Acoustic Emission Waveguide Design

**Purpose and Description**

The sensors can not operate in the 1000-1050F temperature range generally required for online AE testing. Because of this, Acoustic Emission Consulting (AEC) uses waveguides to remove the sensor from the high temperature at the pipe surface and mechanically transmit the signal to the sensor. The waveguides we use are of a proprietary design and have been value engineered to provide optimum functionality and dependability at a reasonable cost.

The waveguides consist of a ¼” stainless steel rod compression fitted and tack welded to a stainless steel baseplate. The baseplate provides the mounting surface for the sensor, which is held firmly to the baseplate face via a spring-loaded mechanism. Waveguide length may vary for different installation requirements, but they all share these common features:

- Shaft, baseplate, and bracket: 304 Stainless Steel for durability, corrosion resistance, and low heat conductivity.
- Welded design for maximum life.
- Compression Spring and Delrin Disk holder to assure optimum contact through all testing conditions.
Installation/Spacing

When installing Waveguides on HRH piping, the preferred orientation is open face down as shown in the following diagrams on vertical and horizontal pipe segments. The reason is we want the signal cable to hang down naturally from the sensor and not force the connector in contact with the waveguide bracket.

Waveguide spacing on hot reheat piping is generally on 18’ centers, but may be as much as 22’ or as little as 10’, depending on the specific application. AEC has found that 18’ works best as a general guide. 10-12’ spacing should be used on thicker walled components like main steam lines and headers. When placing waveguides it is best to maintain a consistent distance between them. The waveguides should not be attached directly to any existing welds, including the seam welds in installations where the seam is easily seen. “Shadow” zones should be avoided, i.e. placing a waveguide directly in the plane of and between two safety valves.
Attachment

Waveguides will generally perform best when welded directly to the structure being tested, but mechanical attachment may be appropriate in some circumstances where welding is impractical. The limiting circumstances include:

- Short term monitoring – 2 weeks maximum.
- The pipe or structure to be tested must be at full operating temperature when the waveguides are installed.
- No startup or cooldown monitoring.

For best sensitivity and all other monitoring conditions welding the waveguides is recommended.

Welding Waveguides

Most utilities have chosen to use the shielded metal arc (SMAW, or “stick”) process for welding the waveguides to the pipe. Some have used stud welding with excellent results as well. AEC has a special side mount fixture available for use with the TRW Nelson stud gun with full instructions for stud welding in a separate document. GTAW or GMAW would also work, but may be impractical for this application.

There are a few general considerations that should always be kept in mind when welding the waveguides to the pipe or header. The first, and most important, is that this is a non load-bearing attachment and not essential to the operation of the unit. The weld, therefore, should be considered a sacrificial weld. With this in mind, make sure that none of the activities associated with the weld harm the base material. The weld metal should always be of a weaker material than the base metal. For this reason, do not use inconel filler, as we would quite often do on a dissimilar metal weld. Typically, for SMAW welding, an E9018 B3L low hydrogen electrode will work quite well for welding to 2 ¼ Cr. material, and an E8018 B2L for welding to 1 ¼ Cr. material. This runs somewhat counter to the general practices for qualifying code welds where the base metal should fail before the weld. A sample SMAW weld procedure is attached to provide general guidelines only.

When making a dissimilar metal weld special care should to be taken to avoid mixing the stainless with the low alloy steels in the weld pool. Please note the instructions given in the sample weld procedure.

Many utilities have chosen to weld the waveguides while the unit was on line. This is generally an acceptable practice, and there are even certain advantages to doing this, especially eliminating the need for preheat. More on this in the section to follow.
Code Considerations

The 1995 AMSE B&PV B31.1 included new rules covering the NDE requirements and post-weld heat treatment (PWHT) of non-load-bearing attachment welds. Table 132 (B) and (C) covers the PWHT requirements for non-load-bearing attachment welds. These notes permit no PWHT providing:

- Stud welds or fillet welds using SMAW or GTAW
- Minimum preheat of 250°F for P4 or 300°F for P5 material
- Low hydrogen electrodes for SMAW welding
- Throat thickness < 3/16”
- The hardened portion of the HAZ does not encroach on the min wall of the base metal, as determined by the WPQ
- The test plate thickness for the WPQ exceeds the thickness of the pipe.

Attachment fillet welds with a throat thickness less than 1/4” are exempt from PT or MT requirements per Table 136.4. Visual inspection (VT) as described in Para 136.4.2 is all that is required. Please refer to the current edition of the B31.1 for the full requirements. Other code requirements vary from state to state.