



SPOT WELD TEST CRITERIA FOR BARE AND COATED STEEL SHEET

Application

This procedure defines the test setup for material qualification of bare and coated (zinc, zinc/iron, zinc/alloy, and aluminized) steel sheet products that are included in the chart below. Additionally, this procedure may be used as the foundation for developing production spot weld processes for high strength steel grades.

Types of Steel	Common Global Grade Name	Ford Global Material Specification
Mild (Low Carbon) Steels	CR1, CR2, CR3, CR4, CR5, HR0, HR1, HR2, HR3	WSS-M1A365-A11/A15 WSS-M1A365-A20/A23
Dent Resistant Steels	CR180, CR210	WSS-M1A367-A11/A12
Bake Hardened Steels	CR180B2, CR210B2, CR240B2	WSS-M1A367-A21/A23
High Strength Low Alloy Steels	CR240LA, CR270LA, CR300LA, CR340LA, CR380LA, CR420LA, HR270LA, HR300LA, HR340LA, HR380LA, HR420LA, HR500LA, HR550LA	WSS-M1A367-A35/A36 WSS-M1A367-A45/A46
Dual Phase Steels ¹⁾	CRDP600, CRDP800, CRDP1000	WSS-M1A368-A13/A14/A15
Ferrite Bainite Steels ¹⁾	HRFB600	WSS-M1A368-A42
Martensitic Steels ¹⁾	CRMS900, CRMS1100, CRMS1300, CRMS1500, HRMS1200, HRMS1400	WSS-M1A368-A81/A84 WSS-M1A368-A91/A92
Press Hardened Aluminized Boron Steels ¹⁾	N/A	WSS-M1A357-A1 ²⁾ WSS-M1A358-A1 ²⁾

1) Advanced High Strength Steels are included within a limited applicability. Requests for source approvals of these grades should be checked against the "Okay-to-Use List" for their expected application. Non-conforming grades/applications need to be reviewed by the Sheet Metal Tech Club.

2) WSS-M99P39-A1/A2/A3/A4 performance specification must be called out with these Boron steels.

Materials covered by the application of this test method are tested in accordance with AWS D8.9M:2012 "Test Methods for Evaluating the Resistance Spot Welding Behavior of Automotive Sheet Steel Materials". The table below defines which sections of the procedure are followed for each type of material being tested.

Material						Weld Tests		
Thickness		Tensile Strength		Coating				
Less than 1.25mm	Greater than or equal to 1.25mm	Less than or equal to 480 MPa Ultimate Tensile Strength	Greater than 480 MPa Ultimate Tensile Strength	Bare (Uncoated)	Coated (Zn or Zn-Fe)	Electrode Endurance Test (Sec. 10 – 10.10.3)	Weld Quality Test (AWS D8.9M:2012 Sec. 11 – 11.8.5)	Weld Lobe (Sec. 10 – 10.4.4 or 11-11.4.4 for two additional weld times +25% & +50% cycles from nom.)
X		X		X				
X		X			X	X		X
X			X	X			X	X
X			X		X	X	X	X
	X	X		X			X	X
	X	X			X	X	X	X
	X		X	X			X	X
	X		X		X	X	X	X
Ford Minimum Requirements						600 welds		2.0 kA

Date	Action	Revisions	Rev 02
2013 05 08	Revised	See summary of Revisions for Updates	D. Ruhno, NA
2009 02 03	Revised	Pages 1 and 2	T. Coon, FNA
2005 11 28	Activated		D. Ruhno



Testing Procedure

All testing procedures are performed per AWS D8.9M:2012 (Sections 4, 5, 6, 7, 8, 9, 10, 11, and 13) with the following exceptions noted below. Communication between the supplier and customer through the course of testing, especially when problems are encountered, is a cornerstone of this FLTM.

- Section 4 – Sample Preparation – No modifications
- Section 5 – Material Characterization – Record all data on the Ford modified B3 data sheet noting all required information (the steel supplier must provide this data as part of the material qualification process).
- Section 6 – Welding Parameters
 - 6.1 Electrode Specifications and Dimensions: Use ISO 5821 B tips with A2/2 alloy. 16 mm body with 6 mm face for 0.50-1.24 mm and 20 mm body with 8 mm face for 1.25-3.00 mm.
 - 6.2.4: Use Ford Vehicle Operations Structures and Standards (VOSS) weld schedules for all testing. Consult with your Ford Joining Engineering Representative for access to this standard or if a deviation from the standard is required. (e.g. pulsed weld schedules)
 - 6.2.8 Welding Rate: Gauge $\leq 1.85\text{mm}$ = 30 WPM, $>1.85\text{mm}$ = 24 WPM
 - 6.7.1 Minimum Weld Size (MWS): Clarification – Use AWS 4 $\sqrt{t}$ method not Table I.3.3.2 from ESBM5A-1N261-AA
 - 6.7.2 Stabilization Weld Size (SWS): Use the following weld sizes ($\pm 0.2\text{ mm}$) for stabilization:
 - Gauge $<1.25\text{ mm}$ = 5.4 mm, 1.25 mm to 1.50 mm = 6.4 mm, $>1.50\text{ mm}$ to 3.00 mm = 7.2 mm
- Section 7 – Preferred Test Equipment
 - 7.1.1 Type: Use a mid-frequency (1000 Hz) direct current, single-point, pneumatic spot welder with "constant current" weld control. When using dissimilar thickness, keep the positive electrode on the thinner sheet.
- Section 8 – Electrode Installation and Dressing Procedure – Alignment of ISO Type B-caps can be judged visually by utilizing a 'heat weld' (see AWS D8.9M Section 8.5.4) and ensuring the imprints are consistent when judged against themselves. Note that this analysis does not generate a number that compares to the face diameter of the electrode.
- Section 9 – Electrode-Face and Weld-Size Stabilization Procedure
 - 9.3.3-9.3.8.3: Increase the set current in 300A intervals until the peel-test sample button diameter exceeds the SWS for two consecutive samples. Use this weld current to produce 100 welds at the proper rate and spacing.
- Section 10 – Endurance Test
 - 10-10.4.4 Expanded Lobe Testing: Repeat these sections at longer +25% and +50% cycle weld times to produce a more complete weld lobe for the steel being tested. Note that if weld properties testing is being performed in addition to endurance testing, 10-10.4.4 may be omitted
 - 10.4.1 & 10.7.1: For weld tests utilizing B20 electrodes, current increments of 200A may be used.
 - 10.4.3: Tip imprinting at this step is omitted to prevent tip contamination
 - 10.5.4: Tip imprints are taken only at the end of the test instead of each test interval.
 - 10.5.5: Endurance test at 1000 welds if test termination criterion is not reached before 1000.
 - 10.5.6: Endurance Limit is defined as the 200-weld checkpoint prior to the first of the two consecutive 200-weld checkpoints that determined the test termination. The Endurance Limit value is recorded in the Endurance Test Report.
 - 10.8 Replication: Not required
- Section 11 – Weld Property Tests
 - 11.4.3: Tip impressions are only recorded after all welding is completed to prevent tip contamination.
 - 11-11.4.4 Expanded Lobe Testing: Repeat these sections at longer +25% and +50% cycle weld times to produce a more complete weld lobe for the steel being tested.
 - 11.5.1 Re-stabilization of the Electrode Faces – Use SWS from Section 6.7.2 above
 - 11.7.1: For weld tests utilizing B20 electrodes, current increments of 200A may be used. (vs.100A)
 - Characterize surface cracking on at least two welds each made at approximately 300A below I_{MAX} , 300A above I_{MIN} , and the midpoint of the current range using liquid dye penetrant testing. Refer to AWS D8.1M:2007 section 5.1.2 (and D8.1 Fig 2) for surface crack acceptance criteria. Evaluate test welds only, not shunt welds. Include pictures of all dye penetrant tests in the report.
- Section 13 – Design of Experiment (DoE) Test Procedure for Resistance Spot Welding Characterization of High Strength and Advanced High Strength Steels – *OPTIONAL (must be specific to Ford; typically only used to explore the performance of new steels, not for material qualification or program stack-up prove-out)*



Forms/Data Sheets

Qualification reports must contain Ford versions of the following forms / data sheets where appropriate. The forms are reproduced in this procedure for convenience. *Note: These are to the 2012 release of AWS D8.9.*

Ford Version	AWS Original	Name
FB-1	B1	Welding Data Sheets
FB-2	B2	Tip Imprint Data Sheet
FB-3	B3	Test Material Data Sheet
FB-4	B4	Endurance Test Report
FB-5	B5	Weld Property Report
FX-1	N/A	Ford Weld Lobe Data Sheet

Summary of Revisions

2013 05 08

- Application
 - Added statement making this FLTM applicable to production spot weld process development
 - Specification Table: (Removed) "Category" column and added "Common Global Grade Name"
 - Grades: (Added) CRDP1000 & HRFB600, (Removed) reference to TRIP steel (unapproved)
 - Renamed "Boron Steel" as "Press Hardened Aluminized Boron Steel"
 - Foot notes: Updated to reflect above changes to the grades and added reference to "Ok-to-Use List"
 - Weld Table: Thickness transition changed from 1.05 mm to 1.25 mm
 - Weld Table: Tensile strength transition changed from 500 MPa to 480 MPa
 - Weld Table: Endurance Test required ("X") for coated material ≥ 1.25 mm with tensile ≤ 480 MPa
 - Weld Table: Minimum requirements added for Endurance and Weld Lobe tests
- Testing Procedure
 - 6.2.4: (Added) Use Ford VOSS weld schedules. Modification to these schedules requires Ford Joining Engineering approval.
 - 6.2.8: (Added) Changes made to welding speed requirement for material > 1.85 mm
 - 6.7.1: (Added) Clarification on method used to calculate minimum weld size
 - 6.7.2: (Added) Required stabilization weld sizes for various gauge ranges
 - 9.3.3-9.3.8.3: (Added) Modified procedure for electrode stabilization
 - 10.4.1 & 10.7.1: (Added) Tests with B20 (20mm) electrodes can utilize a 200A increment vs. 100A
 - 10.5.6: (Added) Definition of Endurance Limit and recording practice
 - 11.4.1: (Added) Tests with B20 (20mm) electrodes can utilize a 200A current increments
 - 11.5.1: (Added) New weld sizes for re-stabilization procedure
 - 11.6: (Removed) Option to perform weld test on only low hold time samples if no hold time sensitivity
 - Modified criteria for performing dye penetrant testing
- Forms/Data Sheets
 - FB-1: Changed "Failure Mode" to "Fracture Mode"
 - FB-2: Added Label titles to table
 - FB-3: Added required elements to the coating and substrate chemistry tables
 - FX-1: Added units to the data sheet
- Global
 - All references to "AWS D8.9M:2009" changed to "AWS D8.9M:2012"





FORD LABORATORY TEST METHOD

BA 113-08

Job# _____ Qualification# _____

WELDING DATA SHEET (FB-1)

Laboratory Name: _____

Address: _____

Test Code: _____

Test Type: _____

Test Operator: _____

Test Date: _____

Steel /Type: _____

Sheet Thickness: _____

Coating Type: _____

Coating Weight/Thickness: _____

Top Bottom

Coil/Heat/ID No: _____

Electrode Type: _____

Electrode-Face Dia.: _____

Electrode-Face Thick: _____

Welding Machine: _____

Welding Control: _____

Welding Mach. Tap: _____

Cooling Tube-OD Dia.: _____

Current Analyzer: _____

Force Gauge: _____

Water Water
Flow: _____ l/min Temp: _____ °C

Welding Rate: _____

Squeeze Time: _____

Weld Time(s): _____

Hold Time(s): _____

Off Time (Repeat Welding): _____

Weld Force: _____

Force Pressure Setting: _____

Welding Mode: _____

Panel Type: _____

Comments: _____
