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Roto Peening Has Its Limitations!

ROTO PEENING (RP) was developed and is still used today mainly in aerospace maintenance, repair and overhaul (MRO) facilities for on-site-repairs of aircraft and helicopters. Over the last decades, RP found entrance in the specifications and service bulletins of most aircraft manufacturers and, in 2010, the AMS2590 specification became available.

Basically RP is a subtype version of conventional Shot Peening (SP) with the major difference being a defined number of contained shot in a polymeric flap accelerated by the rotation of a supporting mandrel (Figure 1).

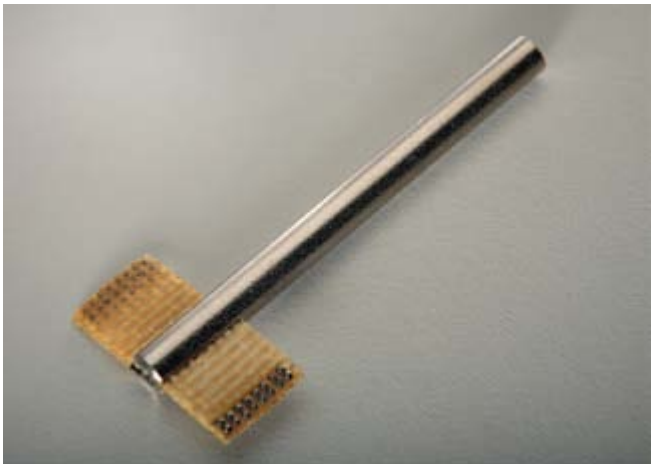

Figure 1. Roto peening flap in mandrel

This smart technical design results in the following major differences between RP and SP in terms of shot and intensity.

	Roto Peening	Shot Peening
Shot Size	Fixed: 0.033 inch (0.84 mm)	Flexible: 0.002 - 0.24 inch (50µm - 6 mm)
Shot Material	Fixed: Tungsten Carbide	Flexible: Cast/Stainless Steel, Glass, Ceramic
Shot Hardness	Fixed: Tungsten Carbide	Flexible: 45 to >70HRC
Intensity Range	Almen N, A	Almen N, A, C

RP and SP—the latter using a large number of independent particles in a shot stream—follow mainly the same technical targets: Controlled creation of a compressive surface residual stress layer to overcome metal fatigue-related failures during the use of critical components. As RP is primarily used in the on-site repair of damage-weakened aerospace components, it is even more important to focus on the appropriate use of this manual-driven repair technology.

In conventional SP, one of the first lessons you learn when you establish a call out for a component is to be aware of the dimensions, especially the smallest radii to be peened. The reason is these radii are where the largest stress causing fatigue problems occur during load (Figure 2).

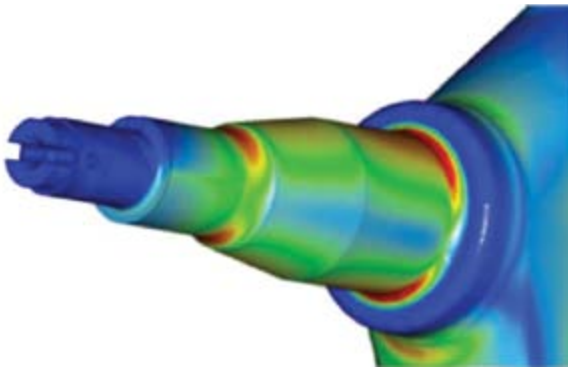

Figure 2. Red colour represents highest stress levels in the radii areas under load

In comparison to SP, the material/hardness (tungsten carbide) and size (S330) of the shot in the RP technique is limited to only one choice. Based on this fact, the use of RP is technically already limited regarding a smallest radius which can be peened. In conventional SP, the AMS2430 declares that the diameter of shot to be used must not be greater than one-half of the smallest fillet radii. In RP, the only size available and bonded to the flap is 0.033 inch (0.84 mm). This rule could be misinterpreted that the smallest radii that can be treated is 0.066 inch (1.68 mm) which, in fact, is wrong!

The reason for this is the embedded shot position in the polymeric strip used in RP technology. First, the position of the embedded shot cannot cover the end of this strip (see Figure 1 and 3). Secondly, the stiffness of the strip limits its

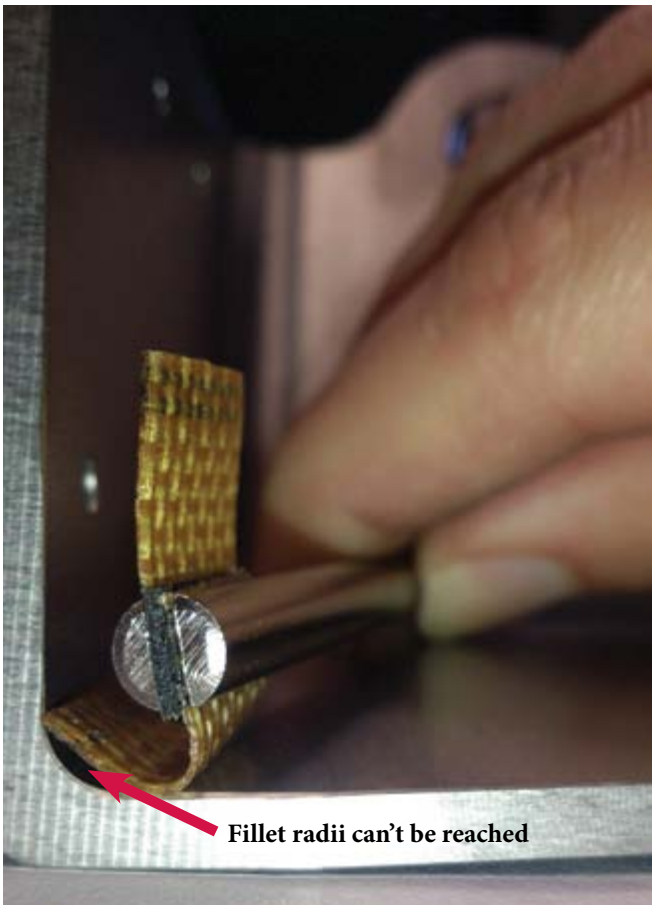

Figure 3. Example of a radius (0.3 inch/8 mm) that is too small for roto peening

ability to peen small radii (see Figure 3). These two facts lead to the result that the smallest radius possible to peen is by far larger than just the double of the used shot size.

This observation already includes the possibility of adjusting the flap to the required surfaces by cutting it down. Even the theoretically smallest single-shot flap is limited by the shot position and strip inflexibility.

An investigation of different specifications and service bulletins has revealed that, in some cases, the above mentioned incorrect radius of 0.0625 inch (1.587 5 mm) has been pointed out. Whereas, in most specifications and service bulletins, no real values or pre-preparation guidance concerning the radius are given. In other cases, including the AMS2590, it is at least mentioned that during the part preparation process "all fillets shall be properly formed."

In a few exceptions, the repair manual offers a detailed and realistic "minimum fillet radii that can be peened" for the three different available RP flap sizes. See the following table as an example.

Flap Size		Minimum Fillet Radii
Length	**Width**	
2.00 inch (50.8 mm)	1.00 inch (25.4 mm)	1.25 inch (31.75 mm)
1.25 inch (31.8 mm)	0.56 inch (14.3 mm)	0.75 inch (19.05 mm)
0.98 inch (25 mm)	0.56 inch (14.3 mm)	0.61 inch (15.6 mm)

Example of minimum fillet radii from an aerospace bulletin

The above values clearly demonstrate that within the available documentation, the smallest possible radii to treat by RP can and should—in the author's opinion—be a minimum of 19 times larger than with conventional SP using the same (S330) shot size.

Summarizing the findings above, they make it clear that the use of RP in terms of peening of stressed radii should be urgently re-evaluated and limited to a minimum radius of >0.6 inch (15.2 mm) for the smallest flap size.

Reflecting upon experience and knowledge, the author furthermore recommends re-thinking the present repair manuals and also AMS2590 in terms of peening holes by RP. Today this kind of peening is allowed down to 0.5 inch (12.7 mm) diameter equal to a radius of 0.25 inch (6.4 mm).

Figure 4. Mid-size roto peen flap (1.25 x 0.56 inch / 31.8 mm x 14.3 mm) in a 0.75 inch (19.1 mm) hole

Figure 4 shows, as an example, a mid-size flap in a 0.75 inch (19.1 mm) hole that is reaming rather than peening. It underlines the concern that holes smaller than 0.75 inch (19.1 mm) cannot be peened correctly with this flap size.

Given this information, it is understandable that major OEMs explicitly recommend using conventional SP instead RP (BOEING Field Service, BAB-LUT-99-00006H, 20 Sep 99) in critical areas.