

STEEL FOUNDERS' SOCIETY OF AMERICA

780 MCARDLE DRIVE UNIT G
CRYSTAL LAKE, IL 60014-8155
PHONE: 815/455-8240

www.sfsa.org



Welding Steel Castings

Welding is a part of the production of steel castings. Steel castings like most steel products are welded into larger structures. Like every other steel product, steel castings are weldable. Steel castings are not like ductile iron or gray iron castings that are not weldable. To make sure that the welded steel castings meet the designer's requirements, weld procedures and welders are qualified prior to their use in steel casting fabrication or production.

All steel is cast. Steel castings are made by melting steel and casting it into a desired shape. Other steel products are mechanically shaped from cast ingots by rolling or forging into the designed shape. Then all steel products are machined and welded to integrate them into the final assembly. For any particular alloy, there is no reason to believe that a steel casting would not be as easily welded as any other product form in that alloy. In fact, steel castings do not have elongated inclusions since they have not been mechanically processed and are less susceptible to cracking after welding (R. Menon and C.D. Lundin, SFSA Research Report 96, "Weldability of Cast Carbon and Low Alloy Steels- Effect of Microstructure and inclusion Morphology on Hydrogen Induced HAZ Cracking Susceptibility," January 1985). Welding is a well developed technique in the production of steel castings. Welding quality is controlled through the use of qualified weld procedures using qualified welders. Steel castings are used in pressure vessel applications like steam boilers or nuclear power plants. Many steel foundries qualify their welders and procedures to Section IX of the ASME Boiler and Pressure Vessel Code. When steel castings are ordered to ASTM specifications they are required to be welded in the foundry to a procedure and with welders that are qualified to ASTM A488. Any steel casting grade ordered to ASTM invokes A703 or A985 for pressure castings or A781 or A957 for structural castings and standards require qualified welders and procedures to ASTM A488. (ASTM A703 8.1, A985 8.1, A957 9.1 and A781 9.1) New grades to be added to ASTM for steel casting production must demonstrate that they are weldable and include documentation about welding the grade. Weld procedure qualification in A488 requires that the weld used for qualifying the procedure must meet the strength and toughness requirements of the material ordered for the casting.

The production of steel castings regularly uses welding as only one process step in achieving the customer requirements. Complex shapes may require access ports or assembly of multiple steel cast components. Non-destructive evaluation may identify needed areas of welding. Welding in the production of steel castings is done not only to fabricate but also to process the casting to meet the purchase specification. In forging or machined products as well as steel castings, components subject to non-destructive examination may be welded if the component does not meet the required standard. Welding is a part of the production process to bring the component into compliance with the purchase quality requirements. Since steel castings are made directly from the liquid steel and the producer must manage the solidification process with chills and risers, steel castings are subject to inclusions and porosity not present in steel products made from simple ingots. Steel casting producers use welding as part of their total manufacturing process to produce the product ordered by the purchaser.

Unfortunately, steel casting producers early adopted the terminology of the welding industry and termed production welding, “repair welding”. “Repair welding can fall into one of three general categories: repair of weld defects, repair of failed parts, and repair of worn parts.”

(<http://www.asminternational.org/portal/site/www/AsmStore/ProductDetails/?vgnnextoid=41597e0e64e18110VgnVCM100000701e010aRCRD#details>)

This use of the term “repair” has led to the idea that welding in steel casting production is a sign of poor quality and is used to repair bad castings. This terminology is clarified in ISO 11970, “Specification and approval of welding procedures for production welding of steel castings.” In paragraph 3, “Terms and Conditions,” paragraph 3.2 defines repair welding- any welding carried out after delivery to the end user, i.e., after the casting has been in service. Paragraph 3.1 defines production welding- any welding carried out during manufacturing before the final delivery to the purchaser including joint welding of castings and finish welding. Welding is an additional cost like machining and manufacturing seeks to minimize the requirement for welding to lower costs and improve quality. Even so, welding is routinely used as a part of the production process to manufacture the highest quality castings.

An example of finishing welding is the “upgrading” of steel castings. This term is often used improperly. The terminology comes from the desire in the valve industry to take a standard valve in stock and “upgrade” it to a special valve. To upgrade a valve that was fully compliant as a standard valve, it must pass additional non-destructive examinations. When the standard valve does not meet the added requirements, production welding may be applied to the valve body casting to meet the requirements. The standard valve was not defective. The welding is not to fix poor quality but to allow the valve to be re-categorized as a special valve.

ASTM steel casting standards impose no restriction on steel casting producers on the use of production welding to meet specification requirements. Steel casting producers with qualified welders and procedures are free to incorporate any amount of welding in any place on the casting to achieve the purchase requirements. Often the producer will have weld procedures for alloys for use prior to final heat treatment with matching heat treat response and another procedure for after heat treatment that may require a stress relieve. Some grades in ASTM require the application of a stress relieve after a major weld. (For example A487 9.3)

Purchasers are free to add restrictions to producers. Common restrictions include the requirement for weld maps, prior approval for major welds, and no weld areas in the casting. Weld maps and the definition of major welds are in ASTM A703 S20, A781 S16, A957 S16 or A985 S20. Prior approval for major welds can be required by calling out ASTM A703 S12, A781 S7, A957 S7 or A985 S12. Specific inspection of weld cavities prior to welding is addressed in ASTM A703 S10, A781 S5, A957 S5 or A985 S10. Some pressure vessel purchasers impose a no major welds on their casting. This is misguided since a leaking casting needs to be through wall welded to assure design performance.

Your steel casting supplier can answer specific questions about welding and steel castings. Additional information in Steel Casting Handbook Supplement 6, “Repair Welding and Fabrication Welding of Carbon and Low Alloy Steel Castings,” and Supplement 7, “Welding High Alloy Castings,” is available on the SFSA website: <http://www.sfsa.org/sfsa/pubs/index.php>



Raymond Monroe, Executive Vice President