NCPWB
National Certified Pipe Welding Bureau

Technical Bulletin

April 2024

A Welder Qualification Record Says: "Backing: With or Without." What Does That Mean?

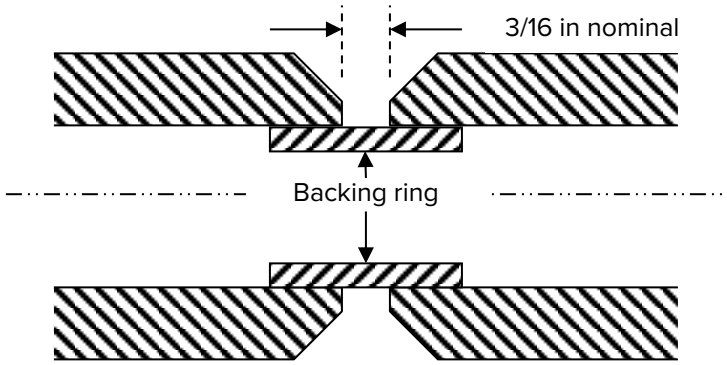
When looking at a Welding Procedure Specification (WPS) or a welder qualification record, there is always some mention of "backing." Sometimes backing is required and sometimes it is optional. It can be metal, nonfusing metal, nonmetallic or weld metal. But just what is "backing?" Let's look at some definitions:

- **ASME Section IX** (published by the American Society of Mechanical Engineers) defines backing as a material placed at the root of a weld joint for the purpose of supporting molten weld metal to facilitate complete joint penetration. The material may or may not fuse into the joint. See *retainer*.
- **AWS A3.0** (published by the American Welding Society) defines backing as a material or device placed against the back side of the joint adjacent to the joint root, or at both sides of a joint in electroslag and electrogas welding, to support and shield molten weld metal. The material may be partially fused or remain unfused during welding and may be either metal or nonmetal.

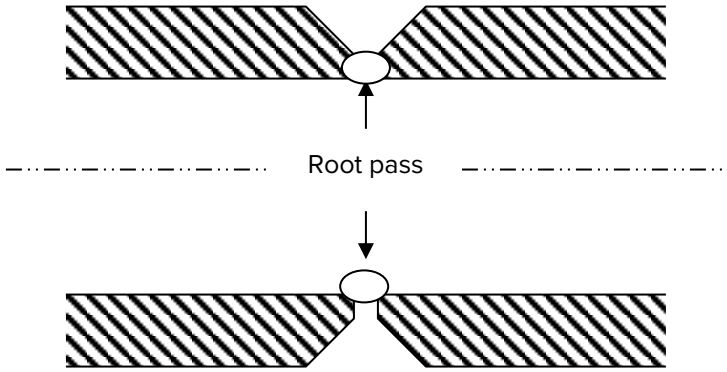
The definitions are similar, but the key words are "material…to support molten weld metal." So, any material that provides support to the molten weld pool is "backing" for that weld pool. Note that backing gas is not a *material*, so welding with a backing gas is not welding "on backing."

Welding Procedure Specifications (WPSs) always address backing. Backing must be used for some processes like submerged arc since the arc is so hot that the weld metal will run out of the joint and make a mess if there is not some material at the root to support it. When backing is "required" on the WPS, it can take the form of a backing ring or strip, or it can be weld metal previously deposited by another process. Fillet welds are considered as welding "on backing," and socket welds are fillet welds.

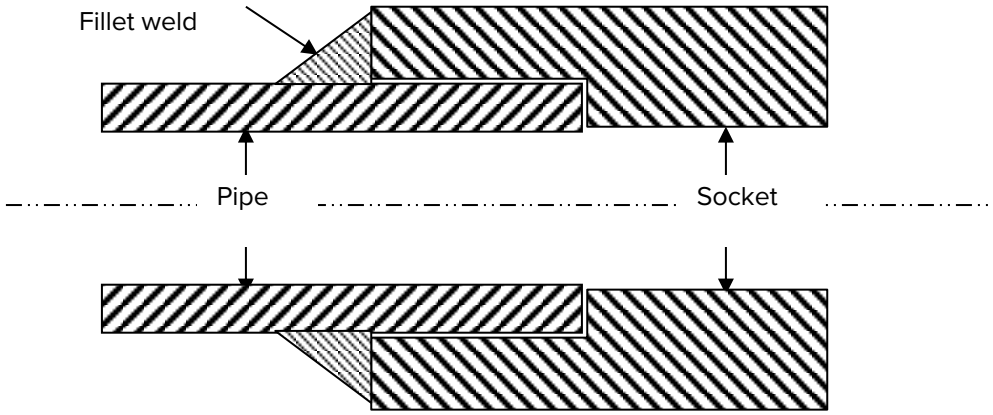
Groove Weld on a Backing Ring



Root Pass Made Without Backing Using Another Process or Electrode Type Provides Backing for the Rest of the Weld



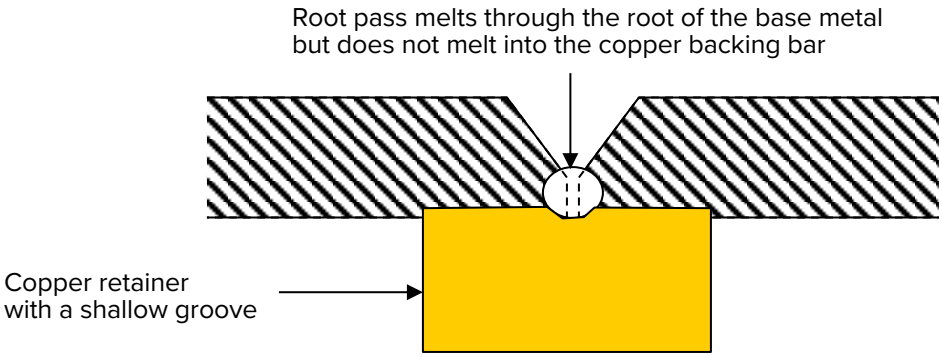
Socket Welded Joint



Another approach when welding from one side of a joint is to use nonfusing metal or nonmetallic retainers. A “retainer” serves the same purpose as backing except that it is always removed after the root pass is completed.

A nonfusing metal retainer is typically a large, thick bar of copper. It is placed at the root of the weld just like a large steel backing ring, but because the root spacing is small, the arc does not impinge on the copper backing bar so the weld metal does not melt into the bar; since the liquid weld metal that drops through the groove is quenched by the copper backup bar without melting into it (this is what makes the copper bar “nonfusing”), the bar can be easily removed afterwards. One can also use a high-temperature stable nonmetallic material like ceramic or fiberglass tape and do the same goal.

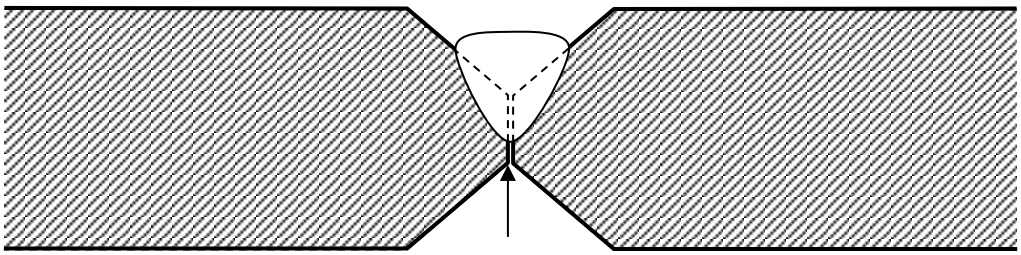
Single Vee-Groove Weld Made Using Massive Copper Backup Bar Retainer



Neither nonfusing metal nor nonmetallic retainers are used commonly in pipe butt welding since removing them after welding would be a serious challenge. They are, however, used in making longitudinal seam welded pipe and for vessel work.

When welding pipe that is large enough to get inside and work comfortably or for vessels and tanks, welds are commonly made from both sides of a joint because fitting-up and aligning the joint is easier, and it takes less weld metal to make the joint. When this approach is taken, the members to be welded are beveled so that the root face (land) is large enough that the weld metal does not penetrate through the joint. This joint is usually backgouged and/or ground from the opposite side of the first weld to sound metal in preparation for welding from the second side.

Double Vee-Groove Showing Thick Root Face (Land)



Backgouge or grind from this side to sound metal before welding on this side

Because the joint design of a partial-penetration groove is similar to the double-welded joint in that the root face is thick enough to support the liquid weld pool, a partial-penetration groove weld is considered welding “on backing.”

Whether or not backing is used during qualification of a welding procedure does not matter since the purpose of qualification of a procedure is to demonstrate the properties of the weld. In contrast, whether a welder uses backing during his test or not is a measure of his skill and ability to deposit sound weld metal. Since the skill level required to weld without backing is greater than that required to weld with backing, a welder who qualifies without backing is qualified to weld with backing.

If a welder tests using backing of any sort during his test, he may only weld on joints that have backing. That means that a single-welded groove-weld test coupon with a backing ring or a groove-weld test coupon that is welded from both sides (such as a plate test) are considered welding “with backing.” On the plate test, even if the welder welds that coupon with an open root, because he also welds from the second side, that makes the test coupon “on backing.” In a similar vein, if a welder “cleans up” the root side of a pipe test coupon by grinding the root to remove incomplete fusion or burn-through, he is not qualified without backing since he will not be able to do the same grinding on production welds.

If a welder welds a fillet weld test coupon, that is also considered welding on backing, but because a fillet weld test only qualifies a welder to make fillet welds, the welder would never weld without backing anyway.

How about a root pass put in with one process using open root (i.e., no backing was used) and completing the weld using a second process? If this was what the welder did on a test coupon, the welder is only qualified to weld open root (i.e., without backing) using the first process; obviously, he may only use the second process on backing since backing was used for the second process. If this example is a production weld, the welder who makes the root pass must be qualified to use the root process without using backing (i.e., his qualification test record must show backing as "optional," "not required," "with or without" or similar) for that process. The fill process may be deposited by a welder who is qualified with or without backing.

A variation on the above can occur with a single welding process when there are different electrodes used for the root and fill passes. The most common example of this is when the root is put in with E6010 and the fill passes with E7018. The E6010 has a strong, digging arc; E7018, on the other hand, has a much softer arc, and it is sufficiently different from E6010 that each electrode type must be separately qualified. The codes assign the E6010 electrode F-number 3 and E7018 F-number 4, and they require separate qualification for each F-number classification. So, when a weld must be made without backing (i.e., open root) and welding procedure specifies using E6010 for the root, the welder must have been qualified using E6010 open root (i.e., without backing). Typically, a welder who tests using E6010 (F-3) open root will weld the rest of his test coupon using E7018 (F-4) for the balance of the weld. This welder may only weld using F-4 electrode types on backing since the welder only demonstrated his ability to weld using F-4 type electrodes on backing.

When using gas tungsten arc (TIG) welding, a welder may weld without backing if he tested without backing; however, there are several variations of welding without backing when using TIG. The welder may weld:

- Using an open root with no backing
- Using a consumable insert
- Using a square groove joint without backing such as is common with schedule 10 piping.

Since the skill required for these variations is different, the Codes require separate qualification for each variation. That is, while a welder who qualifies using a consumable insert is only qualified to weld using a consumable insert, that welder may also weld on backing since that is an easier weld to make. A welder qualified to weld using a square groove without the addition of filler metal may only make welds using a square groove without adding filler metal.

Welder qualification records show what a welder may do in the "Range qualified" column based on whether the welder used backing is his test or not. If the welder used backing, the range qualified is "required," and that means that the welder must use backing in production welding. If the welder tested without backing (i.e., "open root"), the range qualified is "optional" or "with or without" which means that the welder may weld both with and without backing.

Readers should keep in mind that there are other variables that affect what a welder may do in production, such as diameter, thickness, uphill/downhill, backing gas, etc. These other variables also limit what the welder may do in production, and these limitations are shown in the 'Range Qualified" column of the welder qualification record.

This article was prepared by Walter J. Sperko, NCPWB's Technical Consultant. The information presented here represents his opinion, not the opinion of the ASME or AWS committees on which he serves. Questions about welding may be directed to him at (336) 674-0600 or at walt@sperkoengineering.com.