

# Reinforcement Splices

This attachment provides general contract administration guidance for service splice and ultimate butt splice of reinforcement in accordance with the *2018 Contract Specifications, 52-6, Reinforcement – Splicing*. Sections included are:

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## Glossary of Terms

**Affected Zone** – Portion of the reinforcing bar where any properties of the bar, including the physical, metallurgical, or materials characteristics, have been changed by fabrication or installation of a splice. The weld and one (1) inch adjacent to the weld is part of the affected zone.

**Authorized Laboratory** – Independent testing laboratory not employed or compensated by any subcontractor or subcontractor's affiliate providing other services for the contract and authorized by the Department to perform the required testing of the sample splices.

**Authorized Material List** – A list of products prequalified for use on California Department of Transportation projects. Mechanical couplers for both service and ultimate splice systems on this list are authorized for use.

**Complete Joint Penetration (CJP)** – groove weld is a groove weld that extends completely through the thickness of components joined. The primary purpose for the use of the CJP groove welds is to transmit the full load-carrying capacity of the structural components they join

**Lot of Splices** – One hundred and fifty (150) or fraction thereof, of the same coupler model for each bar size, deformation pattern and hoop diameter.

**Operator and Procedure Prequalification** – A requirement of the splice prequalification report. Splice operators and procedures must be certified. Splice test samples must be prepared and tested no more than two (2) years before the submittal.

**Production Service Splice Test Samples** – Four splices prepared in the same manner (i.e., equipment, procedures, position, and operator) as the splices incorporated into the final work. Four samples are selected for every lot of splices and are tested by the authorized laboratory.

**Production Ultimate Butt Splice Test Samples** – Four splices removed from each lot of completed splices. After being notified, the engineer randomly selects the four (4) splice test samples to be removed by the contractor from the completed lot and places tamper-proof markings or seals on them. Except for hoops, the engineer selects splice test samples at the job site. Splice test samples must comply with [California Test 670](#), *Method of Tests for Mechanical and Welded Reinforcing Steel Splices*.

**Quality Assurance (QA) Splice Samples** – Four additional splice test samples prepared or removed for QA testing at the Caltrans Materials Engineering and Testing Services (METS) Laboratory. The samples are prepared or removed concurrently with the first production lot and at one other randomly selected for every five (5) additional production lots (or portion of) thereafter.

**Resistance-Butt-Weld** – A type of butt-welding commonly used to produce column hoop reinforcement. A machine holds both ends of the hoop together and passes a large electrical current through the bar which creates enough heat to fuse the two ends together completing the process.

This type of welding is not covered by the American Welding Society (AWS) code and therefore does not require any of the Non-Destructive Testing (NDT) or Certified

Welding Inspector (CWI) requirements. The current *Contract Specifications* requires that the fabricator must be on the Authorized Material List.

**Service Splice** – A mechanical or welded butt splice that meets the current requirements of the *Contract Specifications (CS)*<sup>1</sup> (i.e., tensile strength of 80 ksi and slip).

**Splice Prequalification Report** – A report that documents the contractor’s proposed splicing system.

**Splicing Quality Control Manager (QCM)** – Contractor designated person who is responsible for both field and administrative work regarding the quality of all service splices or ultimate butt splices.

**Ultimate Butt Splice** – A mechanical or welded butt splice that meets current requirements of CS<sup>2</sup> (i.e., slip test and rupture in the reinforcing bar outside of the affected zone and show visible necking as specified in California Test 670, Necking, Option I or Rupture anywhere and neck as specified in California Test 670, Necking, Option II).

## **What to do Prior to the Start of Any Splice Work**

### **Preconstruction Meeting**

Although not required by the contract, if needed, recommend holding a preconstruction meeting with the contractor to discuss the service splices and ultimate butt splices requirements. The sampling and acceptance criteria are different for these types of splices. It is important that all parties involved understand the specification requirements.

At the meeting, the contractor should have present their splicing QCM, rebar subcontractor, and the representative for the Authorized Laboratory. If possible, a representative from METS should attend the preconstruction meeting. A suggested partial list of items to discuss at the preconstruction meeting is:

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<sup>1</sup> CS 2018, Sections 52-6.02B(1), *Reinforcement – Materials – Service Splices and Ultimate Butt Splices – General*, and 52-6.02B(2), *Reinforcement – Materials – Service Splices and Ultimate Butt Splices – Service Splices*.

<sup>2</sup> CS 2018, Sections 52-6.02B(1), *Reinforcement – Materials – Service Splices and Ultimate Butt Splices – General*, and 52-6.02B(3), *Reinforcement – Materials – Service Splices and Ultimate Butt Splices – Ultimate Butt Splices*

- Splicing QCM's responsibility to inspect the lots of splices for conformance with the specifications and manufacturer's recommendations prior to sampling.
- Splice Prequalification Reports, production, and quality assurance (QA) sampling and testing requirements.
- How samples of ultimate butt splices will be selected from a completed lot of splices that have been assembled for the final time.
- The contractor's method of designating and making the lots available for sampling.
- The engineer's method of random sample selection.
- Labeling and shipping of the samples.
- Result reporting, time allowed, and engineer approval.

## Splice System Prequalification

The *Contract Specifications* require that both service and ultimate splice systems be prequalified, for every job, prior to use. The contractor must select a splice system from the [Caltrans Authorized List of Couplers for Reinforcing Steel](#). If the proposed system is not on the prequalification list, contact METS at (916-227-7253) to verify the latest approved splice systems.

## Splice Prequalification Report

For each splice type to be used in the work, the contractor must submit a Splice Prequalification Report for service splices and ultimate butt splices that includes:

- Copy of the coupler manufacturer's product literature giving complete data on the splice material and installation procedures.
- Names of the operators who will be performing the splicing.
- Descriptions of the positions, locations, equipment, and procedures that will be used in the work.
- Certifications from the fabricator for operator and procedure prequalification including the certified test results from the authorized laboratory for the prequalification splice test samples. For each bar size of each splice type to be used, each operator must prepare two (2) prequalification splice test samples and two (2) additional prequalification splice test samples if using splices dependent on bar deformations.
- Splice test samples must have been prepared and tested no more than two (2) years before the submittal of the splice prequalification report. Splice test samples and testing must comply with the production testing requirements.

# **What To Do During Splice Production Work**

## **Sampling of Production Splices**

The sampling procedures and testing criteria are different for ultimate butt and service splices. Ultimate butt splices are far more critical to the structure's seismic performance. Hence, the sampling and testing requirements are more stringent compared to service splices.

## **Ultimate Splice Sampling Procedures**

The contractor's splicing QCM will notify the engineer when a designated lot of splices is complete and has been inspected. Four samples of production splices from each lot will be selected by the engineer for testing.

Production sample splices are required to be randomly selected from a completed lot. Selecting from a completed lot means that samples will be removed after final splicing has been made. Splices that are unassembled for transportation or other reasons are not considered completed and would require resampling when assembled for the final time.

The intent of the ultimate butt splice specification is to sample splices as close as possible to the in place completed work, which may or may not entail removing splices from bars after they have been tied in their final location. For example, if the main longitudinal reinforcement of a column was spliced together and assembled on the ground prior to full height erection, the straight bar sample production splices could be selected prior to cage assembly. If splices are made vertically at the job site in or above their final positions for bar reinforcement of columns or cast-in-place (CIP) concrete piles, instead of removing the splice test samples from the completed lot, it is acceptable to prepare the samples as specified for service splice test samples provided testing as specified for ultimate butt splices is performed.

Similarly, in most cases, the selection of production samples for welded hoops can be done prior to cage assembly.

All production sample splices removed from the work must be repaired or replaced. The Department does not require ultimate butt splice testing on repaired splices from a lot unless an additional ultimate butt splice test is required on the same lot of splices. If this additional test is required, the engineer may select any repaired splice for the additional test.

The sample length must comply with California Test 670.

## Service Splice Sampling Procedures

The *Contract Specifications* require the contractor to prepare four splice test samples from each lot of completed splices. The service splice samples must be prepared in the same conditions as the production service splices. The same operator, equipment, position, and procedures must be used when preparing service splice samples. The sample length must comply with California Test 670.

## Quality Assurance Testing

Quality assurance (QA) testing is a requirement of the ultimate butt and service splice specifications. Quality assurance tests are always performed concurrently with the first production test. After the first QA test, at least one out of every five additional production tests (or portion of) thereafter will be accompanied by an additional QA test. A random selection method must be used to designate both QA lots and QA sample splices. Below is a table that illustrates the number of QA tests required for a given amount of splice lots.

Number. of Lots	Number of Accumulative QA Tests Required
1	1
2-6	2
7-11	3
12-16	4
17-21	5
22-26	6

To obtain samples for the QA test, four (4) sample splices will be made concurrently with the production test samples. These sample splices do not have to be removed from a completed lot of splices.

The contractor may encase splices in concrete before receiving notification of the QA test results from the engineer. However, the contractor will not be relieved of the responsibility for incorporating material into the work that complies with the contract.

## Tamper Proof Markings and Sample Shipping

To ensure that the sample splices are not tampered with, all samples (i.e., pre-job, production, and quality assurance) must have a tamper proof marking applied to them. Field personnel should apply the marking. Examples of tamper proof markings are:

- Rubberized paint. This will show any re-gripping or disassembly of the splices. See Figure No. 1.
- A digital photo of the splice sent to the lab for comparison.

- Alternative marking systems can be considered with METS concurrence.

All samples must be identified pre-job, production, or job QA and be accompanied with Form [TL-0101](#), *Sample Identification Card*. See Figure No. 2. Both pre-job and quality assurance ultimate butt splice test samples need to be shipped to METS at 5900 Folsom Boulevard, Sacramento 95819, (916) 227-7251. The Structure Representative should discuss the method of shipment with METS.



**Figure 1. Production Sample Splices with rubberized paint used as a tamper proof marking system. Associated control bars are no longer required by the *Contract Specifications*.**



STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION  
**SAMPLE IDENTIFICATION CARD** CARD NUMBER  
 TL-0101 (REV: 10/97) C 697201

PRELIMINARY TESTS      **SAMPLE SENT TO:**      FIELD NO. \_\_\_\_\_  
 PROCESS TESTS             HDQTRS. LAB            DIST. LAB NO. \_\_\_\_\_  
 ACCEPTANCE TESTS         BRANCH LAB            LOT NO. 1 - J11-11700  
 DIST. LAB                    SHIPMENT NO. \_\_\_\_\_ P.O. OR REG. NO. \_\_\_\_\_  
**INDEPENDENT ASSURANCE TESTS**  
 DIST. LAB  
 TRANS. LAB                    AUTHORIZATION NO. \_\_\_\_\_  
 SPECIAL TESTS

SAMPLE OF 4 EA #11 DEXTRA GARTER REBAR COUPLERS  
 FOR USE IN BREA OH T-GIRDERS #TOP DECK  
REINFORCEMENT  
 SAMPLE FROM PRODUCTION LOT #1  
(JOB # J11-11700) HEAT# NF11201061

DEPTH \_\_\_\_\_  
 LOCATION OF SOURCE DEXTRA AMERICA  
NJ COR - NE USA

THIS SAMPLE IS SHIPPED IN 1 AND IS ONE OF A GROUP OF 1 LOT SAMPLES REPRESENTING 100 EA (NO. CONTAINERS) COUPLERS (TONG, GAL. MILLS, STA, ETC.)

OWNER OR MANUFACTURER DEXTRA AMERICA, INC.  
 TOTAL QUANTITY AVAILABLE \_\_\_\_\_ TEST RESULTS DESIRED DATE NEEDED  
 NORMAL  PRIORITY 11-28-2011

REMARKS SEND TO TRANS LAB IN SACRAMENTO  
FOR QA TESTING - SERVICE SPLICE  
CONTACT THEO @ 949.219.8412  
THEO. PHAM @ DOT, CA. GOV

COVER ADDITIONAL INFORMATION WITH LETTER  
 DATE SAMPLED 11.23.2011  
 BY THEO PHAM TITLE S.R. / QA  
 DIST. CO, RTE, PM 12 - ORA - 57 - 18.4 / 20.9

LIMITS SR 57 YORBA LINDA TO LAMBERT

CONT. NO. 12 - SF0324  
 FED. NO. NONE  
 RES. ENGR. OR SUPT. JAMES YU  
 ADDRESS 3020 SATURN ST, SUITE 200, BREA, CA  
 CONTRACTOR CC MEYERS, INC.

MAIL TO SAME DESTINATION AS SAMPLE

Figure 2. Form TL-0101, Sample Identification Card

When completing Form [TL-0101](#), ensure that all items are completed. If incomplete, it could delay METS ability to issue test results. Specific items to consider are:

- Contact information for the person that did the sampling is needed to answer potential questions.
- Email or Fax number is used for METS to send the test results to expedite obtaining results.
- Include with the couplers:
  - A copy of the Material Test Report (MTR) for the heat number of the bar reinforcing steel
  - The MTR for the lot number of couplers represented by the samples. METS cannot issue test results without this information.
  - A copy of the certificate of compliance for the bar reinforcing steel represented by the samples.



METS cannot issue test results without this information.

Also, the sample record can be created through METS Data Interchange for Materials Engineering ([DIME](#)) system. Dime is the web application to communicate the sample information and test data between external labs and Caltrans. User can track and view all test data of the project. For more information, contact the [METS Representative](#).

## **Splice Acceptance Requirements**

### **Slip Test Requirement**

Except for mechanical lap, welded, or hoop splices, test one (1) of the four (4) splice test samples for total slip. If the slip test result complies with the total slip value requirement specified in the *Contract Specifications*<sup>3</sup>, proceed to perform the tensile and/or rupture tests.

If the splice test sample exceeds the total slip value specified in the *Contract Specifications*, test the three (3) remaining test samples for total slip. If any of the three (3) remaining test samples exceed the specified total slip value, the Department rejects all splices in the lot.

### **Other Requirements for Service Splice**

Service splices must develop a minimum tensile strength of 80,000 psi.

Acceptance:

- If only one (1) splice test sample complies with the requirements, the Department rejects all splices in the lot.
- If only two (2) splice test samples comply with the requirements, perform one (1) additional service splice test consisting of four new splice test samples on the same lot of splices. This additional test must consist of tensile testing four (4) splice test samples, randomly selected by the engineer and removed from the lot of completed splices. If any of the four (4) splice test samples from this additional test do not attain the specified minimum tensile strength, the Department rejects all splices in the lot.
- If three (3) or more splice test samples comply with the requirements, the Department accepts all splices in the lot.

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<sup>3</sup> CS 2018, Section 52-6.02B(1), *Reinforcement – Splicing – Materials – Service Splices and Ultimate Butt Splices – General*

## Other Requirements for Ultimate Butt Splice

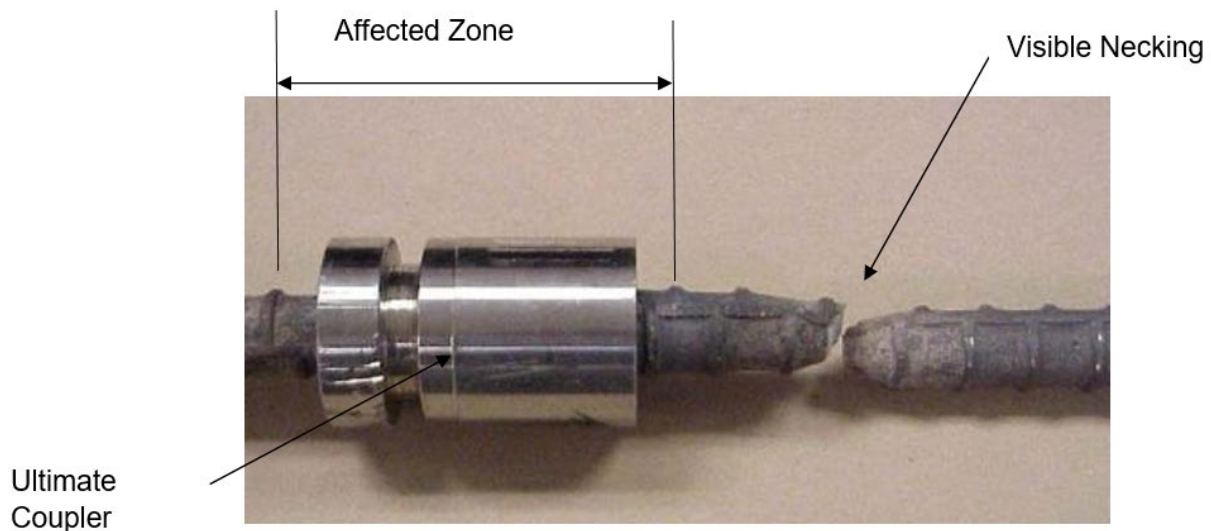
Ultimate butt splices must meet one of the following requirements:

1. Rupture in the reinforcing bar outside of the affected zone and show visible necking as specified in California Test 670, *Method of Tests for Mechanical and Welded Reinforcing Steel Splices, Necking* (Option I).
2. Rupture anywhere and neck as specified in California Test 670, Necking (Option II).

Acceptance:

- If only one (1) splice test sample complies with the requirements, the Department rejects all splices in the lot.
- If only two (2) of the four splice test samples comply with the requirements, perform one (1) additional ultimate butt splice test consisting of four new splice test samples on the same lot of splices. If any of these four (4) new splice test samples do not comply with the specified requirements, the Department rejects all splices in the lot.
- If three (3) or more splice test samples comply with the requirements, the Department accepts all splices in the lot.

Figure No. 3 depicts terms used in California Test 670.



**Figure 3. Passing Tensile Tested Ultimate Coupler. Note the bar rupture outside the affected zone and the visible signs of necking.**

# Mechanical Splice Acceptance Procedure Flow Chart

Figure No. 4 is a flow chart summarizing the Mechanical Splice Acceptance Procedure.

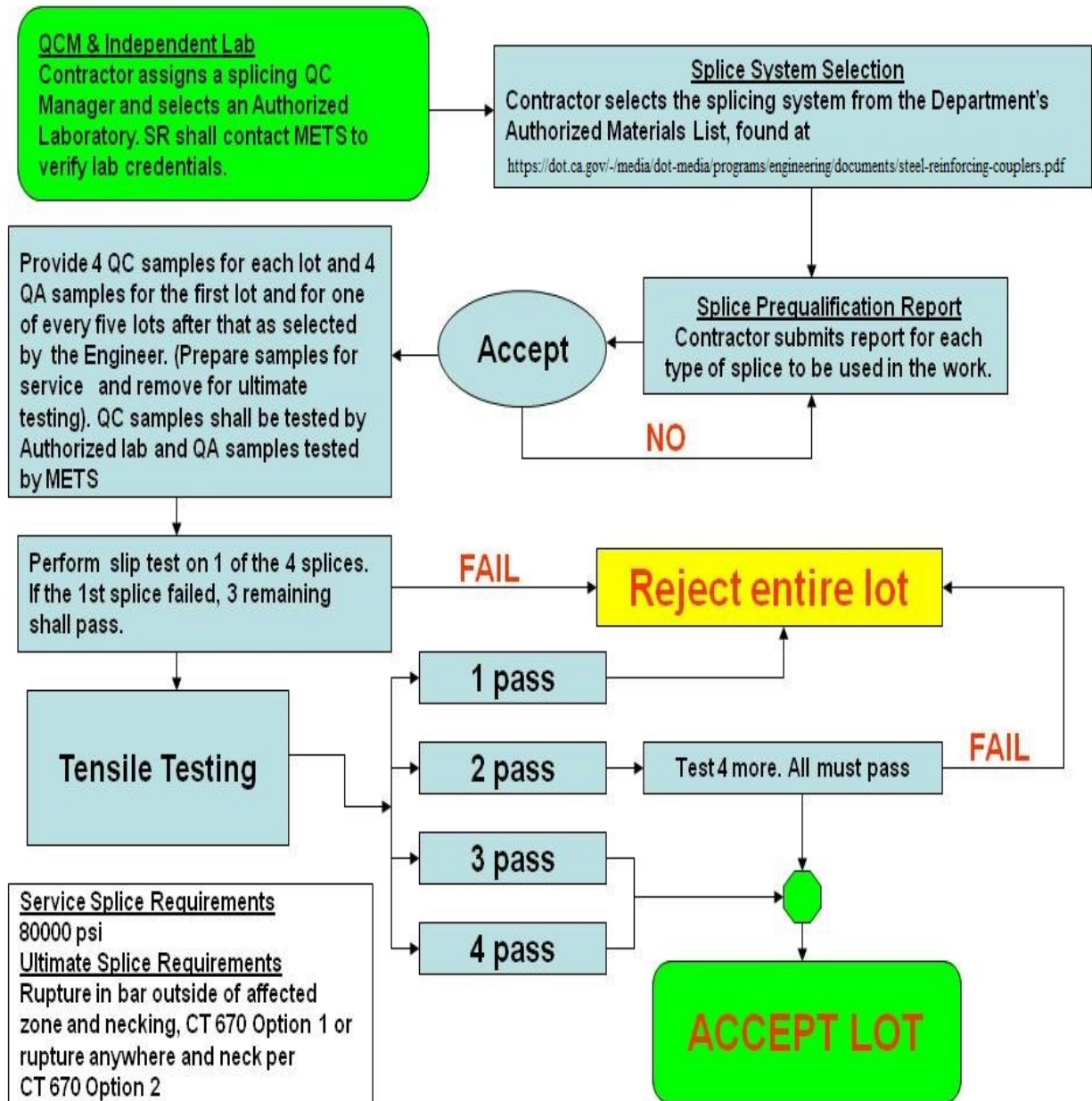


Figure 4. Mechanical Splice Acceptance Procedure Flow Chart.

## **Review Time**

The *Contract Specifications* include a review time for production and quality assurance tests. To avoid costly delays, it is important to respond to the contractor in writing within the time required in the *Contract Specifications* as shown in the table below.

<b>Sample Type</b>	<b>Review Time</b>
Production Sample Tests	Three business days to review each production test report submitted by the QCM.
Quality Assurance	Three business days upon receipt of the samples by METS.  Two extra business days per each simultaneous submittal.

## **What To Do After Completion of Splice Production Work**

### **Review Reports**

The contractor provides the following submittals to the engineer for review:

- Splice Quality Control Test Report
- Splice Rejection Mitigation Report
- Radiographic Film Developing Process Records (when welding is involved)

After completion and acceptance of the bar splices, ensure that the locations of the splices are noted in the as-built plans per [BCM C-6](#), *Required Documents to be Submitted During Construction*, and that all the submittals and test reports are filed in the project records.

## **Testing Requirement Clarifications for Welded Butt Splices**

To follow is information to clarify test requirements for welded butt splices:

1. For Resistance-Butt-Welded Splices (welded hoops):
  - Slip test is not required.
  - Destructive testing is required.

- Radiographic testing is not required.
2. For Complete Joint Penetration (CJP) butt-welded splices (except welded hoops):
    - Slip test is not required.
    - Destructive testing is required for both service and ultimate butt splices.
    - Radiographic testing is not required whenever butt-welded splices are removed from a lot of completed splices (i.e., whenever they require replacement).
    - Radiographic testing is required whenever samples are prepared as described in the *Contract Specifications* (i.e., whenever they do not require replacement due to removal from a completed lot).
  3. Refer to California Test 670 regarding tensile test (destructive testing) requirements.

## **Items to Be Recorded In the Job Files**

During the progress of the work all splice documentation must be filed in Category 37 under the appropriate sub-category headings. Figure No. 5 is an example of summary record of production tests.

Type	Size	Date	Description	Location	Number used		Lot No.	QA Test	QC Test	Note
					This time	To date				
HRC			<i>Sleeve forged ends (i.e. threaded sleeves and headed ends)</i>	<b>Bent 19</b>						
500/510	#29	10/1/2008		<b>Column HOV</b>	14	14	1	OK	OK	
				<b>Bent 16</b>						
				<b>Column HOV</b>	18	32	1			
HRC			<i>Sleeve forged ends (i.e. threaded sleeves and headed ends)</i>	<b>Bent 19</b>						
500/510	#43	10/1/2008		<b>Column HOV</b>	92	92	1	OK	OK	
				<b>Bent 16</b>						
				<b>Column HOV</b>	00	19	1 and 2	na	OK	
HRC				<b>Bent 17 CIDH</b>						
420/410	#57	1/7/2009	<i>Sleeve tapered three</i>	<b>HOV</b>	108	108	1	OK	OK	
Bar Grip			<i>Sleeve swaged</i>	<b>Bent 3R</b>						
XL	#43	1/19/2009	<i>(needs field press)</i>	<b>middle CIDH pile extension</b>	60	60	1			

Figure 5. Summary of Record Production Tests.