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AEROSPACE RECOMMENDED PRACTICE

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AUTOMATED DEBURRING

1. SCOPE:

1.1 This recommended practice establishes procedures for the application of long string abrasive fibers to machined aircraft structures for the purpose of removing burrs produced during the machining operations. This procedure is applicable to aluminum, titanium, and steel.

1.2 The process is applicable to the removal of light machining burrs and will not remove burrs that have been extruded by dull cutting tools.

1.3 The process described responds to the need for a deburring method that would lend itself to machine automation and robotic applications and be applicable to a wide range of part geometry variables.

2. APPLICABLE DOCUMENTS:

2.1 NFPA Publications: Available from the National Fire Protection Association, Battery March Park, Quincy, MA 02269.

Code 65 - National Fire Protection Association

Code 481 - National Fire Protection Association

3. TECHNICAL REQUIREMENTS:

3.1 Process Description:

3.1.1 Deburring of aircraft parts historically has been accomplished primarily by hand methods due to the size, complexity, and part volume variability. This document describes a recently developed process which offers a new approach to the deburring of these parts and offers a simplified approach to the automation of the deburring operation. The process is based on the use of ultra-long string abrasive brushes as the deburring media.

3.1.2 It is a departure from current industry practice of using only the brush tips as the primary deburring mechanism. The fibers are lengthened and fabricated into a cylindrical brush. The centrifugal force, imparted by the rotational speed of the brush, results in the deburring and the rounding of the edges by the surface of the fibers in a draw and file action. The flexible fibers wrap around and deburr the edges of the part, concentrating their force on the edges without adversely affecting other part features.

3.2 Selection of Equipment: The selection of equipment to be used in the application of the process is determined primarily by the size and part complexity. Complex irregular shaped parts (e.g., aircraft bulkheads and landing gear struts) are candidates for robotic application. while long, rectilinear and integrally stiffened parts (e.g., spars and wing planks) are candidates for automated machinery.

3.3 Brush Material:

3.3.1 The fiber material used in the construction of a long string brush deburring head consists of an extruded nylon fiber containing abrasive particles of aluminum oxide or silicon carbide dispersed throughout the fiber and exposed on the surface.

3.3.1.1 New particles are exposed as the fiber wears.

3.3.2 The fiber material is available in 15 different combinations of grit size and filament diameters. Available grit sizes range from 500 to 46, with the larger grit sizes available in the heavier filament diameters.

3.3.2.1 The fiber material is currently available in two choices of grit loadings of 30% and 40% abrasive to 70% and 60% nylon, respectively.

3.3.3 The fiber material is available from the brush manufacturers in low, medium, and high density fiber concentrations. This is a measure of the amount of filament placed in a given length of brush strip.

3.3.4 The brush material is currently available from only two sources (See 9.2).

3.3.5 The brushes are currently available in three basic types; straight and spiral strip brushes, where the strips of brushes are located along the axis of rotation and in parallel order and continuous spiral wrap brushes, where the strips are wrapped in a loose or tight pitch around the axis of rotation.

4. RECOMMENDED BRUSH CONSTRUCTION:

4.1 The following recommended brush construction is based on the best results obtained in the configurations tested and does not imply that all possible combinations have been reviewed.

4.2 Ab.asive Media: Silicon carbide provides better deburrinq effectiveness and longer surface abrasive life than aluminum oxide.

4.3 Grit Size: Should be no coarser than 120 (125 m) grit. Abrasive fibers coarser than 80 (180 m) grit are not as effective in material removal, due to the larger particle size, providing fewer cutting edges on the surface of the fibers.

4.4 Grit Loading: Should be 60% nylon carrier to 40% abrasive material. This combination provides better deburring effectiveness than 70% nylon to 30% abrasive.

4.5 Brush Pack Density: A medium density brush fill is recommended as an economic optimum. The heavy density brush is more aggressive but not enough to offset the increased material cost.

4.6 Brush Trim Length: The brush trim length is the effective length of the fiber from the mandrel diameter and should be not less than 3 in. (75 mm) longer than the highest vertical edge from the base of the part to be deburred.

4.7 Type of Brush: The type of brush construction is primarily dictated by the part configuration and the degree of deburring aggressiveness required. The strip type is recommended for deburring the under edge of protruding surfaces where maximum wrap-around is required. The continuous tight spiral wrap is recommended where maximum deburring agressiveness is required on parts without overhanging edges.

5. PROCESS PARAMETERS:

5.1 Deburring Angle: The deburring angle is defined as the angle of the edge being deburred to the rotational axis of the brush.

5.1.1 The recommended angle is 45 deg with respect to the edge being deburred. The test results indicate that the material removal rate remains relatively constant between 0 deg and 30 deg, decreases slightly between 30 deg and 45 deg, and declines rapidly beyond 45 degrees.

5.2 Brush Speed: Speeds between 400 and 500 rpm provide acceptable material removal rates and edge radiusing between 0.010 to 0.040 in. (0.25 to 1.00 mm). Speeds above 600 rpm are not recommended with the long string process. Speeds above 600 rpm result in very rapid fatigue failure of the brush fibers with little increase in deburring effectiveness. Higher speeds also decrease the brushes' conformity to part geometry.

5.3 Lubrication: The use of water is not recommended with the long string deburring process. Water decreases the deburring effectiveness. The flexibility of the brushes, coupled with the low brush speed, does not cause excessive heating of the surface.

5.4 Brush Oscillation: Brush oscillation is not recommended in this process. This process is based on a draw and file action of the fibers, requiring the fiber to remain in contact with the edge during the process. Oscillation tends to pull the fibers away from the edge, decreasing the deburring effectiveness.

5.5 Deburring Effectiveness: The deburring effectiveness is directly related to the grit size, brush density, brush rpm, material, and feed rate. The distance of the edge of a part, embedded in the brush from the tip of the brush, determines the degree of deburring that will be accomplished with any combination of the variables described above.

5.5.1 The material removal rate decreases as the abrasive wears flush with the fiber diameter and then remains constant until the fibers wear out. Checks should be made on the parts being processed, and feed rates regulated to maintain acceptable deburring levels.

5.5.2 The deburring rate on 7075 aluminum alloy (with the process conditions the same) is approximately twice that for titanium or steel.

6. QUALITY ASSURANCE PROCEDURES:

6.1 Monitoring the Process: This process should be monitored and adjusted as required to maintain an acceptable edge break.

7. ENVIRONMENTAL CONSIDERATIONS:

7.1 Dust Collection: This process produces a very fine dust. A suitable dust collector should be provided on any equipment designed for this process.

7.2 Waste Disposal: The process waste consists of a very fine dust, consisting of the base metal being deburred, along with small amounts of silicon carbide and nylon (or alumimum oxide and nylon) particles. This material should be disposed of by procedures recommended by the Environmental Protection Agency.

7.3 Fire Hazard: The very fine dust produced by this process, as with all current brush and belt deburring equipment, is considered a potential fire hazard, unless the proper handling procedures are followed. All procedures and installations pertaining to the operation of long string abrasive brush deburring equipment should adhere to the National Fire Protection Association Code Nos. 65 and 481 for the processing and finishing of aluminum and titanium.

8. QUALITY ASSURANCE CONSIDERATIONS:

8.1 Edge Quality: This process produces a consistent edge break and radii without chatter marks and nicks prevalent with the current hand methods.

8.2 Surface Finish: This process will improve the surface finish. The higher the surface finish prior to deburring, the greater will be the percentage of improvement. This process has very little effect on surface finishes below 30 microin. (0.8 μm).

8.3 Metallurgical Considerations: This process produces improved stress-corrosion properties on surfaces that the brush contacts. Test results have shown residual surface and subsurface tensile stresses (on surfaces contacted by the brushes) are converted to compressive stresses.