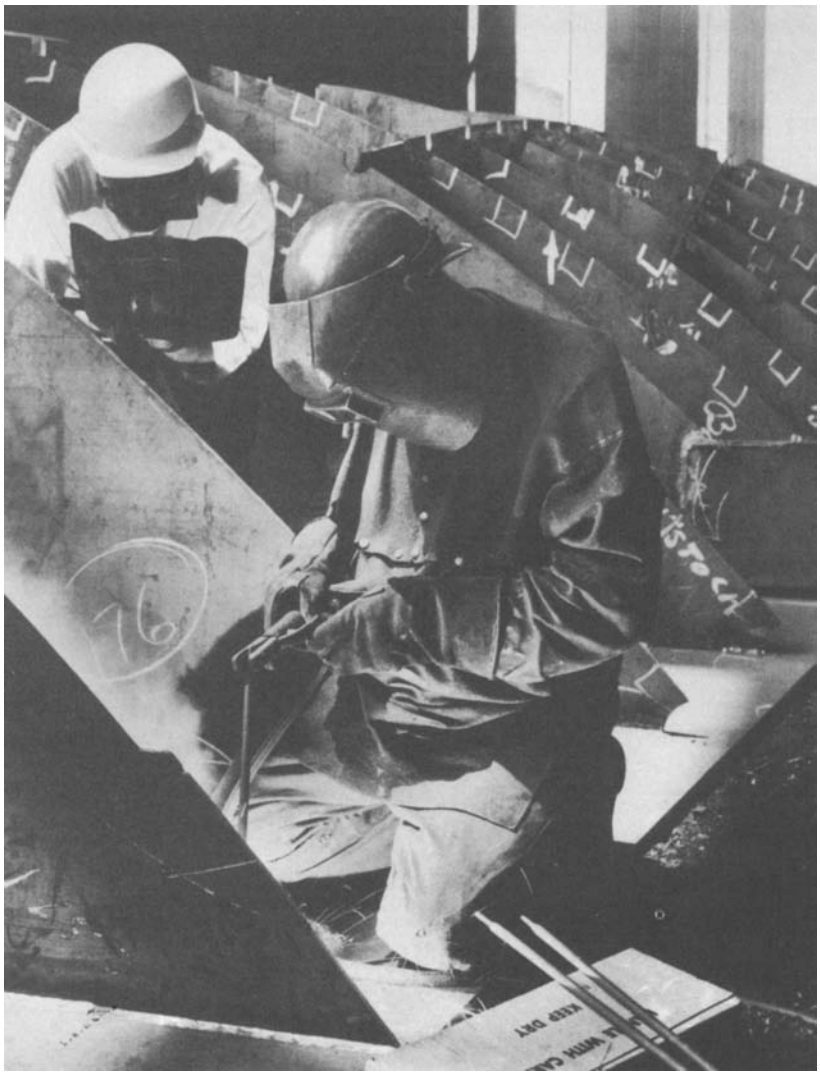
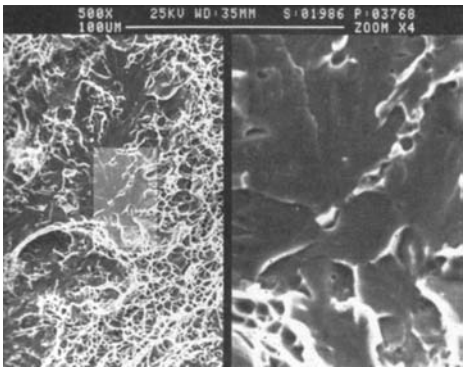
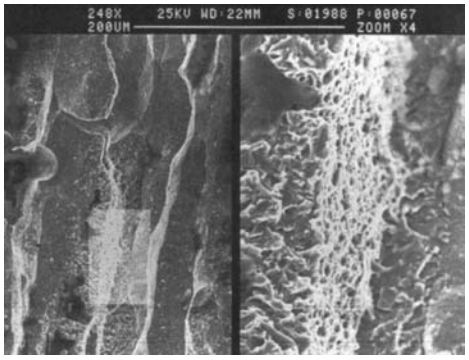
American Welding Society

Guide to Weldability







Carbon and Low Alloy Steels

GUIDE TO WELDABILITY:

CARBON and LOW ALLOY STEELS

How to get the needed results and stay out of trouble

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INTRODUCTION

You are responsible for the operation of an independent fabrication shop, a similar facility within a manufacturing organization, or a maintenance facility in a factory of any type. "Things" are brought to you to fabricate or repair. This guide is intended to help you ask the right questions, and from the answers, select the method, materials, and procedures that will produce the result desired from your "customer," or direct you to more comprehensive guidance that may be needed to produce the desired results.

ACKNOWLEDGMENTS

Most of the information in this reference guide is condensed from information in the current edition of *The Welding Handbook* and *Welding Metallurgy*, Linnert Volume 1, both published by The American Welding Society. Additional sources include AWS D1.1/D1.1M:2004, *Structural Welding Code—Steel*, Jefferson's Welding Encyclopedia, 18th Edition, The Lincoln Electric Company *Procedure Handbook of Arc Welding*, and the *ASM Handbook, Volume VI*.

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Cover photomicrographs courtesy of the AWS *Welding Journal*, and welding a structure with the SMAW process photograph courtesy of the AWS *Welding Handbook*, Vol. 2, 8th Edition, "Welding Processes."

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CHAPTER 1
The Questions (you need to ask)

What is the product and how will it be used?

In other words, what does the product do? Is the weld a simple connection that bears a light static (non-fluctuating) load, or are the welds subject to highly fluctuating loads so that a small defect could grow into a crack and cause a catastrophic failure? Will it be subjected to low temperatures, e.g., winters in the north where temperatures well below 0°F can be encountered? (Some steels become brittle at such temperatures.)

What is the material?

Find out what specification is used to purchase the steel. Some of the more common types of steel are discussed in Chapter 2. If there is no specification, ask if the material is "plain carbon steel" or "mild steel," or (at the other extreme) "tool steel." In most cases, the former materials are relatively easy to weld and somewhat "forgiving." The latter materials require extreme care if they are to be welded satisfactorily.

There are some simple tests to help determine the general class of material that you have, but there is no substitute for the actual composition or the purchasing specification.

What specifications or codes apply to the welding rods or electrodes (wires), and to the finished product, if any?

Most general fabrication is covered by agreement between the customer and the fabricator, with applicable specifications on drawings and related notes. However, you need to know if the work is covered by a code or specification that has legal standing and/or requires approval of a third party, which may require qualification of procedures, operators, materials, or other factors. Examples are the AWS D1.1/D1.1M:2004, *Structural Welding Code—Steel*, the American Society of Mechanical Engineers (ASME) *Pressure Vessel Code*, various U.S. Military Standards, and others. If you see reference to such codes and standards on drawings, notes, or specifications, you and your customer need to reach an agreement on how these requirements will be handled. Certification, qualification, or conformance to such "third party" requirements is covered in detail by each code, and is outside the scope of this guide.

Are there welding procedure requirements? Make sure you understand what is required!

Your customer may require the use of:

- a specific welding process,
- a specific welding material (type and perhaps even the brand or manufacturer),
- a specific range of welding conditions,
- "qualified" welding operators (qualified by whom and to what standard?),
- a written welding procedure subject to the customer's approval.

NOTE: Even if your customer does not require a formal procedure, you should consider preparing one. Then, test your operators to ensure that they can produce satisfactory welds using the procedure. A sample form for preparing an internal record or "control document" is included in Part 8 of this guide. Such a record has many benefits, especially if the job is to be repeated. The control document can be particularly useful if there are problems with the finished product on inspection or in service.

What are the postweld requirements?

Postweld requirements are as follows:

- Specific inspection and/or testing of the finished product,
- A specific post-weld heat treatment, e.g., stress relief,
- Painting, plating, or other surface treatment.