

**FLOW DRILL SCREW SCHEDULE DEVELOPMENT ACCEPTANCE TEST FOR
ALUMINUM, LOW CARBON STEEL SHEET AND EXTRUSIONS****Application**

This procedure defines the acceptance test for Flow Drill Screw (FDS) schedule development for aluminum, low carbon steel sheet and extrusions. All such sheet material must pass minimum performance testing. Consult the appropriate Engineering Material Specification for material exceptions. Testing confirms that the correct screw and processing parameters were used to satisfactorily join materials together. Cross sections of the FDS joint must be evaluated to insure a robust joint. After the correct tooling has been identified, lap shear and coach peel samples are fabricated. Initial testing requires a sample size of 30 each for the strength tests. Samples are pulled on a tensile test machine.

Apparatus Required**FDS Tooling**

This test shall be conducted on an appropriate servo driven FDS system and, in general, complying with the FDS Manufacturing requirements for size and type of machine required. It shall have preclamp, insertion force and torque capacities to meet the requirement of the range of material gauges to be tested.

FDS

Ford standard design will be used for all tests. The base material will be selected from Ford Manufacturing Standard, S900. Processing will follow Engineering Specification ESBUS5A-1B318-AA.

Preparation of Material

The material for FDS qualification shall be representative of production practices in the ordered thickness. The material shall be sheared in 25 mm x100 mm pieces and free from burrs and slivers. Care shall be exercised so as not to remove any oils or die lubrication used for stamping, corrosion or shipping protection. The rolling or extrusion direction of the material should be parallel to the 100 mm dimension.

Coated Galvanized Sheet Material

Coating thickness on each side of panels must meet required manufacturer's specification for production intent.

Metallographic Cross-section Evaluation

There are several significant joint characteristics and dimensions that must be assessed by metallographic and optical microscopy techniques.

Date	Action	Revisions	Rev. 1
2013 12 09	Revised	See Summary of Revisions	A. Freis, NA
2013 05 30	Released		A. Freis, NA

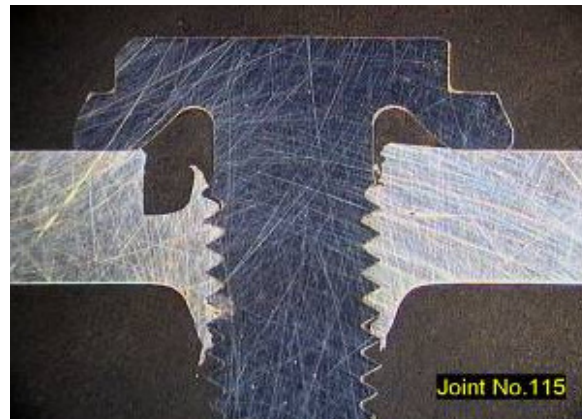


Figure 1: Cross section of FDS

Figure 1 displays a cross section for a flow drill screw joints. The following characteristics shall be checked during metallographic examination/optical microscopy:

Screw Seated	The integrated washer shall be fully seated on the top sheet of material. There should be no gaps between the underside of the screw washer and the top sheet.
Threads Engaged	The number of fully engaged threads shall be counted. A thread is considered engaged if the female thread is fully formed in the substrate material. Partially formed threads are not counted in the engaged thread count.
Rolling Threads	The fastener rolling threads should extend through the joint past the bushing on the back side of the joint.
Cracks in Stack	There should be no cracks present in the layers of material.
Cracked Screw	The screw should not show any cracks or voids.
Gaps in Stack	Ideally no gaps should be present, however if gaps are in the stacks they should not extend out beyond the diameter of the screw head and integrated washer. Any gaps should be measured and quantified by the maximum height and width.

Sample Preparation

Samples must be assembled in a test fixture, which provides a 25 mm overlap of the 25 mm x100 mm lap shear test samples to eliminate testing errors. The fixture ensures that the FDS is installed in the center of the 25 mm overlap consistently. The same fixture can be used for the coach peel samples by stacking the coupons on top of one another. A vice should be machined to accommodate the tip of the FDS when the peel samples are being bent with a 25 mm flat. Figure 2 shows the fixture used to make the FDS samples.

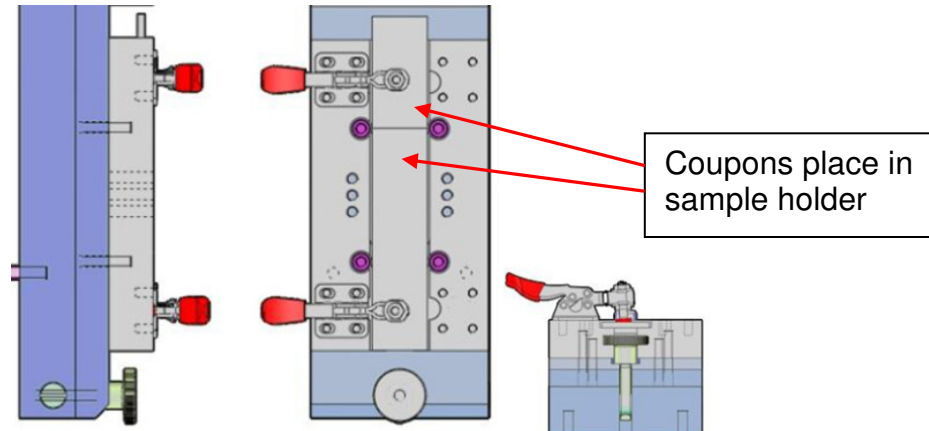


Figure 2: Sample Preparation Fixture (Side, Aerial, End Views from left to right)

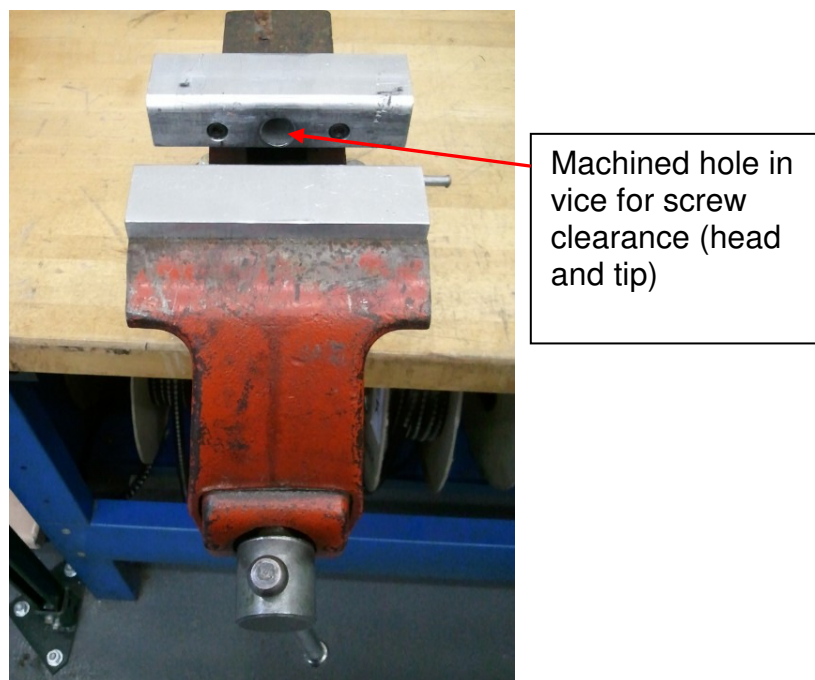


Figure 3: Coach Peel Coupon Bending Fixture

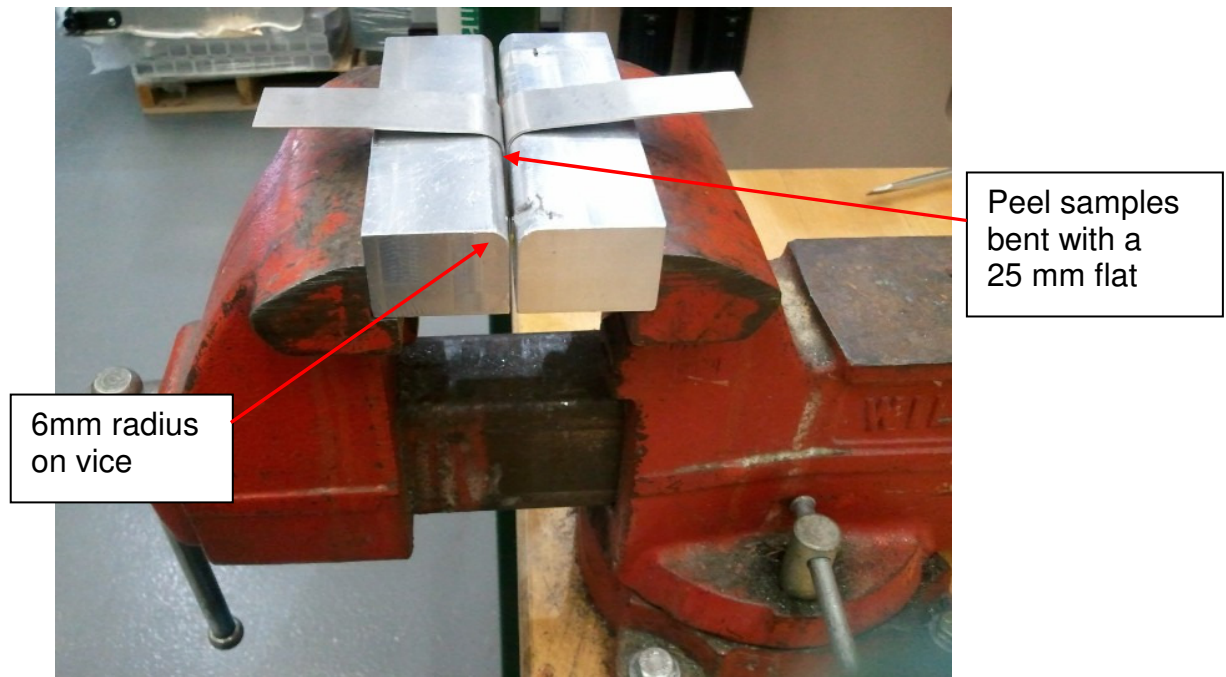


Figure 4. Coach Peel Coupon Bending Fixture

Statistical Analysis (Repeatability of Joint)

The statistical analysis is comprised of 30 lap shear samples, 30 coach peel samples, and one sample comprising of a cross section and bushing for imaging. The samples are assembled using the coupon holder described above. While making the samples, the tightening torque is recorded as it will be used as an input for PV testing. Once the samples have been made they are tensile tested at 10 mm/min and the failure modes for each sample should be identified. Photographs of the failure modes should be taken. Below is an example of a set of the FDS data. Cycle time data should also be recorded at this time for future analysis.

Table 1: Sample Lap Shear Data

Sample #	Tightening Torque (Nm)	Peak Load (N)	Failure Mode
1	9.05	7098	Tearing of top material
2	9.00	7027	Tearing of top material
3	9.01	6994	Tearing of top material
4	9.04	6974	Tearing of top material
5	9.00	6908	Tearing of top material
6	9.04	7079	Tearing of top material
7	9.02	6755	Tearing of top material
8	9.02	6989	Tearing of top material
9	9.02	6925	Tearing of top material
10	9.00	7013	Tearing of top material
11	9.05	6847	Tearing of top material
12	9.05	7154	Tearing of top material
13	9.02	7111	Tearing of top material
14	9.04	6912	Tearing of top material
15	9.04	7031	Tearing of top material
16	9.02	7003	Tearing of top material
17	9.02	6964	Tearing of top material
18	9.02	6878	Tearing of top material
19	9.00	7005	Tearing of top material
20	9.05	7163	Tearing of top material
21	9.02	7047	Tearing of top material



22	9.02	6940	Tearing of top material
23	9.02	7073	Tearing of top material
24	9.00	7144	Tearing of top material
25	9.05	7035	Tearing of top material
26	9.05	7076	Tearing of top material
27	9.02	6911	Tearing of top material
28	9.04	7096	Tearing of top material
29	9.04	6883	Tearing of top material
30	9.02	6995	Tearing of top material
	Mean	7001	
	Std. Dev.	96.90	
	Min.	6755	
	Max.	7163	

Table 2: Sample Coach Peel Data

Sample #	Tightening Torque (Nm)	Peak Load (N)	Failure Mode
1	9.05	907	Tearing of top material
2	9.02	935	Tearing of top material
3	9.02	919	Tearing of top material
4	9.02	897	Tearing of top material
5	9.00	888	Tearing of top material
6	9.05	924	Tearing of top material
7	9.05	891	Tearing of top material
8	9.02	935	Tearing of top material
9	9.04	912	Tearing of top material
10	9.04	902	Tearing of top material
11	9.02	925	Tearing of top material
12	9.05	947	Tearing of top material
13	9.05	951	Tearing of top material
14	9.02	936	Tearing of top material
15	9.02	922	Tearing of top material
16	9.02	912	Tearing of top material
17	9.00	932	Tearing of top material
18	9.05	917	Tearing of top material
19	9.05	918	Tearing of top material
20	9.02	912	Tearing of top material
21	9.05	923	Tearing of top material
22	9.02	957	Tearing of top material
23	9.02	932	Tearing of top material
24	9.02	924	Tearing of top material
25	9.00	930	Tearing of top material
26	9.05	925	Tearing of top material
27	9.05	931	Tearing of top material
28	9.02	911	Tearing of top material
29	9.04	921	Tearing of top material
30	9.04	919	Tearing of top material
	Mean	922	
	Std. Dev.	16.0	
	Min.	888	
	Max.	957	