



GUIDE FOR

THE APPROVAL OF FRICTION STIR WELDING IN ALUMINUM

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Foreword

This Guide provides the guidelines for the approval of friction stir welding procedures, operators and the nondestructive testing requirements for production friction stir welding of aluminum. These guidelines are based on the current knowledge and may be updated as practical experience is gained. The latest knowledge will be considered in approval tests and may require the test program or the range of approval to be adapted accordingly.

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.

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SECTION 1 General

1 Scope and Application

This Guide has been developed with the objective of setting out the requirements for the qualification of friction stir welding (FSW) procedures and operators. This Guide also provides guidelines for the production quality control of FSW and the nondestructive testing (NDT) requirements. FSW produces a weld between two abutting workpieces by the frictional heating and plastic material displacement caused by a rotating tool that traverses along the weld joint. This Guide is for the application of FSW for aluminum groove welds. No other joint configuration is considered in this Guide.

Weld procedure and operator qualification requirements apply for FSW of aluminum alloys identified in Ref. 1.

2 References

The following documents form a part of this overall Guide to the extent they are referenced.

Reference Number	Reference Description
1	ABS Rules for Welding and Materials (Part 2)
2	AWS A3.0 Standard Welding Terms and Definitions
3	ABS Guide for Nondestructive Inspection of Hull Welds
4	AWS D1.2/D1.2M Structural Welding Code – Aluminum
5	AWS D17.3/17.3M Specification for Friction Stir Welding of Aluminum Alloys for Aerospace Applications
6	NASA document PRC-5010C, Process Specification for Pickling, Etching, and Descaling of Metals

3 Definitions

Adjustable Probe (Retractable Pin) Tool – Tool probe length, rotation speed, direction of probe rotation are adjustable.

Advancing Side of Weld – Side of the weld where the direction of tool rotation is the same as the direction of welding.

Direction of Tool Rotation – Rotation as viewed from the spindle that is rotating the tool.

Exit Hole – Hole remaining at the end of a weld after the withdrawal of the tool.

Flash – Material expelled along the weld toe during FSW.

Friction Stir Re-weld – FSW pass upon FSW pass from one side only.

Friction Stir Welding Methods – Methods include, but are not limited to, robotic, single spindle, multiple spindles, adjustable probe (retractable probe) tool, self-reacting (bobbin) tool, and simultaneous two-sided welding.

Heel – Part of the tool shoulder that is at the rear of the tool relative to its forward motion.

Heel Plunge Depth – Distance the heel extends into the workpiece.

Joint Line Remnant – Unmixed and distorted layer of Aluminum Oxide, occurring at the root of the joint faying surfaces, when the joint is welded from one side using anvil backing.

Probe – Part of the welding tool that extends into the workpiece to make the weld.

Retreating Side of Weld – Side of the weld where the direction of tool rotation is opposite to the welding direction.

Self-reacting (Bobbin) Tool – Tool with two shoulders separated by a fixed length probe or an adjustable length probe.

Sweep – Denotes a curve in the horizontal plane.

Tool Offset – The shortest distance from the tool axis to the joint.

Tool Shoulder – Surface of the tool that contacts the workpiece surface during welding.

Tool Rotation Speed – Angular speed of the welding tool in revolutions per minute.

Welding Tool – Rotating component that passes entirely through or partially through the workpiece, and may or may not have a shoulder.