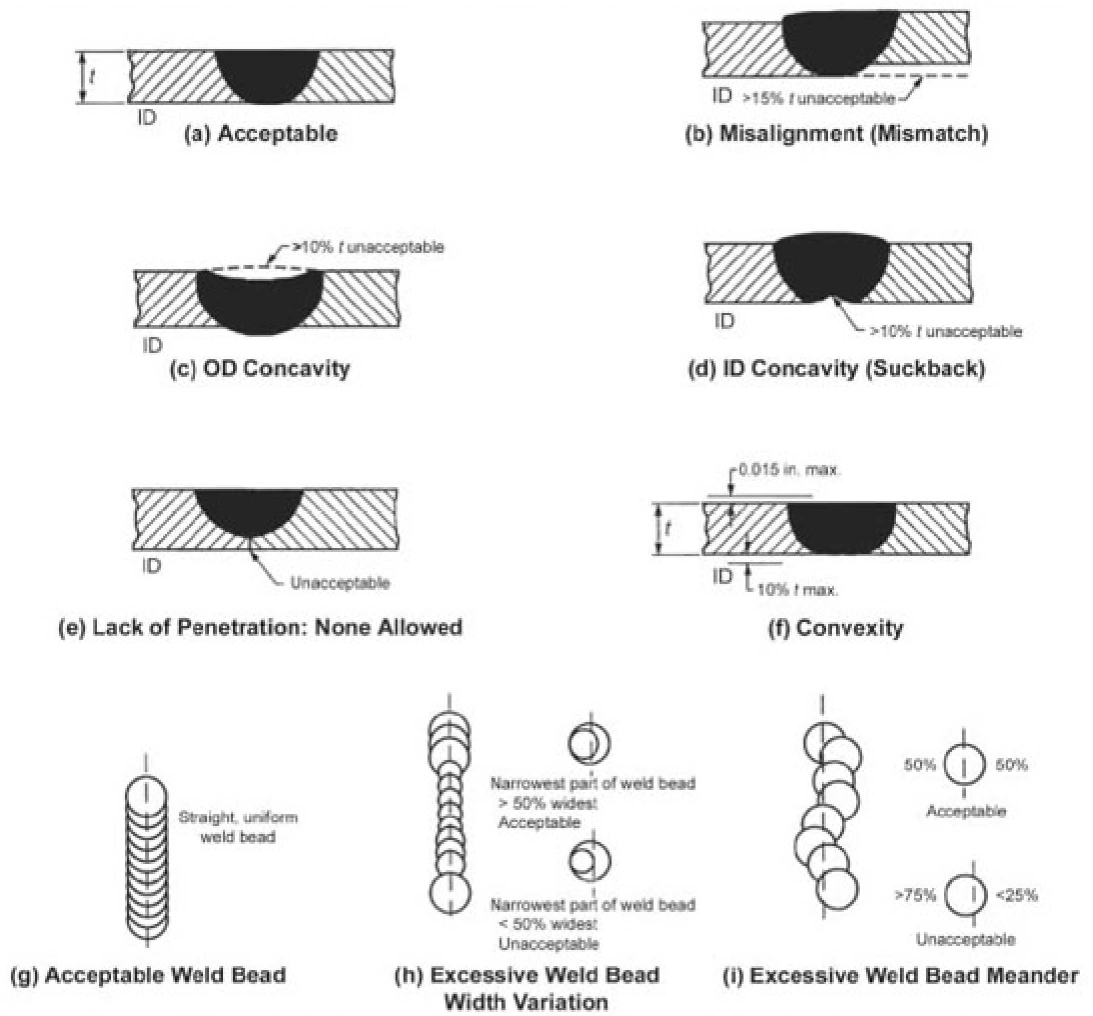
Installation



When a certified welder begins work he connects his orbital welding power supply to a dedicated circuit. He will determine the size of tubing and/or fittings or other components to be welded. The welder selects the appropriate weld head, installs the proper size tube clamp inserts (collets), and a tungsten electrode of Process Piping Installation the correct length. He then calibrates the weld head for rotational speed to the power supply. A certified argon source is used for the weld head purge which protects the outside (OD) of the weld as well as for purging the ID of the part to be welded.

Opening Coupon

Before he can begin production welding, the welder must "coupon in" or perform a sample weld on the exact same material heat which is to be installed. Even with the restricted BPE sulfur range for 316L stainless steel, there is still some variability in weld penetration from heat-to-heat and schedules for different heats may vary by several amperes. A successful coupon demonstrates to the inspector that the machine is set up properly, the purge is adequate, and the welding operator knows how to operate the equipment.

The first coupon of the day is referred to as the "opening coupon" and welders refer to this as "burning a coupon." Coupon welds must be done on an actual weld joint, not just a "bead on pipe" (which is a weld made directly on a tube without a joint) to assure that the equipment and the operator can properly align the components. When the weld is completed, the welder brushes the outside (OD) with a stainless steel brush to remove weld oxidation, removes any burrs or sharp edges from the ends of the coupon. A flow chart showing the sequence of welding, weld inspection, and weld documentation is shown in Figure 6.

Coupon Log

Every coupon, good or bad, must be recorded in a coupon log. The weld is identified by the machine used, in this case labelled A or B, with a sample weld number, for example SWA 001, the date, and the welder's ID number. The time of day, date, and material heat number, argon certification, orbital weld head, and power supply serial numbers also are recorded, and the entry is initialled by the inspector. All of this is cross-referenced to the installing contractor's weld procedure documentation. Test coupons are performed routinely if there is a change in power source, a loss of power, a change in purge set-up, or a change of welding operator. Test welds also are performed 100% of the time after a weld has been rejected before proceeding with production welding.

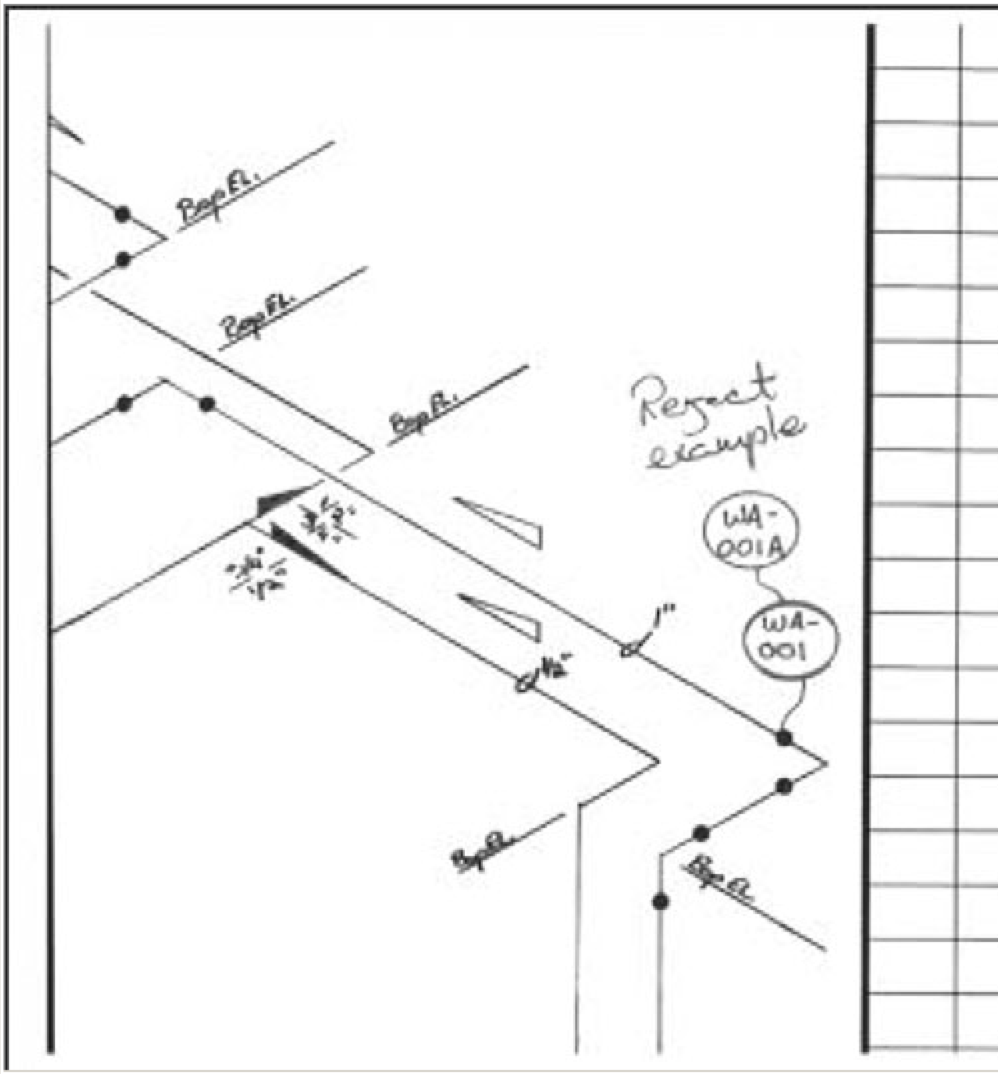


Figure 7. Example of how a rejected weld would be documented on an "iso" drawing. The first weld "window" shows the weld number which is recorded for every weld and the second window indicates that the first weld was cut out, replaced, and the number changed. Courtesy of Pro-Tech Process, Inc.

Orbital Welding of Skids

Orbital welding is used extensively in the manufacture of equipment skids such as CIP skids or skids with stills for producing WFI. A considerable amount of stainless steel tubing is used to connect the various components on the skids. All of these welds and the field welds done when installing the skid on site must meet the same welding QA requirements.

Pressure Testing

After installation and before passivation, the piping systems are pressure tested. This consists of filling the piping system with clean air, nitrogen, or argon at 150% of the design pressure or 150 psi, whichever is greater, and then monitoring the pressure decay for four hours. If there is zero drop in pressure, the system passes. This must be done with a calibrated gauge with certifications.

Passivation

The annealing portion of the stainless steel production process results in a chromium oxide surface film that is enriched with chromium and reduced in iron when compared to the base metal. During the welding process, the passive or unreactive layer is disrupted so that in the weld and in the HAZ, the distribution of elements that comprise the surface may no longer be considered as being passive. During the welding process, the iron concentration at the surface of the weld becomes elevated while the amount of chromium is sharply reduced.[9] Unless a chemical passivation process is conducted before operating the system, the corrosion resistance of the system will be compromised and rouging will occur, especially at welded sites. The purpose of a chemical passivation is to remove free iron or other anodic contaminants from the surfaces of the stainless steel such that a more uniform formation of the passive surface is obtained.
Heat tint-containing oxides of both chromium and iron are formed on the stainless steel surface during welding and must be removed or prevented. Passivation cannot completely remove even relatively light heat tint because, while passivation affects only the outer 50 Å of surface, heat tint can extend to a depth of 400 Å or more.10 Although the pitting potential of a weld with heat tint may be raised by passivation, suggesting that passivation restores the corrosion resistance lost by welding, when corrosion does occur on a heattinted passivated sample it is likely to occur preferentially in the HAZ.[10]

Mechanical grinding and pickling with a solution or paste containing a combination of nitric and hydrofluoric acid may be used to remove heat tint from the welds and HAZs. This treatment removes metal including the area beneath the heat tint which may be reduced in chromium.[11] This treatment, while effective in restoring corrosion resistance, roughens the stainless steel surface and is only suitable for use on surfaces that will be polished and passivated after treatment. Hand-held electrocleaning devices may accomplish the heat tint removal without roughening, but removes metal so dimensional tolerances may be compromised.

The most effective and practical way of retaining the corrosion resistance of a piping system during installation is to be very careful with the purging during the orbital welding operation so as to prevent the formation of visible heat tint to avoid contaminating the system especially with carbon steel tools or any other type of iron contamination, and then complete the process with chemical passivation.

Preoperational passivation is an essential step in bringing a system on line. This is especially important for preventing corrosion of stainless steel systems operating at higher temperatures, subjected to service environments where harsh chemicals such as chlorides are used, or ultrapure water. At the Sicor site, a phosphate based alkaline cleaning solution was used to remove construction debris, organic films, and surface inclusions, i.e., aluminum, sulfides, and others. Citric acid, with a reducing agent and EDTA chelant system, was used for passivating the systems that had been installed with orbital welding. In addition to removing free iron (as with nitric or other mineral acids), citric based chelant systems dissolve surface contaminants and most types of inclusions that contribute to pitting corrosion. Chelants prevent the iron from adhering to the surface so it can be readily flushed from the system. The use of citric acid chelant systems results in an excellent chrome to iron (Cr/Fe) ratio on the surface[12] and is much less problematic from an environmental and safety standpoint than nitric or other mineral acids. However, passivation cannot overcome damage done by improper purging during the welding process.