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Guidelines for specification and inspection of electric resistance welded (ERW) and seamless boiler tube for critical and noncritical service

Scope

This Technical Information Paper (TIP) covers guidelines to assure that boiler tubes for new construction and replacement, both in recovery and other boilers, are metallurgically sound and free from potentially harmful defects. Special emphasis is placed on obtaining tubing of appropriate quality for critical recovery boiler service. This service is defined as that in which tube leaks or failures can directly or indirectly lead to water reaching the smelt bed in the furnace, thereby creating the risk of explosion. Noncritical service encompasses all other recovery boiler tubing and power boiler tubing where leakage can result in increased safety risk or significant service interruption.

Boiler tube materials shown in this document are specified in the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Section II, Part A. Similar specifications are issued by the American Society for Testing and Materials (ASTM).

Background

Experience has shown that a significant number, although a minority, of in-service boiler tube failures are due to tube manufacturing defects. These defects may be associated with a specific heat or process lot and thus can affect many tubes in the boiler. They also may be limited to random tubing lengths.

The most common manufacturing defects are laminations, laps, and other longitudinal indications in seamless tubing and seam lack of fusion (LOF), laminations, and laps in electric resistance welded (ERW) tubes. Figures 1-4 show examples of LOF and laminations. Destructive testing and nondestructive inspection procedures can be used to determine whether new boiler tubes contain manufacturing defects.

ASME specifications for boiler tubes provide mandatory, optional, and supplementary requirements for purchase, quality control, and inspection. The mandatory requirements are the minimum required for the tubing to qualify for installation in an ASME Code boiler. Table 1 lists the ASME specifications for ERW and seamless boiler tubing together with the relevant nondestructive testing (NDT) specifications. The following sections of this document describe how the mandatory ASME requirements may be supplemented to obtain the tubing quality deemed necessary for critical or noncritical boiler applications.

Safety precautions

This TIP may require the use, disposal, or both, of chemicals, which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Material Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this technical information paper, the user should determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, should follow strictly the

procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

Adequate ventilation is required when working with liquid penetrant and solvent materials. Extreme care should be exercised to ensure that the work area around boiler tubes being inspected is well ventilated. Job-site inspection may involve confined space entry – mill procedures for such should be followed.

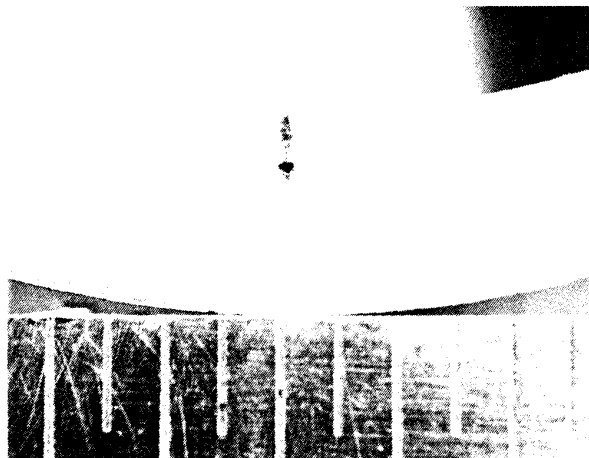


Fig 1. Macroscopic view of lack of fusion defect in SA-178 ERW tube. 7.25X, Nital Etch.



Fig 2. Lack of fusion defect with entrapped oxides in SA-178 carbon steel weld. Note fine grain size associated with fusion line of weld. 110X, Nital Etch.

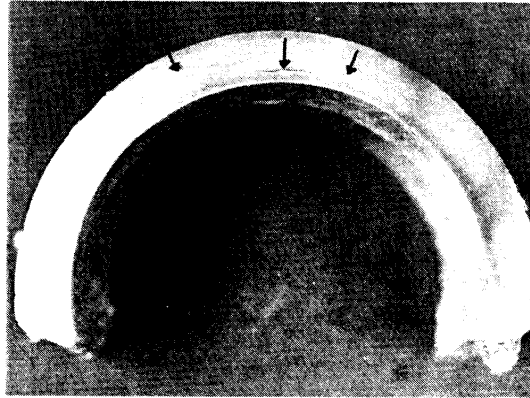


Fig 3. Metallographic cross section showing laminations in ERW tube (SA-178 material) as indicated by arrows. 2.25X, Nital Etch.

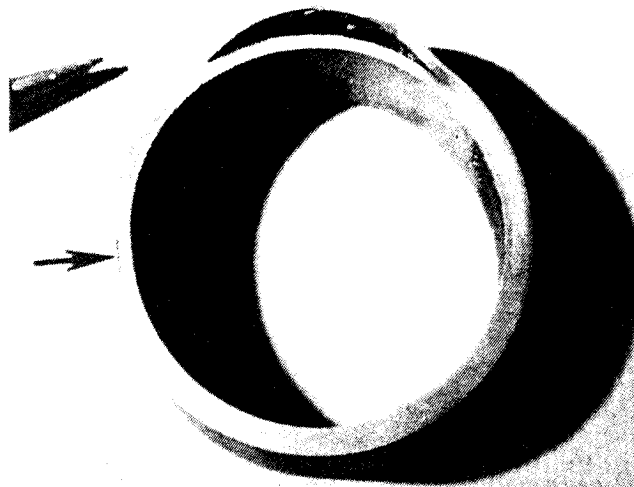


Fig 4. Cross section of boiler tube removed from service due to blister caused by lamination introduced during manufacture. Also note smaller lamination (arrow) that did not blister. 1X, Nital Etch.

Basis of purchase

ASME Section II, Part A, specification SA-450 is the primary specification for boiler tubing. It contains the general requirements for tubing and describes what should be specified when boiler tubes are purchased. ASME SA-450 governs if there are any conflicts with other tube specifications. It also provides references to other appropriate specifications when more specific information is required.

According to SA-450, the basis of purchase at least should include:

- Quantity (feet and/or number of lengths)
- Description of material specification (seamless/ERW, etc.)
- ASME tubing specification
- Material grade (A,B, T-22, TP 304, etc.)
- Size (outside diameter and minimum wall thickness)
- Unit lengths (specific or random)
- Certified test reports (chemical, mechanical, etc.)
- Optional requirements (refer to specific ASME specification)
- Special or additional requirements.