



Turbocharger, Wastegate Assembly Lever Arm-to-Shaft Weld Specification

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose/Material Description. This specification covers the acceptance criteria for electric-arc or laser welding stainless steel and superalloy turbo wastegate shafts and lever arms used in turbo charger assemblies without the use of weld filler material. The application of the requirements of this specification is mandatory unless a specific note on the weld/engineering drawing establishes different weld criteria. Any exceptions from these requirements shall be approved by the GM Charging Materials Engineer. This specification does not preclude the supplier's responsibility for a robust joint to each specific application.

1.1.1 Welds are considered satisfactory when they carry the intended or expected service loads for a required period and meet the requirements of this specification. Any attempted application of this document for other uses, such as post-crash weld quality assessment, may lead to an erroneous result or conclusion.

1.1.2 Welds are considered discrepant when the criteria of this specification are not met. Discrepant welds shall not be re-welded and must be scrapped.

1.1.3 The welding source is responsible for establishing practices and test methods to assure that the criteria of this specification are met. Some of the requirements in this specification are referenced from ISO 13919-1 for laser welds and GMW14058 for arc welds.

1.2 Symbols. Not applicable.

1.3 Applicability. This specification applies to arc and laser welds only in the instance that pertain to stainless steel and/or nickel-based alloy turbocharger wastegate shafts and lever arms in the turbo charger assembly, Figure 1. This specification may be applicable to other material combinations given approval by the GM Materials Engineer or as specified in the statement of requirements.

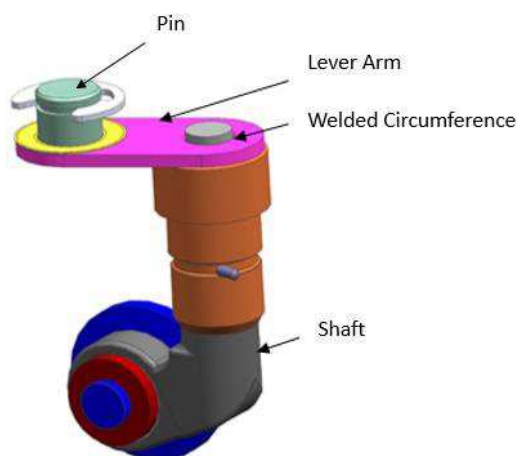


Figure 1: Example of a Turbo Wastegate Lever Arm-Shaft Assembly

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM E384 ISO 13919-1

2.2 GM Standards/Specifications.

GMW3059 GMW14058

3 Requirements

3.1 Components to be welded together shall be in an annealed and cold worked condition, but not aged, coated or plated in the welded area as these processes may interfere with weld quality. Exceptions must be brought forward to the GM Materials Engineer along with comparative microstructures and weld strength data to prove otherwise.

3.2 Requirements on Test Specimens. Requirements shall be verified on production intent arm-shafts that are made from production intent processes. Samples shall be carefully cut and polished with at least a 3 micron polishing media and etched in the appropriate etchant such as Vilella's etch. The weld start-stop location as well as 180° away from the start-stop shall be examined, see examples of microstructural photos in Figure 2 and Figure 3.

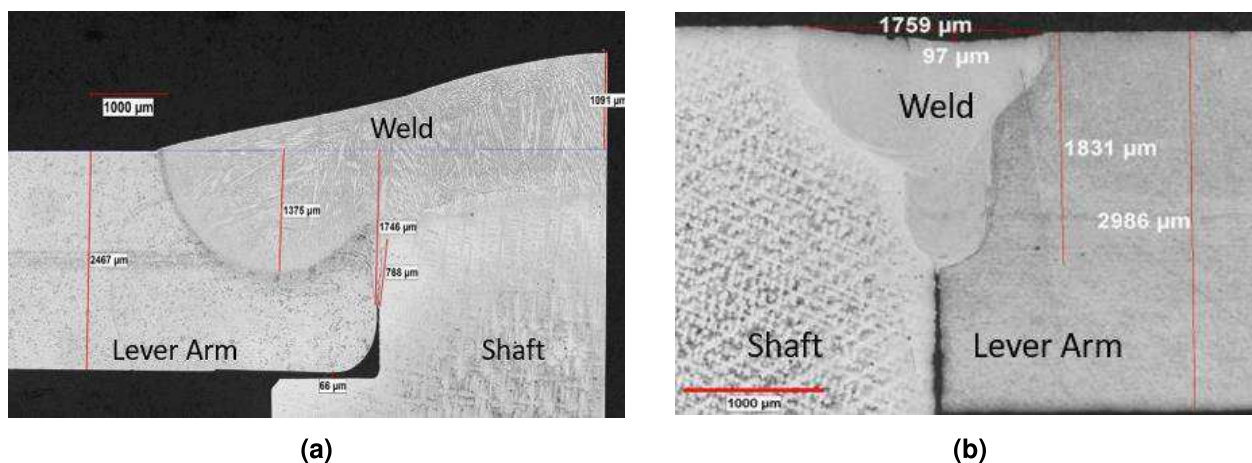


Figure 2: Examples of Microstructural Photos

3.2.1 Figure 2. Example of an arc weld (a) and laser weld (b) microstructural cross section with Vilella's etch at 25x showing depth of penetration, crack length and gap between lever arm and shaft. Note that arc welds are not typically used in combination with turbos having springs located on the underside of the lever arm due to the high heat input during welding causing damage to the adjacent spring. Also note that both welds are relatively shallow at the joint potentially resulting in less mechanical joint design strength.

3.3 Sampling Size and Frequency. The number of samples examined for part qualification shall be based on the supplier's process capability and approved by GM Engineering. Once validated, the supplier shall sample a minimum of one weld once per shift per welder. The weld needs to be revalidated whenever changes to the weld process or materials are made including but not limited to changes with: base metal composition, base metal thickness, base metal preparation such as cleaning, weld flux, weld atmosphere conditions, weld temperature, weld time, joint design, joint clearance, weld position, and post weld heat treatment if applicable.

3.4 Weld Throat. The effective weld throat is the minimum distance, minus any convexity, between any weld root and the weld face and correlates to joint strength. See Figure 3 (a) and (b) for convex and concave weld examples. The minimum weld throat shall be 70% of the arm thickness and the maximum shall be 100% of the arm thickness provided there is no heat effect on the adjacent turbine bushing spring which is located on the underside of the arm. Melting material through the bottom of the arm, called excessive penetration or drop through, is also not allowed.

3.4.1 Weld Root. The weld roots are the point(s) where penetration intersects each component being welded at the closest proximity between the parts. When there is no gap, there will only be one weld root. See red dots in Figure 3 (a) and (b).

3.4.2 Weld Toe. The junction of the weld face and the base metal. See green dots in Figure 3 (a) and (b).

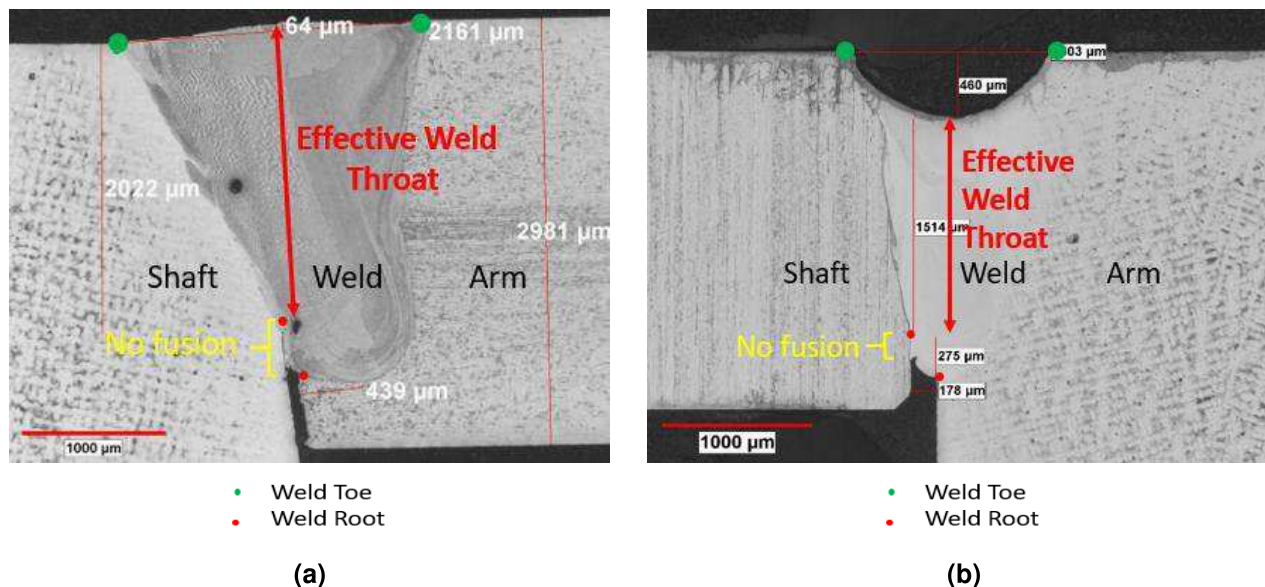


Figure 3: Examples of Weld Toe and Weld Root

3.4.3 Figure 3 (a). Weld throat of a slightly convex laser weld having a root that is offset in the arm material, see bold red line.

3.4.4 Figure 3 (b). Weld throat of a concave laser weld having a gap between parts, see bold red line. This weld is not 70% of the shaft thickness and is, therefore, discrepant. It is common to see a high degree of concavity when there is a relatively large gap between the shaft and arm; it is a result of the melted material filling in the gap.

Note: The melted material below the bold red arrow is not fusing the two parts together as indicated by a yellow bracket in each photo. Both pictures are at 25x magnification.

3.5 Continuity. The full circular seam weld shall be made in a continuous single pass when using a laser to weld. If more than one pass is used to weld, whether it is arc or laser welded, it must be reported to GM Engineering since it can create cracking and may sub-optimize the resulting microstructure. The laser weld shall have an approximate ten degree overlap at the weld start/finish location and then extend away from the joint on a tangent projection from that point as the weld energy is tapered off, see Figure 4 and Figure 5. This weld "tail" shall be located in an area of low stress and assumes that the weld is ending in a more weld-friendly material. The point of tangent projection shall be located at the point of minimum dynamic loading of the joint circle as determined by computational analysis.

3.5.1 Sometimes the welder chooses to have a nontangential weld tail in the center of the shaft, see Figure 6, which is typically an area of low stress; however, weld tails in the shaft can result in cracks if the shaft material is not as weldable due to a higher carbon content. Therefore, it is expected that the supplier will examine the weld tail after dynamic load testing to ensure that the weld is sound and no detrimental cracking starts or propagates to threaten weld integrity. This data will be necessary to review with the Charging Technical Specialist to be granted a deviation for a nontangential weld tail. No unfused areas, skips, pinholes, shrinkage cavities shall be present in the weld, nor on either side of the weld seam when the surface is examined without any sample preparation at 10x magnification. The weld solidification pattern shall be consistent and be free of restarts or sudden changes.