



SEP 24 1984

FOR INFORMATION ONLY

CADWELD INSPECTION ACTIVITIES

PREPARED BY:

[Signature]

9-7-84
Date

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9-22-84
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1.0 REFERENCES

- 1-A Specification 2323-SS-11, "Cadweld Connectors for Reinforcing Steel"
- 1-B B&R Construction Procedure, 35-1195-CCP-19,
- 1-C Procedure CP-QP-16.0, "Nonconformances "

2.0 GENERAL

2.1 PURPOSE

To describe the QC inspection and testing methods for mechanical splicing of reinforcing bars using the Cadweld Rebar Splice Method.

2.2 SCOPE

To control methods for qualification, requalification, identification of splicer and cadwelds, production records, cadweld inspection, and sampling and testing.

HISTORICAL FILE

FOIA-85-59
C/344



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3.0 INSTRUCTION**3.1** **QUALIFICATION OF CADWELD SPLICERS****3.1.1** Training

Verify from attendance lists for cadweld splicing training sessions that each prospective cadweld splicer has received training from an Erico representative or by Erico-qualified personnel in accordance with Reference 1-B. This training must be administered in each splice position in which the prospective cadweld splicer is to be qualified prior to preparation of qualification splices.

3.1.2 Qualification

- a. After the training session, the proposed splicer shall prepare two splices for each position that he is qualifying for:

NOTE: Bar size #18 Test Splices qualify for all bar sizes.

- b. The QC Inspector shall visually inspect the completed splices in accordance with paragraph 3.4 and document results on the Cadweld Splicer Qualification Form (Figure 1).
- c. If the splices are determined by the QC Inspector to be visually acceptable, they shall be tensile tested in accordance with Reference 1-A and the results documented on the Cadweld Splicer Qualification Form (Figure 1).
- d. Upon receipt of satisfactory tensile test results, the qualified splicer shall be issued a unique I.D. symbol to be used as part of the identification for all of his future splices. An example of a typical splice sleeve identification is "ABH2P" where:

AB Is the splicer's I.D. symbol

H Denotes that splice was shot in the horizontal position (V-Vertical or D-Diagonal)

2 Denotes the second splice for the splices in the horizontal position for this particular bar size.

P Denote a Production Test Splice (S-Sister Test Splice or Q-Qualification Test Splice).



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- e. The splicer's I.D. symbol, name and badge number shall be entered in the Cadweld Splicer Qualification Status Report (Figure 2) by Civil QC Personnel to reflect the splicer's current qualification status.

In addition, the QC Inspector shall sign and date Line 7 on the Cadweld Splicer Qualification Form (Figure 1) to denote:

- 1) that the verification of training (Para. 3.1.1) in the applicable splice position has been performed and
- 2) that he has verified that results of visual inspections and tensile tests of the qualification splices are satisfactory.

3.2 REQUALIFICATION

3.2.1 Conditions for Requalification

- a. If the position (Horizontal, Vertical, Diagonal) has not been used for three months or more, or
- b. If completed splices fail to pass visual inspection. It is not necessary to requalify a splicer on the basis of a single visual reject, but consistent visual rejects by the QC Inspector shall be cause for requalification, or
- c. If completed splices fail to pass the tensile tests (i.e. failure rate exceeds one failure in 15 consecutive tensile tests), or
- d. If there is another reason for the QC Inspector to question the splicer's ability.

3.2.2 Method of Requalification

The method of requalification shall be identical to the original qualification procedure for the applicable splice position.

3.3 INSPECTION REQUIREMENTS FOR SPLICE SET-UPS

3.3.1 Frequency

The QC Inspector shall perform random inspections of the preparation and set-up of Cadweld Splices during each shift in which cadwelding is performed.



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3.3.2 Cadweld Splicer Qualification

On those splice set-ups observed, the QC Inspector shall verify that each splicer is currently qualified in the splice position and bar size to be used.

3.3.3 Cleaning

- a. On those splice set-ups observed, the QC Inspector shall verify that bar ends are properly cleaned by heating and wire brushing to remove all loose millscale, rust, moisture, etc.. In addition, prior to splice set-up the QC Inspector shall verify that all rust and foreign matter are removed from the sleeve I.D. and that the sleeve is heated with an oxyacetylene rosebud torch to ensure removal of moisture.
- b. If hand wire brushing is used, the bar shall be heated and brushed twice, then wiped with a clean dry cloth to remove dust.
- c. The bar ends shall be cleaned a distance equal to $\frac{1}{2}$ the sleeve length + 2 inches.
- d. When either the ambient temperature is 32° F or less or the relative humidity is above 65%, the QC Inspector shall verify that the splice sleeve is dried by preheating after all materials and equipment are in position and immediately prior to pouring the filler powder in the crucible.

3.3.4 Reference Marks

- a. On those splice set-ups observed, the QC Inspector shall verify that reference marks are placed on each piece of rebar a distance of $12'' \pm \frac{1}{4}''$ from the bar end.
- b. The marks shall be inscribed in the rebar rib with a draw file, preferably prior to putting the sleeve on the bars.
- c. If the bars must be marked after the sleeve is centered, the QC Inspector shall visually check the bar end locations through the tap hole before the marks are added.
- d. If for some reason the marks cannot be located at $12'' \pm \frac{1}{4}''$ from the bar ends, the QC Inspector shall verify sleeve centering by looking through the tap hole. The QC Inspector shall document the location of the marks (if other than at $12'' \pm \frac{1}{4}''$) for future reference on the Cadweld Sleeve Inspection Record (Figure 3).



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- e. If the 12" reference marks are on the bar end and it is necessary to change the marks (prior to igniting the splice), the QC Inspector shall verify the new mark location from the bar end. He will then require the splicer to peen out the original mark with a hammer.
- f. Removal of the reference marks by peening also applies when it is necessary to trim the bar ends after marks have been placed on the bars.

3.3.5 Positioning of Sleeve

- a. When inspecting the position of the sleeve for centering, the QC Inspector should be able to see the gap between rebar ends through the tap hole. On vertical set-ups the gap shall be 1/8" - 3/16" (using a spacer) and a maximum of 3/8" on horizontal or diagonal set-ups.
- b. The QC Inspector shall verify that asbestos packing is installed in sleeve ends and that sleeve end alignment clamps are properly installed (i.e. sleeve is centered concentric with the bars and packing is seated properly).

3.3.6 Filler Metal Powder Cartridge

- a. The QC Inspector shall verify that the sleeve and filler metal powder cartridge to be used are the proper size for bars to be spliced. In addition, he shall verify that filler metal powder is remixed immediately prior to use.

3.3.7 Documentation of Splice Set Up Inspection

The QC Inspector shall document inspection of splice set-up or preparation on the Cadweld Sleeve Inspection Record (Figure 3).

3.3.8 Inspection of "B" Series Splice Set-ups

In addition to completing the Cadweld Sleeve Inspection Record (Figure 3), the QC Inspector shall complete the Inspection Report (Figure 6) for those "B" Series Splice Set-ups observed.

3.4 INSPECTION OF COMPLETED SPLICES

Each completed splice shall be inspected by the QC Inspector in accordance with the following criteria:



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3.4.1 Reference Marks

- a. The QC Inspector shall inspect each splice for proper sleeve centering by using reference file marks provided on the rib of each piece of rebar.
- b. The reference file marks are placed on the rebar by the splicer during the set-up operation.
- c. The QC Inspector shall measure the distance from mark to mark, locate the midpoint of that distance, and verify that the center of the tap hole is located within $\pm \frac{1}{2}$ " of the midpoint.
- d. Maximum allowable distance between marks is $24 \frac{7}{8}$ ". Minimum allowable distance between marks is $23 \frac{11}{16}$ ". These tolerances are based on the reference marks being $12" \pm \frac{1}{4}"$ from the bar ends.
- e. If a completed splice fails to meet any of the criteria in 3.4.1.a through 3.4.1.d, the splice shall be rejected.

3.4.2 Tap Hole Inspection

- a. The QC Inspector shall inspect the tap hole of each completed splice for the presence of good filler metal, slag, or porous metal.
- b. The inspector can determine that the material in the tap hole is good filler metal if it shines after being hit with a hammer.
- c. Slag is hard, brittle, ceramic type material with a flat chalky gray color. It will shatter when hit with a hammer.
- d. Porous metal will have a physical appearance similar to sponge. A single shrinkage bubble in the tap hole should not be confused with porous metal and is not cause for rejection.
- e. If the QC Inspector should determine that slag is in the tap hole, the slag shall be removed. If it is determined that the slag extends beyond the inside diameter of the sleeve, the inspector shall reject the splice.



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- f. If the slag is removed from the tap hole and good filler metal is discovered before passing beyond the inside diameter of the sleeve, the splice shall not be rejected for slag in the tap hole.
- g. All slag must be removed from the tap hole before accepting the splice.

3.4.3 Inspection of Sleeve Ends

- a. Each accessible end of each completed splice shall be inspected by the QC Inspector for excessive voids, low fill, porous metal, and slag.
- b. Void area shall be determined by using a short piece of tie wire to measure the depth and a standard steel tape to measure the width.
- c. The void width shall be measured at the bar and the void depth shall be determined by the deepest point of the void. The void shall be considered rectangular in shape.
- d. Excessive low fill shall be calculated by the same method used for voids.
- e. If a splice has both low fill and spot voids, the area shall be added for a cumulative total of void area.
- f. The QC Inspector can use the chart (Figure 4) as an aid for calculating the spot void and/or low fill area.
- g. The QC Inspector shall use the Cadweld Manufacturer's criteria (Figure 5) for acceptance or rejection of a spot void or low fill area. Void area in a sleeve end which is greater than the allowable void area in Figure 5 shall be cause for rejection of the applicable splice.
- h. Porous metal or slag in a sleeve end shall be cause for rejection of the applicable splice.
- i. Sound splices often have pin holes, shrinkage fissures, and cold joints visible at the ends of completed splices which are not cause for rejection.



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3.4.4 Inspection of "B" Series Splices

In addition to completing the Cadweld Sleeve Inspection Record (Figure 3), the inspector shall use the Inspection Report (Figure 6) for the inspection and documentation of "B" Series splices.

3.4.5 Cadweld Acceptance

- a. Prior to splice acceptance the QC Inspector shall verify that sleeve identity markings are legible and that splicer identified thereon is currently qualified in the applicable position.
- b. The QC Inspector shall apply a white acceptance stripe to each splice inspected and found to be satisfactory.
- c. The Cadweld Sleeve Inspection Record (Figure 3) shall be used to document inspection of satisfactory splices.

3.4.6 Cadweld Rejection

- a. The QC Inspector shall apply a yellow rejection stripe to each splice inspected and found to be unsatisfactory.
- b. A rejected splice shall be cut out, removed from the area and shall not be used for tensile testing purposes.
- c. The Cadweld Sleeve Inspection Record (Figure 3) shall be used to document the inspection of a rejected splice and shall indicate the reason for rejection.

3.5 TENSILE TESTING OF COMPLETED SPLICES

3.5.1 Sampling and Tensile Testing

- a. The QC Inspector shall select the location of production and sister splices for tensile testing to maintain the frequency requirements. (Reference 1-A Para. 7.7.1 & 7.7.2).
- b. Sister Test samples shall be substituted for Production samples for "B" series splices welded to embedments and "B" series anchorage splices where the configuration doesn't allow for Production samples.



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- c. On tightly curved bars (as determined by the responsible Civil Quality Control Level II Inspector) Sister samples shall be made in lieu of Production samples and the sample frequency shall be as noted in Reference 1-A Para. 7.7.2.
- d. All other test samples shall be Production splices removed per the frequency noted in Reference 1-A Para. 7.7.1.
- e. The QC Inspector may use the Daily Test Status Report (Figure 7) as an aid to determine the next applicable test for each splicer, position, and bar size.
- f. If a test is required, the QC Inspector shall check the appropriate blank on the Cadweld Consecutive Splice Record (Figure 8) under "Test" (P-Production, S-Sister).
- g. The QC Inspector shall not notify the splicer of a Production Test until after the splice is completed.
- h. If the requirement is for a Sister splice, the QC Inspector shall notify the splicer that a sample will be required immediately after the one that the splicer is currently setting up.
- i. Test samples shall be identified by the QC Inspector with a red stripe and documented on the Cadweld Sleeve Inspection Record (Figure 3); "P" for Production and "S" for Sister.
- j. The test splice shall be removed by B&R Construction and subsequently delivered to the Site Testing Lab by QC personnel for tensile testing.

3.5.2

Reporting

- a. QC personnel shall complete items 1,2 and 3 on Cadweld Splice Testing Report (Figure 9) for each splice tested and submit to Site Test Lab, which will perform each test and return completed report to the responsible Civil Quality Control Level II Inspector for QA review and signature.
- b. QC personnel shall enter the results of all Production and Sister splice tensile tests in the order in which they are tested on the Cadweld Splice Tensile Test Average Report (Figure 10). Completed reports shall be submitted to the Permanent Plant Records Vault (PPRV). Either of the following conditions shall be cause for the issuance of a nonconformance report in accordance with Reference 1-C and the immediate stoppage of further Cadwelding activities:



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1. If the results of more than one in any 15 consecutive individual tensile tests are less than 75,000 psi.
 2. If the average of any 15 consecutive tensile test results is less than 90,000 psi.
- c. QC personnel shall perform the Cadweld 90 Day Review (Figure 11) and submit to the Permanent Plant Records Vault (PPRV).

3.6 MAPPING SPLICE TEST LOCATIONS

Each splice location on the Containment wall and dome shall be located, by QC personnel on a record drawing prior to embedment of applicable splice in concrete. Information shall include test splice locations and numbers on the record drawing.



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Figure 1

CADWELD SPLICER QUALIFICATION

PROJECT: COMANCHE PEAK JOB NO.: _____ UNIT: _____ PAGE _____ OF _____

1. Splicer's Name _____ Badge No. _____

2. B&R Splice I.D. No. _____

3. Position: Horizontal, Vertical, Diagonal (Circle One)

4. Qualification Data

Visual Inspection	Ultimate Load (lbs)	Nom. X-Section Area (in ²) ^a	Tensile Strength (p.s.i.) ^b	Failure Type ^c
See #3.4	_____	4.0	_____	_____
_____	_____	4.0	_____	_____

5. Average tensile strength equals _____ p.s.i.

6. Tensile Testing by _____ Date: _____

Checked _____ Date: _____

7. Qualification Test Results: Satisfactory; Unsatisfactory (Circle One)

Quality Control _____ Date: _____

COMMENTS:

- NOTES:
- a. All qualification tests performed on a 18 rebar.
 - b. Minimum p.s.i. for each test is 75,000 p.s.i.
 - c. Failure Types: (P) Pullout; (S) Sleeve Failure; (B) Bar Failure

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Figure 1

CADWELD SPLICER QUALIFICATION

PROJECT: **COMANCHE PEAK** JOB NO.: _____ UNIT: _____ PAGE _____ OF _____

1. Splicer's Name _____ Bridge No. _____

2. B&P Splice I.D. No. _____

3. Position: Horizontal; Vertical; Diagonal (Circle One)

4. Qualification Data:

Visual Inspection Accept (✓) Reject (X) See 13.4	Ultimate Load (lbs)	Nom. X-Sept. Area (in ²) ^a	Tensile Strength (p.s.i.) ^b	Failure Type ^c
_____	_____	4.0	_____	_____
_____	_____	4.0	_____	_____

5. Average tensile strength equals _____ p.s.i.

6. Tensile Testing: by _____ Date: _____

Checked _____ Date: _____

7. Qualification Test Results: Satisfactory; Unsatisfactory (Circle One)

Quality Control _____ Date: _____

COMMENTS:

- NOTES:
- a. All qualification tests performed on #18 rebar.
 - b. Minimum p.s.i. for each test is 78,000 p.s.i.
 - c. Failure Types: (P) Pullout; (S) Sleeve Failure; (BF) Bar Failure

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Figure 2

CADWELD SPLICER QUALIFICATION STATUS REPORT

PROJECT: COMANCHE PEAK JOB NO.: UNIT _____ PAGE _____ OF _____

SPLICER'S I.D. NO.	SPLICER'S NAME	SPLICER'S BADGE NO.	QUALIFICATION STATUS						
			HORIZONTAL		VERTICAL		DIAGONAL		
			DATE	QC INITIALS	DATE	QC INITIALS	DATE	QC INITIALS	

NOTES:

CADWELD BLEEVE INSPECTION RECORD

PROJECT: COMANCHE PEAK

JOB NO.:

UNIT _____ PAGE _____ OF _____

DATE SPLICES MADE: _____

CADWELD RECORD DWG. NO.: _____

TEST SPLICE TYPE PROD. (P) SISTER (S)	O & N SPLICE I.D.	BAR SIZE	PREPARATION INSPECTION			COMPLETED SPLICE VISUAL INSPECTION		
			CONSTR. INSP. (INITIALS)	CHECK IF INSPECTED BY QC	QC INSPECTOR (INITIALS)	DATE	RESULTS ACCEPT (A) REJECT (R)	INSPECTOR (INITIALS)
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Figure 3

TEXAS UTILITIES GENERATING CO.



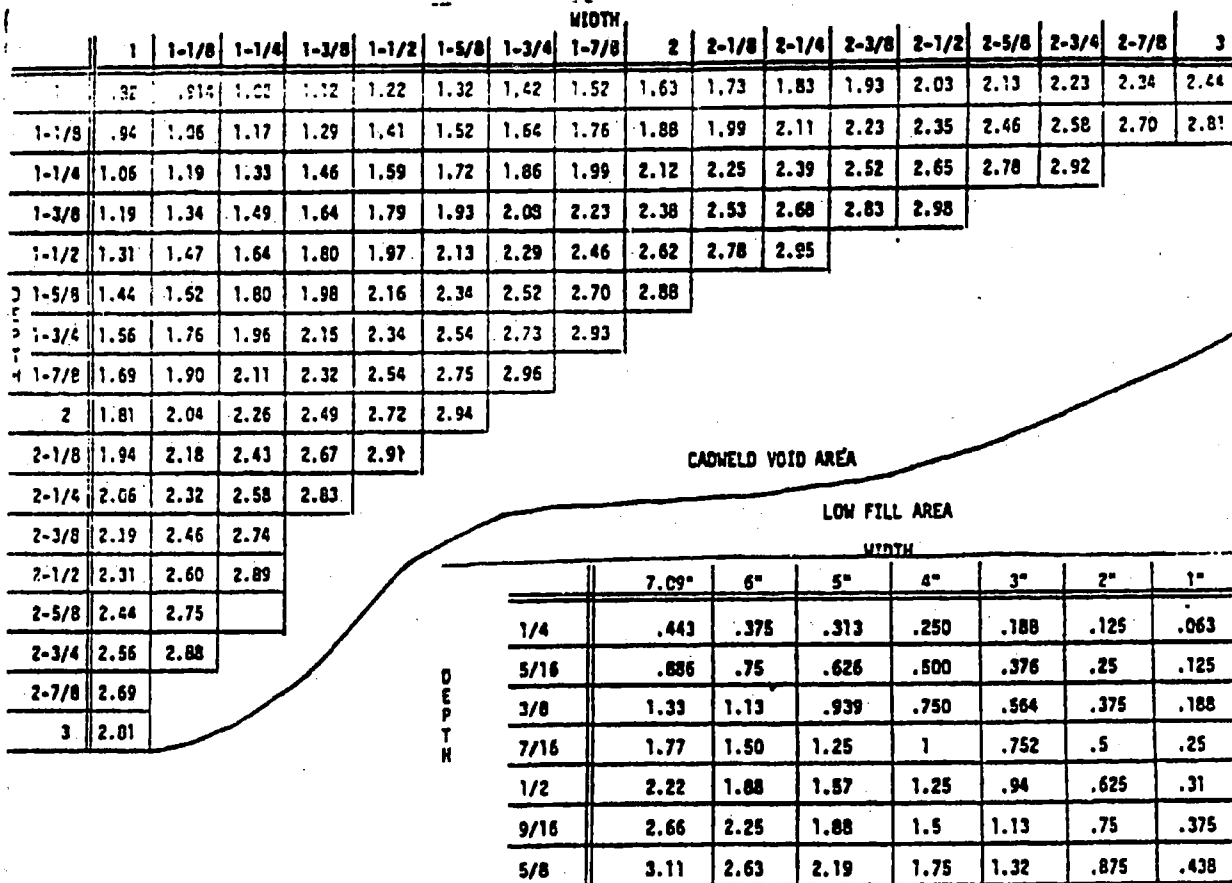
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Figure 4



NOTE: Add answers from both charts as needed.

* -3/16 for packing has already been figured in both charts



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Figure 5

REBAR SPlicing

void limits

Splices shall be acceptable if the void per end does not exceed the area listed below. Void areas are approximated as shown in the illustrations below. More exact void measurements should be made only when necessary.

Bar Size	Splice Cat. No. Series*	Allowable Void Area—Square Inches	
		Column A—Spot Voids (1)	Column B—Full Circumference Low (2)
# 4	RBT-8101(-M)	0.47	1/8"
# 4/5	RBT4-8101(-M)	0.67/0.93	1/8"
# 5	RBT-8101(-M)	0.93	1/8"
# 5/8	RBT5-8101(-M)	0.97/1.05	1/8"
# 6	RBT-8101(-M)	1.96	1/8"
# 6/7	RBT6-7101(-M)	1.86/1.03	1/8"
# 7	RBT-7101(-M)	1.83	1/8"
# 7/8	RBT7-8101(-M)	1.03/1.03	1/8"
# 8	RBT-8101(-M)	1.82	1/8"
# 8/9	RBT8-8101(-M)	1.52/1.03	1/8"
# 9	RBC-1078(-M)	0.81-1.02	1/8"
# 9/10	RBC9-1078(-M)	1.02	1/8"
	RBC9-1078(-M)	.40/ .81	1/8"
	RBT9-1078(-M)	1.02/1.03	1/8"
# 10	RBC-1078(-M)	.81	1/8"
	RBT-1078(-M)	1.03	1/8"
	RBT-10101(-M)	1.98	1/8"
# 10/11	RBC10-1176(-M)	1.03/1.03	1/8"
	RBT10-11101(-M)	1.84/1.53	1/8"
# 11	RBC-1176(-M)	1.03	1/8"
	RBT-11101(-M)	1.83	1/8"
# 11/14	RBC11-1476(-M)	1.03/1.24	1/8"
	RBT11-14101(-M)	1.83/1.82	1/8"
# 11/18	RBC11-1876(-M)	1.53/1.70	1/8"
	RBT11-18101(-M)	1.83/1.89	1/8"
# 14	RBC-1476(-M)	1.24	1/8"
	RBT-1476(-M)	1.82	1/8"
	RBT-1476(-M)	2.15	1/8"
	RBT-14101(-M)	2.15	1/8"
# 14/18	RBC14-1876(-M)	1.52/1.70	1/8"
	RBT14-18101(-M)	2.15/1.89	1/8"
# 18	RBC-1876(-M)	1.89	1/8"
	RBT-1876(-M)	2.84	1/8"
	RBT-1876(-M)	2.84	1/8"
	RBT-1891(-M)	2.89	1/8"
	RBT-18101(-M)	2.89	1/8"

notes:

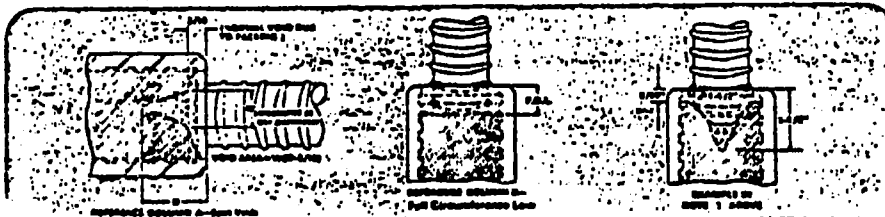
① Allowable accumulative void is shown for each end. For example, a splice of #18 bar in RBT-1891 is acceptable with a spot void 1 1/2" wide, 1 1/2" deep and 1/8" low fill around remaining perimeter of bar. (Cumulative void area = 1 1/2 x (1 1/2 - 1/8) + (1 1/2 - 1/8) x (7.09 - 1 1/2) = 2.66 square inches). The width (W) of any void is measured at the bar perimeter.

② Use this column for all standard splices: vertical, horizontal, horizontal side fill, angled splices and B-series Structure Splices with spot voids.

③ Use this column for vertical splices only with low filler metal around entire circumference (for spot voids, use Column A). Applicable also for vertical B-series Structure Splices with low filler metal around entire circumference.

NOTE: Void dimensions can be established by use of a probe of the wire—

*Series Series refers to all splices having a similar casting number with different suffix (e.g., -12, -VS, -60N, -1, -1M, etc.).



**void limits—C-16 series
compression only splices**

Compression only splices shall be acceptable where solid filler metal is in evidence at the Splice Sleeve Top Hole, and voids are no deeper than 1 inch, either as spot voids or full circumferential low fill.

summary

The inspection of a CADWELD Rebar Splice is visual. Occasional checking of the workmanship of the splicer to make sure that he is following the correct splicing procedures will serve to reinforce the judgment of the inspector on the job. Erico standard instructions should be consulted for additional information.



Figure 6

**COMANCHE PEAK STEAM ELECTRIC STATION
 INSPECTION REPORT**

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ITEM DESCRIPTION		IDENTIFICATION NO.		SYSTEM/STRUCTURE DESIGNATION																																																																																																																									
"B" Series Castwelds																																																																																																																													
SPEC. NO.	REV.	REF. E.C. DOC. & REV. & CHANGE NO.		MEASURE OR TEST EQUIP. BEST. #																																																																																																																									
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C1/01 8/84

TEXAS UTILITIES GENERATING CO.

- CPSES -



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Figure 8

CADWELD SPLICER CONSECUTIVE SPLICE RECORD

PROJECT: CO' ANCHOR PEAK

JOB NO.: 35-1195

UNIT

PAGE

OF

CONSEC. NO.	DATE	DRUG. NO.	TEST		CONSEC. NO.	DATE	DRUG. NO.	TEST	
			P	S				P	S

BAR SIZE _____

POSITION: _____ SPLICER NO. _____



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Figure 9

CADWELD SPLICE TESTING REPORT

PROJECT: COMANCHE PEAK JOB NO.: _____ UNIT: _____ PAGE _____ OF _____

- 1. Test Splice Type: (P) Production; (S) Sizer
- 2. Splice I.D. Number
- 3. Bar Size
- 4. Test Splice Tensile Test Data:

Ultimate Load (lbs)	Nominal X-Section Area (in ²)	Tensile Strength (p.s.i.) (a)	Failure Type (b)
_____	_____	_____	_____

- 5. Tensile Testing: by _____ DATE _____
Checked _____ DATE _____
- 6. Tensile Test Results: (Sat.) Satisfactory; (Unsat.) Unsatisfactory

COMMENTS:

NOTES: (a) Minimum p.s.i. requirement is 78,000
 (b) Failure Types: (P) Pullout; (S) Sleeve Failure; (BF) Bar Failure.

QA Review _____ DATE _____



Figure 10

CADWELD SPLICE TENSILE TEST AVERAGE REPORT

PROJECT: _____ JOB NO. _____ UNIT _____ PAGE _____ OF _____

B&R SPLICE I.D. NO.	BAR SIZE	TEST SPLICE TYPE		INDIVIDUAL TENSILE STRENGTH (PSI)	AVERAGE OF SAMPLE & PREVIOUS 14 CONSECUTIVE (PSI)
		PROD. (P)	SISTER(S)		

Each average of 15 consecutive samples
(Minimum of 90,000 psi) SATISFACTORY _____ UNSATISFACTORY _____

Not more than one individual tensile
strength in 15 consecutive less than
75,000 psi. SATISFACTORY _____ UNSATISFACTORY _____

QUALITY CONTROL:

COMPUTED BY: _____ DATE _____ CHECKED BY: _____ DATE _____

QA REVIEW: _____ DATE _____

