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CADWELD INSPECTION ACTIVITIES	PREPARED BY: <u>Ed Holland</u>	DATE: <u>6-25-79</u>		
	APPROVED BY: <u>R. J. Tolson</u>	DATE: <u>6/25/79</u>		

FOR INFORMATION ONLY.

1.0 REFERENCES

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

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.

3.0 INSTRUCTION

3.1 QUALIFICATION OF CADWELD SPLICERS

3.1.1 Training

- a. Proposed splicer shall attend a documented slide film presentation on Cadweld Splice Preparation given by the B&R Training Coordinator/Designee.
- b. A QC Inspector shall attend the film presentation with the proposed splicer(s) and document by submitting a list containing the name, date, badge number and social security number of those attending to the Civil Inspection Supervisor/Designee.
- c. The proposed splicer(s) shall then receive training from a qualified instructor on the presentation of splices for each position that he is being qualified.

**HISTORICAL FILE**

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for at that time. Qualification for all positions is not mandatory at the same training session.

- d. The proposed splicer's training session will be witnessed and documented by the QC Inspector.

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 inspect the completed splices in accordance with paragraph 3.4 of this Instruction.
- c. If the splices are found satisfactory, 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 Denotes a Production Test Splice (S-Sister Test Splice or Q-Qualification Test Splice).

- 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.

3.2

REQUALIFICATION

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3.2.1 Conditions for Requalification

- a. 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 (rate exceeds one of 15 test failures), 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 all positions utilized.

3.3 INSPECTION REQUIREMENTS FOR SPLICE SET-UPS

3.3.1 Frequency

- a. The QC Inspector shall visually watch the preparation and set-up of Cadweld Splices on a random basis.
- b. It will be to the QC Inspector's advantage to watch as many splices set-ups during a shift as possible.

3.3.2 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 mill scale, rust, etc., and verify the sleeve I.D. is free of rust.
- 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.

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3.3.3

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 splicer shall notify the QC Inspector before igniting the powder so that he can 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).
- 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.

3.3.4

Positioning of Sleeve

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 should be 1/8" - 3/16" (using a spacer) and a maximum of 3/8" on horizontal or diagonal set-ups.

3.3.5

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).

3.4

INSPECTION OF COMPLETED SPLICES

Each completed splice shall be inspected by the QC Inspector by:

3.4.1

Reference Marks

- a. The QC Inspector will 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 from mark to mark, locate the center of that measurement, and check to see if the center of the tap hole is located within  $\pm \frac{1}{2}$ " of that center.
- 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",  $\pm \frac{1}{2}$ " from the bar ends.

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 a hard, brittle, ceramic type material; a flat chalky gray color, and 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 determines that slag is in the tap hole, the slag will be removed. If it extends past the thickness of the sleeve, the inspector shall reject the splice.
- f. If the slag is removed from the tap hole and good filler metal is discovered before passing through the thickness of the sleeve, the splice will 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 and porous metal.
- b. Excessive voids may be determined by using a piece of small tie wire to measure the depth and a standard steel tape to measure the width.
- c. The width will be measured at the bar and the depth will be determined by the deepest point of the void. The void will be considered rectangular in shape.
- d. Excessive low fill will be calculated by the same method used for voids.
- e. If a splice has both low fill and 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 void or low fill area.
- g. The QC Inspector shall use the Cadweld Manufacturer's criteria (Figure 5) for acceptance or rejection of a void or low fill area.
- h. Porous metal in the sleeve ends having the same physical appearance as a sponge, is cause for rejection.

1. Sound splices often have pin holes, shrinkage fissures and cold joints visible at the ends of completed splices which are not cause for rejection.

3.4.4

Inspection of "B" Series Splices

The inspector shall use the Inspection Report (Figure 6) for the inspection and documentation of "B" Series splices.

3.4.5

Cadweld Acceptance

- a. The QC Inspector shall verify that sleeve identity markings are legible prior to acceptance.
- 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 it's rejection.

3.4.7

Sampling and Testing

- a. The QC Inspector shall select the location of production and sister splices for testing to maintain the frequency requirements. (Ref. 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 Production samples.

- c. On tightly curved bars (as determined by the TUGCO Civil QC Supervisor/Designee) Sister samples shall be made in lieu of Production samples and the sample frequency shall be as noted in Ref. 1-A Para. 7.7.2.
- d. All other test samples shall be Production splices removed per the frequency noted in Ref. 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, check the appropriate blank on the Cadweld Consecutive Splice Record (Figure 8) under "Test" (P-Production, S-Sister).
- g. The QC Inspector shall notify the splicer of a Production Test 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.

3.4.8

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 Civil Inspection Supervisor/Designee.
- b. QC personnel shall complete the Cadweld Sleeve Tensile Test Average Report (Figure 10) for each 15 Production or Sister tensile tests and submit to the Civil Documentation Supervisor.



- c. QC personnel shall perform the Cadweld 90 Day Review (Figure 11) and submit to the Civil Documentation Supervisor.

3.5

MAPPING SPLICE TEST LOCATIONS

All splice locations on the Containment wall and dome shall be located, by QC personnel, on a record drawing prior to concrete placement. Information shall include test splice locations and numbers on the record drawing.

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**Figure 1  
CADWELD SPLICER QUALIFICATION**

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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 Accept (✓) Reject (X) (See Para. 5.7.3.)	Ultimate Load (lbs)	Nom. Y. Sect. Area (in <sup>2</sup> ) <sup>a</sup>	Tensile Strength (p.s.i.) <sup>b</sup>	Failure Type <sup>c</sup>
_____	_____	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 75,000 p.s.i.  
c. Failure Types: (P) Pullout; (S) Sleeve Failure; (BF) Bar Failure





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Figure 4

	WIDTH																
	1	1-1/8	1-1/4	1-3/8	1-1/2	1-5/8	1-3/4	1-7/8	2	2-1/8	2-1/4	2-3/8	2-1/2	2-5/8	2-3/4	2-7/8	3
1	.82	.914	1.02	1.12	1.22	1.32	1.42	1.52	1.63	1.73	1.83	1.93	2.03	2.13	2.23	2.34	2.44
1-1/8	.94	1.06	1.17	1.29	1.41	1.52	1.64	1.76	1.88	1.99	2.11	2.23	2.35	2.46	2.58	2.70	2.81
1-1/4	1.06	1.19	1.33	1.46	1.59	1.72	1.86	1.99	2.12	2.25	2.39	2.52	2.65	2.78	2.92		
1-3/8	1.19	1.34	1.49	1.64	1.79	1.93	2.08	2.23	2.38	2.53	2.68	2.83	2.98				
1-1/2	1.31	1.47	1.64	1.80	1.97	2.13	2.29	2.46	2.62	2.78	2.95						
1-5/8	1.44	1.62	1.80	1.98	2.16	2.34	2.52	2.70	2.88								
1-3/4	1.56	1.76	1.96	2.15	2.34	2.54	2.73	2.93									
1-7/8	1.69	1.90	2.11	2.32	2.54	2.75	2.96										
2	1.81	2.04	2.26	2.49	2.72	2.94											
2-1/8	1.94	2.18	2.43	2.67	2.91												
2-1/4	2.06	2.32	2.58	2.83													
2-3/8	2.19	2.46	2.74														
2-1/2	2.31	2.60	2.89														
2-5/8	2.44	2.75															
2-3/4	2.56	2.88															
2-7/8	2.69																
3	2.81																

CADWELD VOID AREA

LOW FILL AREA

DEPTH

	WIDTH						
	7.09"	6"	5"	4"	3"	2"	1"
1/4	.443	.375	.313	.250	.188	.125	.063
5/16	.886	.75	.626	.500	.376	.25	.125
3/8	1.33	1.13	.939	.750	.564	.375	.188
7/16	1.77	1.50	1.25	1	.752	.5	.25
1/2	2.22	1.88	1.57	1.25	.94	.625	.31
9/16	2.66	2.25	1.88	1.5	1.13	.75	.375
5/8	3.11	2.63	2.19	1.75	1.32	.875	.438

NOTE: Add answers from both charts as needed.

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

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	Column B - Full Circumference Low(s)
# 4	RBT-810(-H)	0.47	%
# 4/5	RBT4-510(-H)	0.47/0.53	%/ %
# 5	RBT-510(-H)	0.53	%
# 5/8	RBT5-610(-H)	0.91/1.05	%/ %
# 6	RBT-610(-H)	1.05	%
# 6/7	RBT6-710(-H)	1.05/1.03	%/ %
# 7	RBT-710(-H)	1.03	%
# 7/8	RBT7-810(-H)	1.03/1.02	%/ %
# 8	RBT-810(-H)	1.02	%
# 8/9	RBT8-910(-H)	1.02/1.02	%/ %
# 9	RBC-976(-H)	06-60	%
# 9/10	RBT-910(-H)	1.02	%
	RBC9-1076(-H)	60/ 51	%/ %
	RBT9-1010(-H)	1.02/1.03	%/ %
# 10	RBC-1076(-H)	E1	%
	RBT-1076(-H)	1.03	%
	RBT-1010(-H)	1.58	%
# 10/11	RBC10-1176(-H)	1.03/1.03	%/ %
	RBT10-1110(-H)	1.58/1.53	%/ %
# 11	RBC-1176(-H)	1.03	%
	RBT-1110(-H)	1.53	%
# 11/14	RBC11-1476(-H)	1.03/1.24	%/ %
	RBT11-1410(-H)	1.53/1.52	%/ %
# 11/18	RBC11-1876(-H)	1.53/1.70	%/ %
	RBT11-1810(-H)	1.53/1.99	%/ %
# 14	RBC-1476(-H)	1.24	%
	RBT-1476(-H)	1.52	%
	RBT-1410(-H)	2.15	%
	RBT-1410(-H)	2.15	%
# 14/18	RBC14-1876(-H)	1.52/1.70	%/ %
	RBT14-1810(-H)	2.15/1.99	%/ %
# 18	RBC-1876(-H)	1.99	%
	RBT-1876(-H)	2.64	%
	RBT-1876(-H)	2.64	%
	RBT-1891(-H)	3.00	%
	RBT-1810(-H)	3.00	%

**notes:**

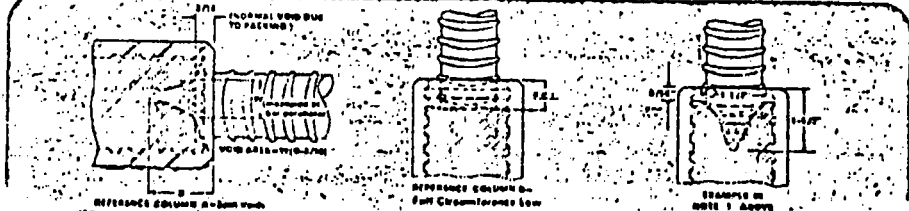
① Allowable accumulative void is shown for each end. For example, a splice of #18 bar in RBT-1891 is acceptable with a spot void 1 1/2" wide, 1 1/2" deep and 1/8" low fill around remaining perimeter of bar. (Cumulative void area = 1 1/2" x (1 1/2" - 1/8") + (1 1/2" - 1/8") x (7.09 - 1 1/2") = 2.66 square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

\*Splice Series refers to all splices having a similar catalog number with different suffix (e.g. -HS, -VS, -GM, -T, -HM, 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 Tap 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. Enco standard instructions should be consulted for additional information.

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Figure 6

LUMACHE PEAK STEAM ELECTRIC STATION  
INSPECTION REPORT

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ITEM DESCRIPTION <b>"B" SERIES CADWELDS</b>		IDENTIFICATION NO.	SYSTEM/STRUCTURE DESIGNATION				
SPEC. NO.	REV.	REF. C.C. DOC. & REV. & CHANGE NO.	MEASURE OR TEST EQUIP. IDENT. NO.				
<input type="checkbox"/> IN-PROCESS INSPECTION		<input type="checkbox"/> PRE-INSTALLATION VERIFICATION	<input type="checkbox"/> INSTALLATION INSPECTION	<input type="checkbox"/> FINAL INSPECTION	<input type="checkbox"/> POST-TEST INSPECTION		
INSPECTION RESULTS							
<input type="checkbox"/> INSPECTION COMPLETED, ALL APPLICABLE ITEMS SATISFACTORY							
<input type="checkbox"/> INSPECTION COMPLETED, UNSATISFACTORY ITEMS LISTED BELOW							
QC INSPECTOR	DATE						
ITEM NO.	INSPECTION ATTRIBUTES			SAT	UNSAT	DATE	QC SIGNATURE
1	12' reference mark is required when cadwelding rebar to embedment (see figure 1, item A)						
2	No reference mark is required when rebar passes through sleeve (see figure 1, item C)						
3	Verify that dimension Y is correct as per drawing						
REMARKS (LOGS, SPECS, ETC.)							
RELATIVE NO.	I.R. CLOSED	<input type="checkbox"/>	DATE	SIGNATURE			
15				QC INSPECTOR			









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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) Sinter .....
2. Splice I.D. Number .....
3. Bar Size .....
4. Test Splice Tensile Test Data:

Ultimate Load (lbs)	Nominal X-Section Area (in <sup>2</sup> )	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 75,000  
 (b) Failure Types: (P) Pullout; (S) Sleeve Failure; (BF) Bar Failure.

QA Review \_\_\_\_\_ DATE \_\_\_\_\_



