AEROSPACE RECOMMENDED PRACTICE

ARP1330	REV. D

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Superseding ARP1330C

Welding of Structures for Ground Support Equipment

RATIONALE

ARP1330D results from a five year review of this specification.

STABILIZED NOTICE

This document has been declared “Stabilized” by the AMS B Committee and will no longer be subject to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist. The last technical review of this document occurred in April, 2006.

AMS Committee B recommends that the following technically equivalent (e.g., properties, fit, form, function) specifications be used for future procurement. This listing does not constitute authority to substitute these specifications for the “STABILIZED” specification unless use is approved by the cognizant engineering organization.

AWS D1.1 Structural Welding Code - Steel

AWS D1.2 Structural Welding Code - Aluminum

AWS D1.6 Structural Welding Code - Stainless Steel

AWS D17.1 Specification for Fusion Welding for Aerospace Applications

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1. SCOPE

1.1 This recommended practice provides general recommendations for welding structural assemblies for aerospace ground support equipment.

1.2 The recommendations are based on practical engineering experience and reflect design practices and fabricating procedures that have been found to be effective in providing good strength and structural rigidity.

1.3 Safety-Hazardous Materials

While the materials, methods, applications and processes described or referenced in this procedure may involve the use of hazardous materials, this document does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of this document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 AWS Publications

Available from American Welding Society, 550 NW LeJeune Road, Miami, FL 33126, Tel: 1-800-443-9353, www.aws.org.

D1.1 Structural Welding Code - Steel

D17.1 Specification for Fusion Welding for Aerospace Applications

3. TYPES OF WELDING

Most welding of ground support equipment is performed with gas-tungsten-arc welding (GTAW), gas-metal-arc welding (GMAW), and shielded-metal-arc welding (SMAW). In addition to these three, oxyacetylene welding (OAW) and oxyhydrogen welding (OHW) have limited applications for welding thin steel and thin aluminum, respectively.

3.1 Gas-tungsten-arc welding (GTAW) is probably the most versatile welding process because it can be used for welding all the materials in Table 1. GTAW is normally used for welding thin material, but can be used for welding thick material when heavy duty equipment is available. However, it requires more welding time than GMAW or SMAW when welding thick material.

3.2 Gas-metal-arc welding (GMAW) is more limited in use than GTAW because it is normally used for welding carbon steel, aluminum alloys, and sometimes low-alloy steel but is not commonly used for welding corrosion-resistant steel. GMAW is normally used for welding thick material, but can be used on thin material by a skilled welder.

3.3 Shielded-metal-arc welding (SMAW) is similar in application to GMAW with the exception that corrosion-resistant steels can be welded but aluminum alloys are not normally welded with this process. SMAW is also used for welding thick material although skilled welders can weld thin material.

4. FILLER METALS

The welding process, basis metal, strength requirements and, in some cases, color match, will dictate which filler wire is to be used. The filler materials listed in Table 1 represent an optimization of these factors.

5. RECOMMENDATIONS

5.1 Base Materials and Condition

5.1.1 Ground support structures that are to be assembled by welding should specify materials that can be readily welded and require a minimum of preheat or postweld stress-relief. Materials that meet these criteria are listed in Table 1. Materials within a given category can be welded in any combination.

5.1.2 Materials should be welded in the annealed or normalized condition. Heat treatment of 4130 low-alloy steel and of 6061 and 6063 aluminum alloys after welding is recommended if maximum properties in the base material and the weld are desired. Welding of heat-treatable material to non-heat-treatable material will result in only the heat-treatable material being capable of responding to postweld heat treatment. Aluminum alloys and corrosion-resistant steels can be welded in the heat treated or strain hardened condition but the base material properties will be reduced in the area of the weld. Welding of 4130 steel in the heat treated condition is not recommended.

5.2 Design Considerations

5.2.1 Double-fillet welds are preferred over single-fillet welds because they tend to neutralize the effects of the built-in crack. The effects of such cracks can also be eliminated by using a groove weld, with a prepared joint if necessary, to give full penetration in combination with either a single-fillet or double-fillet weld. Joints should be designed for complete welding, i.e., full penetration, where the assembly is to be heat treated after welding. Intersecting joints should be kept to a minimum because they create problems in joint preparation and assembly and often cause distortion. Intermittent welds should also be kept to a minimum as they do not afford a continuous load path between the two joined members. Joint configurations are described in AWS D1.1.

5.2.2 Material thickness dictates both the joint configuration and the welding process. Thin materials require processes that afford low heat and normally no special edge preparation. Thick materials require processes that produce high heat and may require prepared grooves.

5.2.3 Weld joint accessibility must be considered when designing the assembly. Accessibility requirements vary greatly with the welding process to be used. The maximum practicable clearance should be provided around each joint.

5.2.4 Inspection test requirements must be considered when the joint configuration is being determined. Designs should be such that a minimum of nondestructive testing (NDT) is required. Conservative designs and proof testing will, in most cases, eliminate the need for costly and time-consuming nondestructive testing. Visual inspection should be made of each weld, but where additional nondestructive test methods are required, they should be specified on the drawing. Specific welds may require more inspection than others and these requirements should be indicated on the drawing. The type, direction, and load for proof testing should be indicated on the drawing when used in lieu of, or as a supplement to, NDT methods. Penetrant and magnetic particle inspection methods can be used on most joint configurations. Radiographic inspection should be used only on critical weldments and only when straight-through, single-wall radiography can be employed. Use of radiographic inspection on "T" type joints is not recommended as results are often misleading and may lead to unnecessary rework.

5.3 Process Recommendations

Joint preparation information can be found in AWS D1.1.

5.3.1 Cleaning

Welds in ground support equipment do not normally require cleaning. Detail parts and weld joints should, however, be free of oil, grease, and scale prior to welding to ensure a quality weld. Post-weld cleaning is required only on welds made by the SMAW process and consists of removing the solidified weld slag.

5.3.2 Edge Preparation

Weld joint configuration will dictate assembly and edge preparation requirements and will influence inspection and test requirements. Joints designed for fillet welding require a minimum of special edge preparation. Butt joint square groove welds in thin material require no edge preparation. Full penetration groove welds offer optimum joint strength with a minimum of stress raisers. Prepared groove joints may be required where joint strength cannot be attained because the material thickness is such that the desired joint penetration cannot be achieved without a prepared groove. Special edge preparation, which is costly, time consuming, and in some cases extremely difficult, is required for groove welds, except square groove. Double grooves are more difficult to prepare than single grooves but help reduce weld distortion when welding thick material.

5.4 Post-Weld Thermal Treatment

It is desirable to stress-relieve carbon and low-alloy steel parts, particularly when the part will be extensively machined after welding. Stress-relief can be omitted on parts that will be subsequently heat treated. Aluminum alloys and corrosion-resistant steels do not require stress relief after welding. Low-alloy steels and 6061 and 6063 aluminum alloys can be heat treated to higher strength after welding.