendor certified supports, was found to be acceptable. (See SIT Report at pp. 54-58, item 4.)

In sum, Applicants' design process reflects adequate consideration of the effects of punching shear, and CASE's allegations are without merit.

Q. Would you please describe the results of your evaluation of design procedure for tube-to-tube joints with betas equal to 1.0.

A. The AWS requirements regarding design of tube-to-tube joints with beta equal to 1.0 are set forth in Section 10.5.1.1 of AWS D1.1. This section has two equations for determining the allowable capacity for loads normal to the main member:

$$F_1 = 2t_c a_x \ (0.6\ Q_f\ F_y) \qquad (1)$$

where:

F_1 = load capacity of the main member along its sides as determined by web crippling effects

t_c = thickness of branch member tube wall

a_x = width of loaded area along the tube wall

Q_f = stress interaction factor based on the main member stress level. It ranges from .72 to 1.00 as shown in Table 10.5.1 of the AWS Code

F_y = specified minimum yield strength

$$F_2 = 2t_c b \left[Q_B \; Q_f \; \frac{F_y}{0.6\gamma}\right] \qquad (2)$$

where:

F_2 = load capacity of the main member along the heel and toe welds

b = width of branch tube perpendicular to the main member cross section

Q_B = geometric modifier factor determined from Table 10.5 as a function of B

γ = geometic parameter as defined in Figure 10.1.2(M), AWS Code

The AWS Code allowable static load for the connection is $F_w = F_1 + F_2$; (Equations 1 plus 2).

The capacity of tube-to-tube connections with beta equal to one is also addressed in the ASME Code in NF Appendix XVII (paragraph 2261.2) of Section III in a substantially similar manner. The ASME formula for the allowable capacity for loads normal to the main member is:

$$F_m = 2t\ (N + 2k)(.75F_y) \quad (3)$$

where:

$2t_c a_x$ is essentially equal to $2t\ (N + 2k)$

N = length of bearing equal to A_x

k = distance from outer face of flange to web toe of fillet

(Finneran) For tube-to-tube connections with beta equal to one, these provisions of the ASME Code are requirements for CPSES.

In sum, the ASME Code contains specific requirements regarding tube-to-tube connections which provide results which are substantially similar to those set forth in the AWS Code. These provisions of the ASME Code are requirements for these type joints at CPSES. Accordingly, CASE's allegations regarding this issue are without merit.

Robert C. Iotti

Sworn to before me this 15th day of May, 1984.

Notary Public

John C. Finneran, Jr.

Sworn to before me this 15th day of May, 1984.

Notary Public

John D. Stevenson

Sworn to before me this 15th day of May, 1984.

Notary Public

My Commission Expires January 31, 1985

ATTACHMENT 1

CPPA 22, 616

TEXAS UTILITIES SERVICES INC.

INDEXED

OFFICE MEMORANDUM

Gordon Purdy/Quality Assurance Mang. Glen Rose, Texas DATE: August 27, 1982

Subject COMANCHE PEAK STEAM ELECTRIC STATION
PIPE SUPPORT WELDS AT TUBE STEEL SKEWED JOINTS

Ref.: Pipe Support Engineering, ITT Grinnell and NPSI are analyzing fillet welds at skewed tube steel joints as follows:

Attachment 1, A, $\theta > 135^{\circ}$

Fillet welds at obtuse angles greater than 135° are ignored in design verification, unless the weld exhibits a "mach. req'd." note.

Attachment 2, B, $90^{\circ} < \theta \leq 135^{\circ}$

The effective throat of these fillet welds is calculated by engineering based on the dim.'s of the weld shown.

Attachment 1, C, $90^{\circ} > \theta \geq 60^{\circ}$

The effecitve throat is calculated by engineering by multiplying the leg size(s) by .707. This becomes more conservative as the angle approaches 60°.

Attachment 1, D, $60^{\circ} > \theta \geq 45^{\circ}$

This is outside the range of a fillet weld. However, many BRH's exist with a fillet weld symbol shown. The weld is actually a "V" groove and engineering calculates the effective throat as such. In the field this is a difficult weld to measure. Therefore, we've computed the measurements at the face of the welds on attachment two for your inspectors convenience.

As noted above, this memo addresses tube steel skewed joints. Pipe connections will be addressed separately.

Jay Ryan
Jay Ryan
PSE Large Bore Chief Engineer

GMC

JJR/GMC/cs

cc: Bob Siever, QA
Dave Rencher
Hal Goodson
Gary Mochel
Barry Hill
Jeff Oliver
Jimmy Sherrer
Mike Yazhari
Mark Cotugno
Mike Prescott
ARMS

JOB NO. 35-1195
RECEIVED
SEP 1 1982
RECEIVED

B & R DCC DIST.

PROJECT MGR.	
PROJECT ENGR.	
QA MGR.	
PROJECT CONT. ENGR.	1 ea
TUGCO QA	
PROJECT GEN. MGR.	
ARMS	1 ea
CPPA	1 ea

ATTACHMENT 1 CPPA – 22, 616

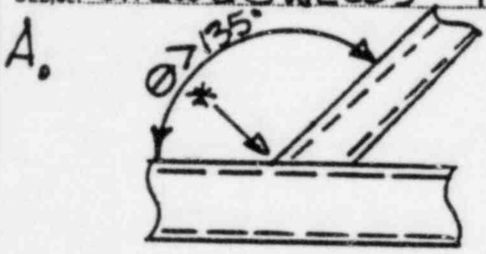
FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date.........
Calc By GMC
Chk'd/Apprd. By.........
Filing Code.........
Sheet No. 1 Of.........
G & H Job. No.........

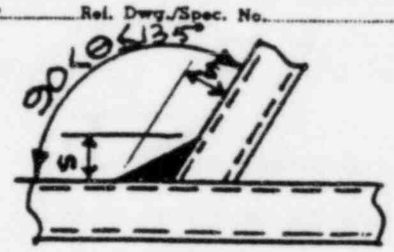
Subject: SKEWED WELDS - TUBE STEEL   Ref. Dwg./Spec. No.........

A.



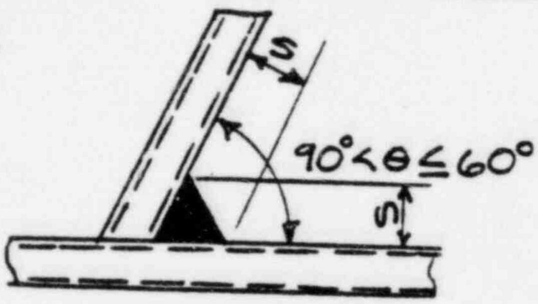
* IGNORE THE WELD IN DESIGN REVIEW UNLESS MACHINING IS CALLED FOR

B.



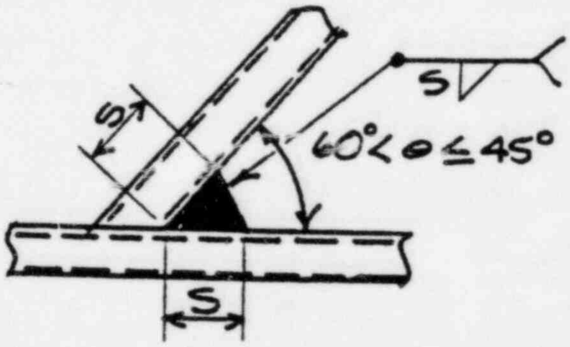
ENG'G IS CALCULATING THE EFFECTIVE THROAT IN DESIGN VERIFICATION BASED ON DIM'S SHOWN ABOVE

C.



ENG'G IS USING .707 X WELD SIZE AS EFF. THROAT. THIS BECOME MORE CONSERVATIVE AS THE ANGLE APPROACHES 60°

D.



EVEN THOUGH MANY DRAWINGS SHOW A FILLET WELD IN THIS SITUATION, ENG'G IS CONSIDERING THE WELD A GROOVE WELD AND CALCULATING THE EFFECTIVE THROAT AS IF IT WAS.

ATTACHMENT 2 CPPA- 22,616

FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 8-26-82

Calc By GMC

Chk'd/Apprd. By

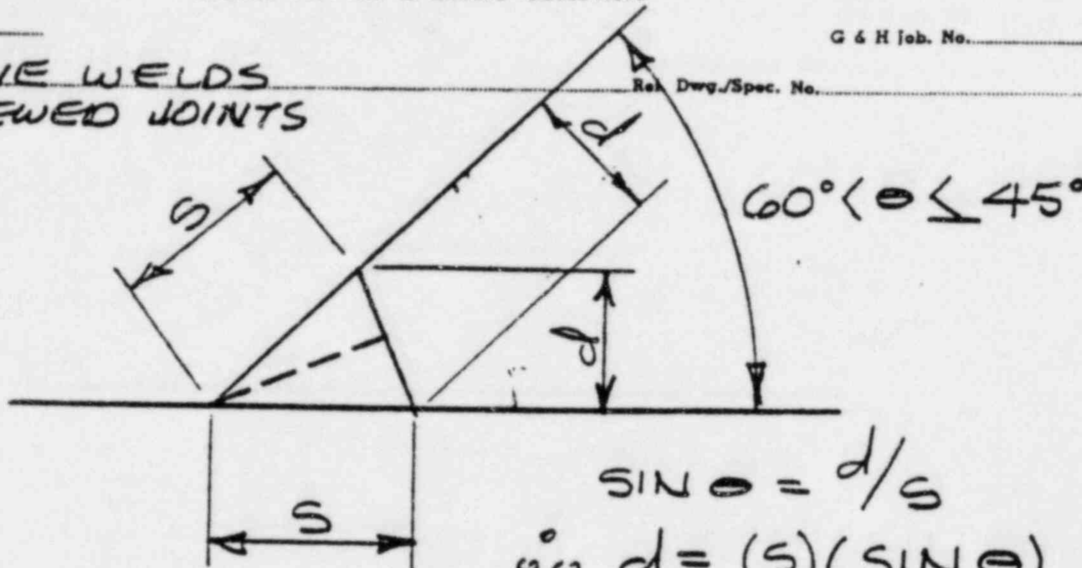
Filing Code

Sheet No. 2 Of

G & H Job. No.

Ref. Dwg./Spec. No.

Subject GROOVE WELDS AT SKEWED JOINTS



$\sin\theta = d/S$

$\therefore d = (S)(\sin\theta)$

WELD SIZE (S)

DEGREE	3/16	1/4	5/16	3/8	7/16	1/2	
57°	.1572	.2096	.2620	.3145	.3669	.4193	
55°	.1536	.2047	.2559	.3071	.3583	.4195	
53°	.1497	.1996	.2495	.2995	.3494	.3993	
50°	.1436	.1915	.2393	.2872	.3351	.3830	
48°	.1393	.1857	.2322	.2786	.3251	.3716	
45°	.1325	.1767	.2209	.2652	.3093	.3535	

THE CHART SHOWS VALUES FOR "d".

ATTACHMENT 2

STUDY:

TO VERIFY THAT THE APPROACH USED ON ORIGINAL DESIGNS AT SKEWED TUBE STEEL JOINTS WAS CONSERVATIVE, A REVIEW OR RANDOMLY SELECTED SUPPORTS WAS PERFORMED. 1300 LB. HANGERS WERE IDENTIFIED AS BEING ISSUED PRIOR TO 1982. APPROXIMATELY EVERY HUNDRETH SUPPORT WAS CHOSEN TO BE EVALUATED. BY THE AREA METHOD.

RESULTS:

CC-1-028-700-A33R	8078 PSI/18KSI	= 45%
CC-1-323-700-A43K	2141 PSI/18KSI	= 12%
CC-2-139-710-A63R	780 PSI/18KSI	= 5%
CS-1-241-702-A42R	235 PSI/18 KSI	= 1.3%
CC-2-019-713-A43S	5848 PSI/18KSI	= 33%
BR-X-001-720-A53A	4812 PSI/18KSI	= 27%
CH-2-239-702-E23S	363 PSI/18 KSI	= 2%
CC-1-140-707-E63R	4288 PSI/18KSI	= 24%
CS-1-620-700-A42A	3825 PSI/18KSI	= 21%
DD-2-16-700-S33R	1961 PSI/18KSI	= 11%
DD-2-17-711-A33R	3183 PSI/18KSI	= 18%
CC-X-32-700-A43R	4289 PSI/18KSI	= 24%
DD-1-012-707-A33A	2921 PSI/18KSI	= 16%

AVERAGE 19%

(3-5-84) [signature]

ATTACHMENT 3

SUPPORT NUMBER	CASE EXHIBIT #	ASME ALLOW.	ALLOWABLE PCH'G/AWS	ACTING LOAD	COMMENTS & WORST CASE
SI-1-031-704-A32R	12 H,I,J & K	86,175#	152,817#	22,530#	ITEM 7&8, T.S. TO T.S. MATCHED CONNECTION (EMER)
CC-1-020-001-A33K	4 I, J, & K	15,320 #/in²	10,766 #/in²	2032 #/in²	REAR BRACKET AT T.S. 8×8×1/2 STEPPED CONN. (EMER)
CT-1-008-010-S22K	13 HH & II	71,595#	NA	6815#	ITEM 6 AND REAR BRACKET FOR SNUBBER (EMER)
CS-1-079-036-C42K	13 SS & TT	27,900#	22320#	2070#	PUNCH'G @ ITEM 4 & STANCHION (FLT)
CS-1-239-007-A42R	13 EE, DD, FF & GG	15,320 #/in²	11,632 #/in²	2010 #/in²	REAR BRACKET TO TUBE STEEL COMPARES EMER. LOAD w/ N&U ALLOW
CC-2-008-709-A43K	11 FF & GG	62,775#	72,540#	11,869#	REAR BRACKET TO TUBE STEEL COMPARES EMER LOAD w/ N&U ALLOW
CC-1-028-701-A33R	13 MM & NN	15,320 #/in²	6185 #/in²	1312 #/in²	REAR BRACKET AT TUBE STEEL (EMER) 21%
CC-1-116-038-F43R	11 WW & XX	15,320 #/in²	3953 #/in²	2261 #/in²	REAR BRACKET @ TUBE STEEL COMPARES EMER. w/ N & U ALLOW
CT-1-124-418-C72R	11 UU & VV	14,880 #/in²	11,139 #/in²	1774 #/in²	REAR BRACKET TO TUBE STEEL (EMER) 16%
MS-1-001-002-S72R	4 S & T	15,320 #/in²	7640 #/in²	2246 #/in²	REAR BRACKET TO TUBE STEEL (N&U) 29%
MS-1-001-005-S72R	4 Q & R	272,886#	218,310#	101,456#	REAR BRACKET TO ITEM 7&5 47%
RH-1-025-004-S22R		15,320 #/in²	8218 #/in²	2845 #/in²	REAR BRACKET AT TUBE STEEL COMPARES EMER LOAD w/ N&U ALLOW
CC-1-008-019-A33K	13 AAA & BBB	15,320 #/in²	10,766 #/in²	3796 #/in²	REAR BRACKET AT T.S. 8×4×1/2 (EMER) 35%
CT-1-017-034-C72R	11 QQ	26,746#	NA		REAR BRACKET @ WF
CT-1-008-006-S22K	11 OO & PP	NA	NA	NA	NO PUNCH'G, SHEAR OR WEB CRIPPLING
SI-1-104-008-C52K	12 F & G	NA	NA	—	