

What Are Welding Procedure Specifications?

Think of a welding procedure specification as the recipe for successful welds

BY ALBERT J. MOORE JR.

This article is the first of a series aimed at helping you understand the concept of Welding Procedure Specifications (WPSs) are, how to write them, and how to use them. This first article defines the types of Welding Procedure Specifications. The second will focus on essential and nonessential variables. Article three will cover qualifying a WPS by testing, and the fourth article will help you write a WPS that, in the author's words, "will do more than collect dust."

Every CWI and SCWI knows the welder should follow a welding procedure specification (WPS) if he or she is working to a welding code such as AWS D1.1, *Structural Welding Code — Steel*, or the *ASME Boiler and Pressure Vessel Code*. Many welders are unaware of what a WPS is and how it influences their work. Maybe we should include manufacturers and contractors in that last sentence because there are more than a few who have little to no understanding of what WPSs are or why they exist.

The first step in our journey to a better understanding of the WPS is to provide a working definition of what it is. Simply put, it is a recipe for making a weld that meets the requirements of a welding code or standard. It is a written document that provides the welder with information needed to make a weld with the mechanical properties required to meet "code" in a consistent manner.

Those who make their living creating welds have their own opinion of what information should be contained in a WPS. A welder who uses the WPS may have an opinion that differs substantially from what an engineer believes the WPS needs to include. Everyone involved with welding has an opinion of what belongs in a WPS.

A Recipe for Success

So how do we decide what a WPS actually should contain? Let's return to the paragraph where we defined a WPS as "a recipe for making a weld." With that in mind, let us consider the information provided in a cookbook containing a recipe for brownies. Why brownies? Because with brownies we have a common frame of reference since nearly everyone, welders and engineers alike, enjoys brownies and most everyone has a fairly good idea of how they are made. The cookbook does not sim-

ply list the ingredients. It also lists the quantity of ingredients so the cook knows how many eggs, and how much flour, sugar, etc., goes into the batter. It tells the cook the order in which to mix the dry ingredients and then it instructs the cook how to incorporate the wet ingredients. Still, even that is not enough information. The cookbook tells the cook how large a pan is needed, to preheat the oven to 350°F, and to grease the pan. The recipe tells the cook how long to bake the brownies, and it even goes so far as to tell the cook how to test the batter to determine if the brownies have baked long enough. Most likely you remember how to test the batter to see if it is completely baked: Stick a toothpick into the center of the batter-filled pan, pull it out, and if there is batter clinging to the toothpick, bake it a little longer.

So why did we spend so much time talking about baking brownies? The answer is simple: Depositing a sound weld is a lot like making brownies. Unless you have memorized the recipe, you need to review it before you start baking. Likewise, the welder should follow a recipe to make a sound weld. For that recipe to be of value to the welder, it must contain all the information he or she needs to know to make a weld. Keep in mind, however, that just as it is presumed the cook knows the basics of cooking, the WPS presumes the welder knows the basics of welding.

Rich in Details

The recipe for welding — from now on we'll call it by its correct name, Welding Procedure Specification, or its abbreviation WPS — should be as detailed as a recipe for baking. The WPS should provide the welder with all the information needed to make a sound weld with the mechanical properties required by the code. So, what does the welder need to know? For a start, the welder needs to know what welding process is to be used. It is also necessary that he or she knows what base metal or metals are being welded and what filler metal, if any, is going to be used. If a gas shielded welding process is to be used, the welder needs to know what shielding gas to use. Certainly, in addition to which shielding gas is required, the welder needs to know what flow rate and what size gas nozzle are required, and if a root purge is needed. What weld type is needed, fillet weld or groove weld? If a groove weld is specified, what groove angle

ALBERT J. MOORE JR. (AMoore999@comcast.net) is vice president, Marion Testing & Inspection, Canton, Conn. He is an AWS Senior Certified Welding Inspector and an ASNT ACCP NDT Level III. He is also a member of the AWS Certification Committee and the Committee on Methods of Inspection of Welds.

and what root opening are to be used? As you can see, the list gets rather long and detailed.

To make life easier for the person writing the WPS, the codes typically specify the welding variables that have to be addressed. The welding variables are separated into two primary groups, essential and nonessential variables. An essential variable is one that has a profound influence on the mechanical properties of the completed weld whereas a nonessential variable is one that does not have a significant influence on the mechanical properties. The WPS must address both types of variables.

The Different Types of WPSs

There are several types of welding procedure specifications. The first type are those WPSs that have been validated by testing. That is, the WPS has been put to the test by welding a sample, then subjecting that sample to a regimen of tests to verify it is free of defects and the mechanical properties meet the minimum requirements of the applicable code or standard. The third article in this series presents more details on how the WPS is qualified by testing.

The second type of WPS is one that is prequalified by the applicable code. This type of procedure has to meet certain limitations and requirements listed in the code. They are based on acceptable historic use. For instance, they have to utilize base metals that have a history of good weldability and utilize a listed welding process that has a history of successful use. The filler metals must have matching mechanical and chemical properties, and the joint details have to be selected from the approved

joint details, etc. A WPS that meets prequalification status is exempt from testing and can save the contractor or fabricator substantial time and money.

There are standard welding procedure specifications (SWPS) that are available from AWS for a fee (www.awspubs.com). A few are recognized by welding codes such as the ASME *Boiler and Pressure Vessel Code*. These WPSs are supported through tests performed by various contractors and fabricators. The use of a SWPS minimizes the costs associated with doing a complete welding procedure qualification, but there are limits on their application.

When the application is very specialized and it is nearly impossible to qualify the WPS in the normal manner, a mock-up might suffice. The mock-up would be subjected to different tests than required for a normal WPS. The specifics of the testing regimen is usually agreed upon by the manufacturer/fabricator and the customer/owner.

Summary

So, what have we learned? The WPS is a written instruction intended to provide the welder with the information needed to create a weld that complies with the applicable welding code or standard. There are several types of WPSs. Some are prequalified and can be used without qualification testing. There are WPSs that are qualified by testing a sample weld. There are Standard WPSs that have been qualified by testing by other companies, and there are WPSs that are qualified by testing a mock-up of the weldment required for production. ❖