

Lens shade selector

Operation	Shade No.	Operation	Shade No.
Soldering	2	Nonferrous	
Torch Brazing	3 or 4	Gas Tungsten-Arc Welding	
Oxygen Cutting		Gas Metal-Arc Welding	
up to 1 in.	3 or 4	$\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$ in. electrodes	11
1 to 6 in.	4 or 5	Ferrous	
6 in. and over	5 or 6	Gas Tungsten-Arc Welding	
Gas Welding		Gas Metal-Arc Welding	
up to $\frac{1}{8}$ in.	4 or 5	$\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$ in. electrodes	12
$\frac{1}{8}$ to $\frac{1}{2}$ in.	5 or 6	Shielded Metal-Arc Welding	
$\frac{1}{2}$ in. and over	6 or 8	$\frac{3}{16}$, $\frac{7}{32}$, $\frac{1}{4}$ in. electrodes	12
Shielded Metal-Arc Welding		$\frac{5}{16}$, $\frac{3}{8}$ in. electrodes	14
$\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$ in. electrodes	10	Atomic Hydrogen Welding	10 to 14
		Carbon-Arc Welding	14

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PIPELINE WELDING**Meeting Today's Quality Requirements For Manual Vertical Down Techniques**

Pipelines are inspected more critically than ever before, and today's radiographic equipment and techniques produce clearer radiographs with greater sensitivity than in the past. Although codes have not changed drastically, interpretation standards have been upgraded. The combination of more rigorous inspection, better testing methods, and high acceptability standards often approaches an attitude requiring zero defects.

This poses some serious problems because the job of welding cross-country pipelines under typical conditions has always been an extreme challenge requiring specialized and highly developed skills. Now that the demands are greater, even the best welding operators are having trouble. Rejectable defects usually require cutting out the entire weld. This is expensive and can cost competent pipeline welders their jobs.

The purpose of this bulletin is to discuss some of the more common reasons given for rejecting a pipeweld and to suggest what may be done to correct some of these conditions.

Change in attitude

Any discussion on this subject should begin by accepting the fact that the standards are higher than they were a few

years ago. Therefore, it will take a change in the attitude of the welders and everyone else involved if this new level of quality and workmanship is to be met. In turn, a commitment to new methods, equipment, and theory will be required by all concerned.

Importance of joint preparation

It must be recognized that all joint preparation details (Figure 6) are critical and any variation could directly contribute to rejected welds.

Without good cooperation from those who prepare the pipe edges and the line-up crew, the welder has very little chance of meeting today's rigid inspection requirements. Too often the attitude exists that variations in fit-up and joint preparation are permissible and that the welder can compensate for them. This attitude cannot be tolerated. It puts too much responsibility on the welder and inevitably leads to rejects.

Recommended procedures for properly cleaning pipe

For lowest cost and highest quality, careful attention to the cleaning of pipe joint surfaces is critically important.



Courtesy of Pipeline & Gas Industry.

Today's pipe welders face pipe that may be covered with a variety of coatings; these include primers, epoxy, tar, paper, varnish, rust, scale, or moisture.

While joint cleanliness is important in all welding, it is especially so in the root pass of pipe. Even a thin film of contaminants, which may be difficult to see with the naked eye, may be present. Failure to recognize and properly clean joints can result in a hollow bead or other welding defects.

Follow these instructions to minimize costly defects:

1. Remove all moisture and condensations of any type prior to welding. The joint must be completely dry.
2. Clean BOTH ends of the pipe **INSIDE AND OUT** to remove traces of paint, rust, scale, oil, epoxy, or organic materials. The area to be cleaned should extend at least 1 inch (25 mm) from the end of the bevel (per ANSI/AWS D10.11-80 Page 1) on both the **INSIDE** and **OUTSIDE** surfaces.
3. A recommended method for cleaning in the field as described above is the use of a heavy duty straight shaft grinder with a rubber expanding wheel and a carbide coated sleeve. The small shaft and reduced overall weight allows easy access to the inside and outside surfaces of the pipe.

Internal undercut

See Figures 1 through 5 for x-rays of the various defects that can cause rejects. Of these, one of the most common and troublesome is internal undercut (undercut on the inside of the pipe). This is understandable because it occurs on the "blind side" and the operator cannot see it happening. Consequently, he cannot immediately do anything to correct it. To make matters worse, he seldom gets a chance to see the x-ray negative or the actual weld itself. All of this makes it difficult for him to correct the situation.

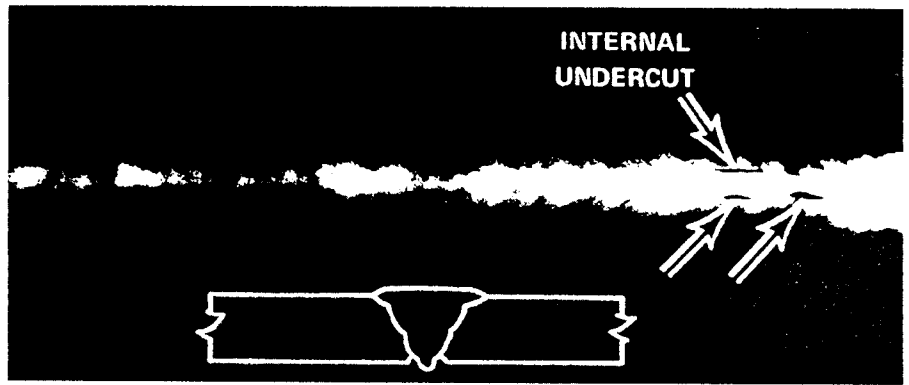
Undercut may be the direct result of poor joint preparation or fit-up. If the joint does not conform to the details specified in the established procedures (see Figure 6), every reasonable effort should be made to correct it before starting to weld.

Internal undercut will tend to occur if:

1. The root face (Land) is too small.
2. The root opening is too large.
3. If a severe high-low condition exists.
4. The current is too high.

When any undesirable variation occurs in the joint preparation, the normal reaction is to compensate for it by

Figure 1. Radiograph of internal undercut. This defect may be intermittent or continuous (Figure 2) and either on one side or both sides of the weld centerline.



WHEN RADIOGRAPHS ARE INDICATIVE OF POOR WORKMANSHIP, BEST RESULTS CAN BE OBTAINED BY SHOWING THE RADIOGRAPHS TO THE WELDER SO THAT HE OR SHE CAN UNDERSTAND WHAT HE OR SHE IS DOING WRONG AND CORRECT IT.

Figure 2. Radiograph of internal undercut and the lack of penetration that tends to occur at a stop and start.

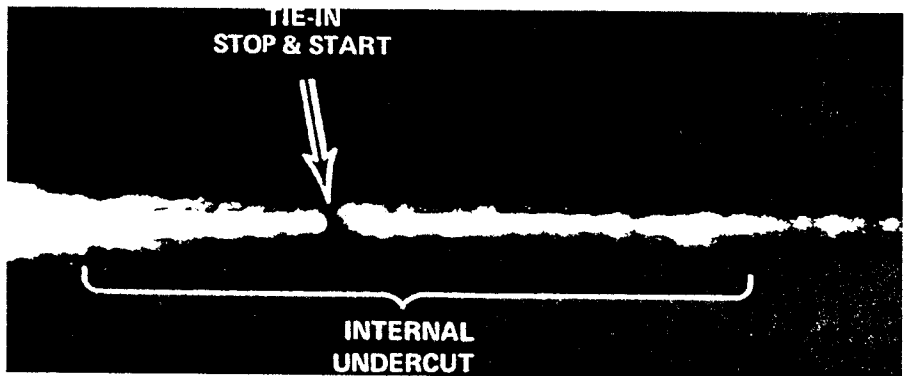


Figure 3. Radiograph of lack of penetration on the stringer bead appears as a single, straight, dark line.

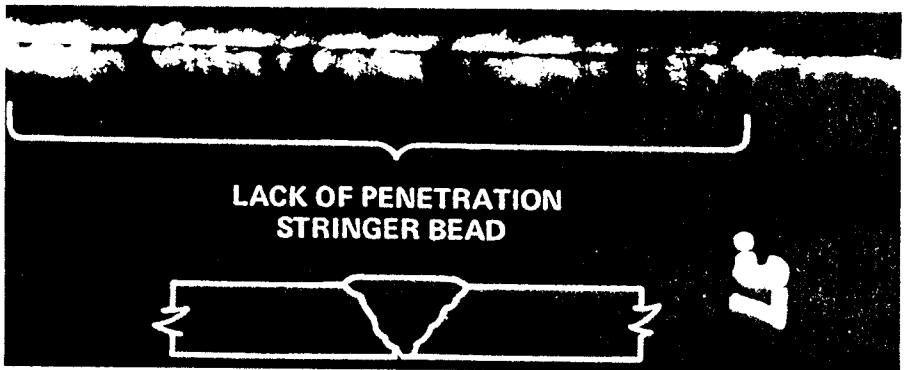
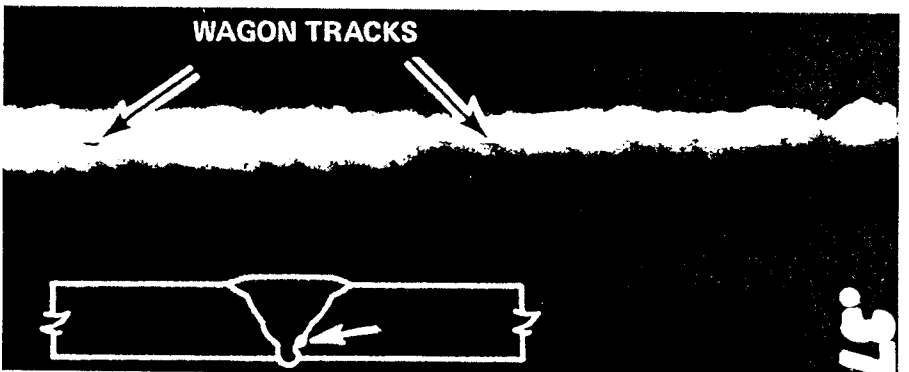


Figure 4. Radiograph of unfilled wagon tracks. Distinguishing between this defect and internal undercut required skill and experience.



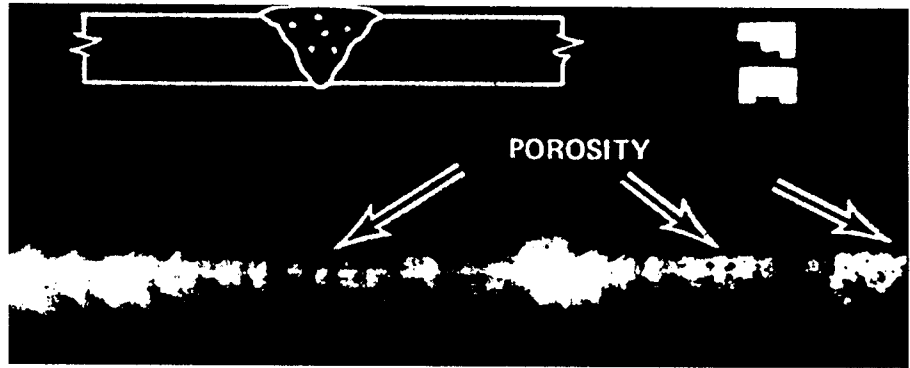


Figure 5. Radiograph of porosity.

juggling the root spacing. Within limits, this can be fairly effective. For example:

Condition	Change in Root Spacing
Land too small.	Decrease root spacing.
Land too large.	Increase root spacing.
High-low condition.	Decrease root spacing.
Bevel too small.	Increase root spacing.

A skillful line-up crew can be helpful in juggling the root spacing to bring about the most favorable results, but this has limitations. And it is at best a poor substitute for a uniform and consistent joint preparation.

Internal chamfer

It is important to remove any burr or overhang on the inside edge of the pipe after the root face has been machined

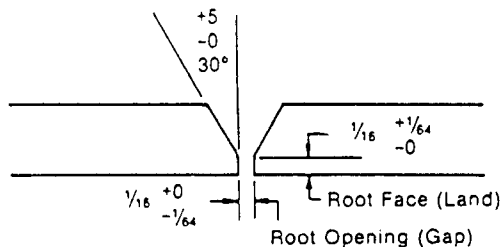


Figure 6. Recommended joint preparation and typical procedures—operate within these tolerances to help ensure good-quality welds.

Pass	Electrode ⁽¹⁾ In. (mm)	Current ⁽²⁾ Amps DC(+) ⁽³⁾	Alternate Stringer Bead Procedure Amps DC(-) ⁽⁴⁾
Stringer Bead	1/8 (3.2) ⁽¹⁾ or 1/32 (4.0) ⁽²⁾	90 — 120 140 — 185 ⁽¹⁾	85—115 115—140
Hot Pass	1/32 (4.0)	160 — 185	—
Fill and Stripper	3/16 (4.8)	160 — 190	—
Cap Pass	3/16 (4.8)	150 — 180	—

- ⁽¹⁾ Fleetweld 5P+, Shield-Arc® HYP or 70+ suggested depending upon the pipe steel requirements and contractor specifications.
- ⁽²⁾ The ideal current should be selected from within the range shown. In general, the best quality will be obtained by operating at the lower end of the range. Hot pass currents up to 200 amps are often used but cause early coating breakdown and larger stub losses.
- ⁽³⁾ Use 1/8" (3.2 mm) diameter electrode for stringer beads when the wall thickness is .250" (6.35 mm) or less and when the gap is too small to permit use of the 1/32" (4.0 mm) size [1/4" (3.2 mm) diameter electrode should also be used on other passes when the wall thickness is .250" (6.35 mm) or less; however, 1/32" (4.0 mm) diameter can also be used on fill and cap passes on .250" (6.35 mm) wall].
- ⁽⁴⁾ Weld stringer bead at 23-25 arc volts and 10-16 in/min arc speed. Measure arc voltage between the pipe and electrode holder.
- ⁽⁵⁾ Polarity — DC (-) (negative polarity) should be used for stringer bead welding when burn-through, internal undercut and hollow bead defects are a problem. These problems generally occur on thin wall pipe steels containing over .1% silicon. Lower currents are used with DC(-) which helps to reduce these problems. Travel speeds with DC(-) will be equal to travel speeds with DC(+).

Hot pass and all other passes should be run DC(+) (positive polarity).

Welding DC(-) (negative polarity) on the stringer bead will not be harmful to either mechanical or metallurgical properties.

General Guidelines for Power Source Adjustment (SA- and SAE Machines)

In general, the "Current Range" or "Current Control" switch (whether a tap or continuous control), should always be set as low as possible to get the current wanted, and the "Fine Current Adjustment" or "Job Selector" control (which controls open circuit voltage) should be set as high as possible. It is usually better to set this control (for OCV) at the mid-point or higher for best arc stability and fewest popouts.

When using a Lincoln SA-250 engine driven power source, it will normally be necessary to set the "Current Range Selector" tap switch one position lower than used on a Lincoln SA-200 power source to get the same operating characteristics.