We Take the Hard Out of HARDFACING

LINCOLN® ELECTRIC

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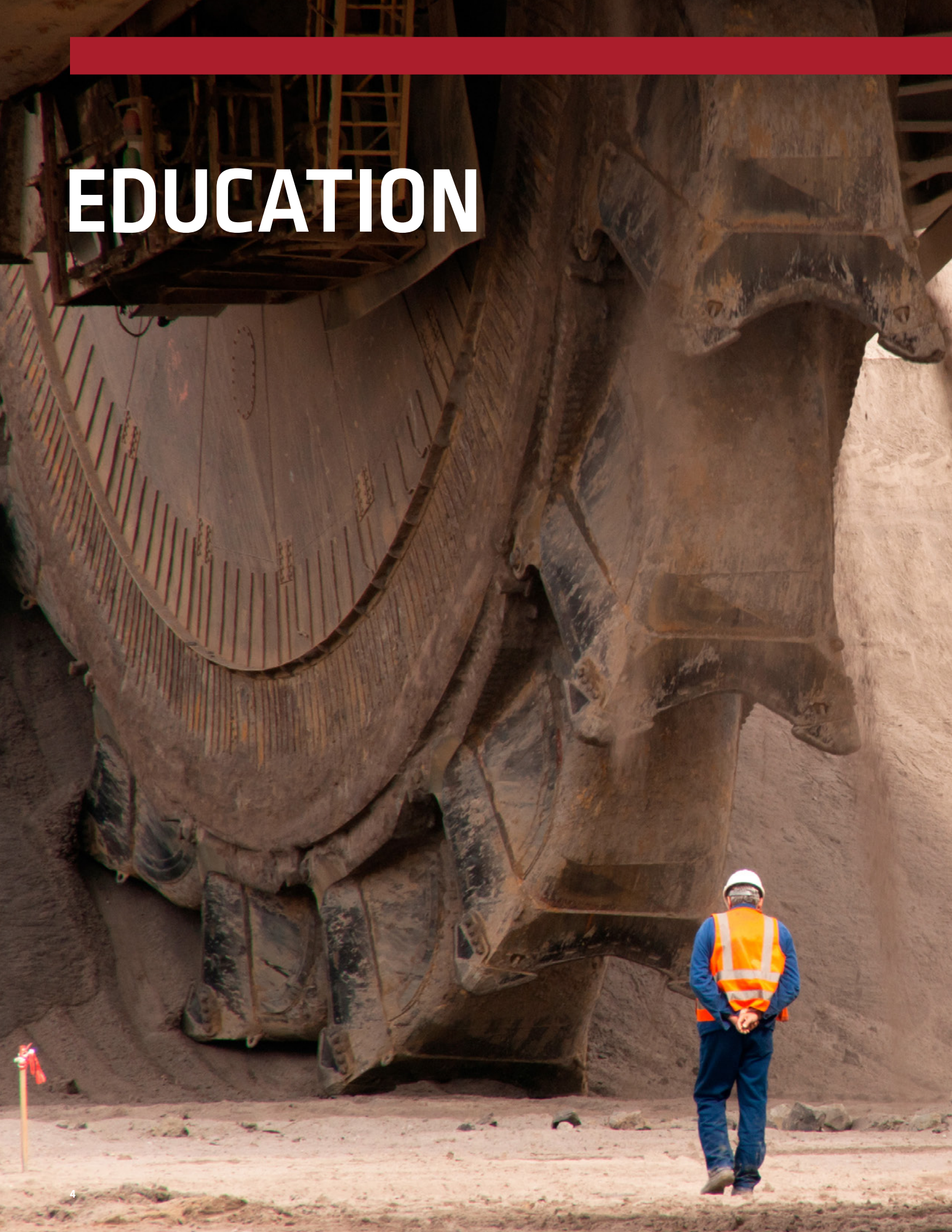
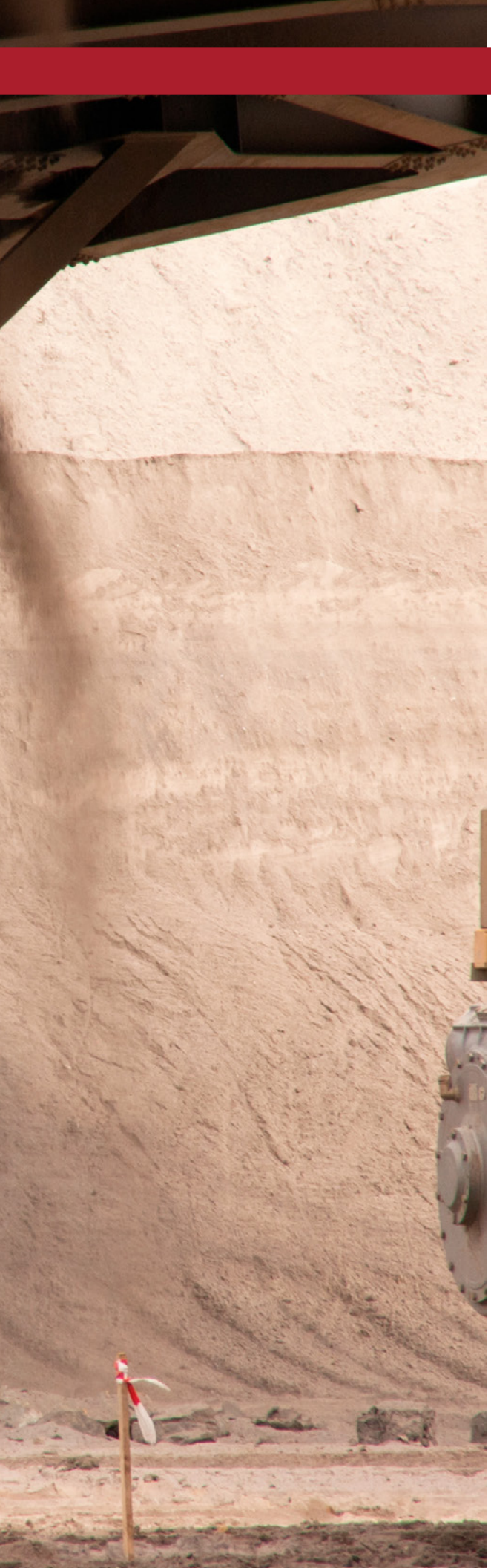
EDUCATION





Benefits of Hardfacing

Hardfacing is a low cost method of depositing wear resistant surfaces on metal components to extend service life. Although used primarily to restore worn parts to usable condition, hardfacing is also applied to new components before being placed into service.

In addition to extending the life of new and worn components, hardfacing provides the following benefits:

- Fewer replacement parts needed
- Operating efficiency is increased by reducing downtime
- Less expensive base metal can be used
- Helps reduce overall costs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Build-up and Hardfacing

Restoring worn parts frequently involves the following three steps:

1. **Buttering**

For a deposit that will dilute the carbon and alloy content of base metal.

2. **Build-up**

Seriously worn areas should be rebuilt close to working size using tough, crack-resistant welding materials which can be deposited in an unlimited number of layers.

3. **Hardfacing**

Wear resistant surfaces deposited on the base metal or on build-up deposits extend service life. Hardfacing is usually limited to two to four layers.

Cladding or Weld Overlay (WOL)

Cladding operations deposit weld metal on the surface of the base material to extend the service life of the part, while most arc welding processes are used to join two pieces of base material.

Cladding can be used to enhance the wear resistance or corrosion resistance of a base material. With cladding, the material deposited is often different than the base material.

Lincoln Electric offers arc, hot wire and laser hot wire solutions for cladding operations.

Consumable Selection

Choosing a hardfacing consumable involves the following considerations:

1. BASE METAL

Primarily affects the choice of build-up materials

- Manganese steel is used for components subject to high impact loading. Rebuild to size using manganese steel weld deposits
- Carbon and alloy steel components are rebuilt to size using low alloy build-up deposits
- Stainless steel and cast iron base materials may also be addressed for build-up deposits

2. ARC WELDING METHOD

The choice of arc welding method depends primarily upon the size and number of the component(s), available positioning equipment and frequency of hardfacing.

Available methods are as follows:

- **Manual Welding** using Wearshield® stick electrodes requires the least amount of equipment and provides maximum flexibility for welding in remote locations and all positions.
- **Semiautomatic Welding** uses wire feeders and self-shielded or gas-shielded, flux-cored Lincore® electrodes increasing deposition rates over manual welding.
- **Automatic Welding** requires the greatest amount of initial setup, but provides the highest deposition rates for maximum productivity. It can be done with combinations of Lincore® wires and Lincolnweld® submerged arc flux:
  - Neutral flux and alloy wire
  - Alloy flux and mild steel wire
  - Self-shielded or gas-shielded flux-cored wire used with or without flux

Hardbanding

One example of severe abrasion is specific to the energy segment. Hardbanding operations deposit a wear-resistant alloy to the surfaces of drill pipe and drill collars segment drill pipe and drill collars to combat frictional abrasion between the drill string and casing or the drill string and the earth.

Hardfacing layers are typically added using advanced and specialized mechanized handbanding equipment.

3. TYPE OF WEAR

The primary consideration in selecting the final hardfacing layers is the type of wear to be encountered in service.

These include:

Corrosion

Corrosion is often defined as the degradation of a metal by a chemical or electrochemical reaction with its environment. The effective wear is often a result of a combination of wear types. Corrosion is commonly addressed by cladding, often with austenitic stainless steels and nickel-based alloys.

Build-Up

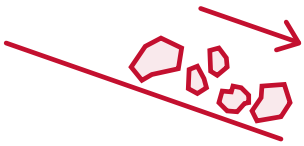
Severely worn areas can be rebuilt close to working size dimensions using tough, crack-resistant welding materials which can be deposited in an unlimted number of layers.

Metal-to-Metal Friction

Wear from steel parts rolling or sliding against each other with little or no lubrication.

Severe Impact

Wear from severe pounding which tends to squash, gouge and crack the surface. Manganese steel deposits, which work harden in service, provide the greatest impact wear resistance.



Abrasion Plus Impact

Wear from gritty material accompanied by heavy pounding which tends to chip or crack, as well as grind, away the surface.

Severe Abrasion

Wear from gritty materials which grind or erode the surface. Severe abrasion is often accompanied by heavy compression or moderate impact. Hard deposits are required to resist abrasion but they may also need substantial impact resistance.

Metal-to-Earth Abrasion

Wear from soil or aggregate materials accompanied by moderate impact (pounding).

Common Hardfacing Considerations

FACTORS TO BE CONSIDERED WHEN SELECTING A SUITABLE WELDING PROCESS

Welding Equipment Type

- What welding equipment is available?
- Is the equipment amperage range adequate for hardfacing?

Process Preference

- Does your equipment or preference lead you to SMAW stick welding, FCAW-S or FCAW-G semi-automatic welding or SAW mechanized welding?

Consumable Availability

- Do you have a knowledgeable Lincoln Electric technical sales representative, regional alloy sales specialist or distributor hardfacing specialist nearby to assist with consumable selection?

Consumable Diameter

- Which SMAW stick or wire diameter is best for your application?

Wire Process Selection

- If wire welding, which wire process is best for your application?
- FCAW-G Gas-shielded wire, FCAW-S open-arc wire or SAW submerged arc wire?

Operator Skill

- What is the level of your the operator's welding skill, process knowledge, hardfacing knowledge?

COMMON HARDFACING PROCESSES

SMAW (Stick)
Shielded Metal Arc Welding

GTAW (TIG)
Gas Tungsten Arc Welding

PTAW (Powder)
Plasma Transferred Arc Welding

GMAW (MIG)
Gas Metal Arc Welding

GMAW-C
Gas Metal Arc Welding with a cored wire

Welding Location

- Are you welding indoors or outdoors?
- Is there proper and adequate ventilation and/or fume extraction equipment?

Welded Component Configuration

- What is the size, shape and the area to be hardfaced?

Deposit Thickness

- What is the desired deposit thickness or final dimensions?

Deposition Rate

- Do you have specific production targets that determine a target depositon rate?

Welding Position

- Can the component be moved into the flat position for welding or must the weldment be welded out-of-position?

Machining Requirements

- What are the final surface requirements?
- Is machining required? To what resolution?

Desired Bead Finish

- Will welding beads be left without grinding or machining?
- Will the welds be visible?
- Are there surface finish requirements for appearance?

Component Preparation

- Have the parts been previously hardfaced?
- Is there paint, oil or dirt to be addressed?

Preheat And Post Welding Treatments

- Will the part benefit from specific pre and post heating and cooling practices to achieve maximum hardness, maximum service life or crack resistance?

FCAW
Flux-cored Arc Welding

FCAW-S
Flux-cored Arc Welding with a self-shielded wire

FCAW-G
Flux-cored Arc Welding with a gas-shielded wire

SAW
Submerged Arc Welding, using a wire and flux combination

HVOF
High Velocity Oxygen Fuel Coating – typically used with a powder or wire

Thermal Arc Spray Process
Typically generating an arc between two wires

Applying the Weld Deposits

1. CLEANLINESS

Remove rust, dirt, grease, oil and other contaminants from the surfaces to be welded.

2. SURFACE PREPARATION

Badly cracked, deformed or work hardened surfaces should be removed by grinding, machining or carbon-arc gouging.

3. DEPOSIT THICKNESS

Avoid excessive build-up of hardfacing deposits or they may crack and break off rapidly in service. If thick deposits are needed, use the appropriate build-up materials before hardfacing.

4. PREHEAT AND INTERPASS TEMPERATURE

The combination of alloy content, carbon content, massive size and part rigidity creates a necessity to preheat in many build-up and hardfacing operations. (See the chart of recommended preheats at the end of this publication.) Slow cooling may also be needed. Low or minimum preheat, low heat input, and low interpass temperature are used on Manganese steels.

CAUTION

- Manganese steel becomes brittle if overheated. While a 100°F to 200°F preheat may be required, do not allow interpass temperatures to exceed 500°F
- Some alloy steel components require a specific heat treatment to perform properly in service. This must be considered when preheating and welding. Contact the part maker for information

5. DISTORTION

A small amount of distortion can destroy the usability of some parts. Rigid bracing, pre-bending, skip welding and other distortion control techniques may be required.

6. WELDING PROCEDURES

Obtain the recommended typical operating procedures from the appropriate Lincoln Electric product literature or from procedures and techniques referenced in this manual. The procedures and techniques listed are general guidelines for specific applications. Final responsibility must be that of the builder/user.

FUMES AND GASES can be hazardous to your health.

- Fumes from the normal use of this product contain significant quantities of potentially hazardous compounds. See consumable product label/insert
- Keep your head out of the fumes
- Use enough ventilation and local exhaust to keep fumes and gases from your breathing zone and the general area
- An approved respirator should be used unless exposure assessments are below applicable exposure limits

BEFORE USE, READ AND UNDERSTAND THE MATERIAL SAFETY DATA SHEET (MSDS) FOR ANY PRODUCT AND SPECIFIC INFORMATION PRINTED ON THE PRODUCT CONTAINER.

Rockwell hardness tester

COMMON HARDFACING TESTING METHODS

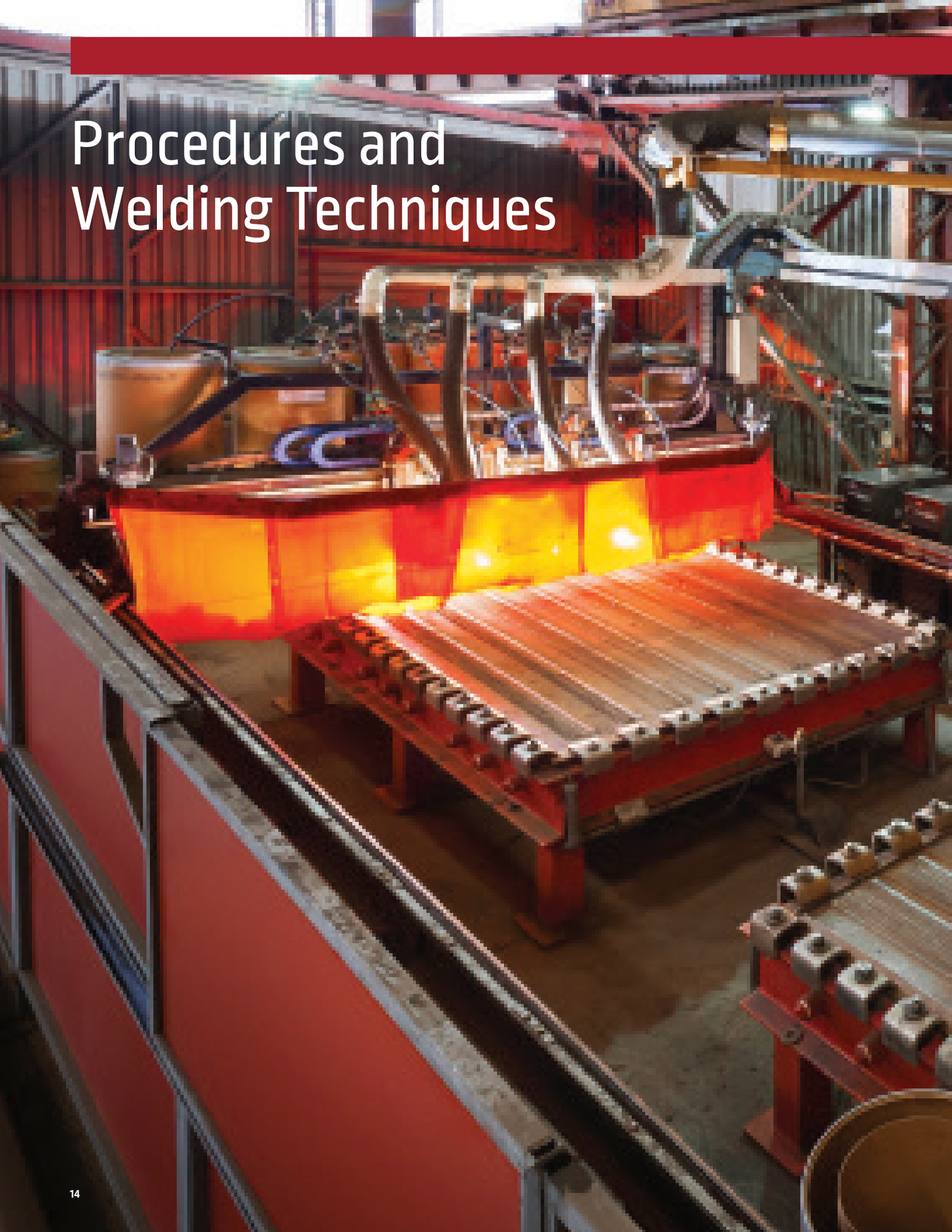
Rockwell Scale

The Rockwell Scale is designed to put a score on the measure of penetration of an 'indenter' on a surface. In welding, the Rockwell C scale, noted by R_c, provides a resulting numeral score. When applied to testing on metals, the R_c score tends to correlate with tensile strength.

G65 Abrasion Test

The ASTM G65 test is designed to measure sliding abrasion wear on a surface. In this test, under moderate pressure, dry sand is metered between a rubber wheel and a block coupon of the hardfaced material under test. The result is a score for sliding abrasion wear-resistance by measuring the volume loss of material in cubic millimeters. In this test, the greater the wear resistance, the lower the volume loss and resulting score, allowing comparison between different hardfacing deposits.

Procedures and Welding Techniques



Process Selection

MANUAL ELECTRODE WELDING

Recommended:

For irregular shapes, out-of-position welding, low volume applications, and many small parts.

Advantages:

1. Highly versatile because it handles:
   - Nearly any shape or contour
   - All positions. However, positioning for downhand welding is recommended
   - Small or large parts
   - Any deposit pattern
2. Inexpensive equipment. Requires only minimum fixturing and any conventional welder: rectifier or engine driven. DC polarity is recommended, but AC can be used with many electrodes.

Limitations:

1. Labor costs are relatively high because deposition rates are lower than mechanized processes.
2. Human error can result in poor weld quality or a rough surface.

SEMI-AUTOMATIC AND AUTOMATIC WELDING

Recommended:

For large or repeated applications when labor savings offset equipment costs.

Advantages:

1. Low weld costs due to high deposition rates and fast welding speeds can enhance production.
2. Consistent weld quality and a smooth surface are assured by mechanical guidance and automatic controls.
3. Semiautomatic welding with Lincore self-shielded electrodes (no granular flux or shielding gas) approaches the versatility of stick electrode welding. Lincore gas-shielded flux-cored or metal-cored wires can typically add greater deposition and an improved bead appearance.
4. Almost any conventional semiautomatic or automatic welder can be used.

Limitations:

1. Welding equipment costs can be substantial. Fixturing is also often required.
2. Submerged arc welding is limited to the flat position or roundabouts. Its ability to weld contours and odd shapes is limited.

General Guidelines

Remember, when considering steps to avoid spalling and cracking problems, you are usually depositing the buildup layer on the base metal and the hardfacing on the buildup metal.

Wearshield Mangjet, Wearshield 15CrMn, Lincore M and Lincore 15CrMn deposits are manganese steel.

Wearshield BU, Lincore BU or BU-G, Lincore 30-S, Lincore 33 and Lincolnweld H-535/L-60 deposits are low carbon, low alloy steel.

If underbead cracking becomes a problem when rebuilding high carbon or other crack-sensitive steel, an initial buttering layer with Excalibur® 7018, Innershield®NS-3M or mild steel flux and wire may be needed.

THE BUILDUP MATERIALS

Some hardfacing deposits have a limited practical deposit thickness. Therefore, rebuild badly worn parts to within 3/16–3/8 in. (4.8mm–9.5mm) of original size before hardfacing.

Choice of the buildup material depends primarily on the base metal of the part as follows:

- Buildup Manganese Steel Parts with Wearshield Mangjet, Wearshield 15CrMn stick electrodes or Lincore M or Lincore 15CrMn flux-cored wire.
- Buildup Carbon and Low Alloy Steels with either Wearshield BU stick electrode, Lincore BU-G, Lincolnweld H-535 submerged arc flux and L-60, Lincore 30-S/801 flux or Lincore 33.

PREPARING THE SURFACE

Remove grease and oil with a solvent and rust and dirt by wire brushing.

If not removed, these contaminants can cause porosity, cracking and poor deposit quality.

To provide a good bond between base metal and weld, remove cracks, remains of old high alloy hardfacing deposits and badly work hardened or distorted surfaces by arc gouging or grinding. Fill cracks, gouges and surface depressions by manual welding. Use Wearshield BU or Lincore BU-G on carbon and low alloy steels or Wearshield Mangjet on manganese steel.

PREHEAT AND INTERPASS TEMPERATURE

Most applications require preheating, as a minimum to bring the part to room temperature of 70–100°F.

Medium to high carbon and low alloy steels may require higher preheat to prevent underbead cracking, weld cracking, spalling, or stress failure of the part.

Higher preheat and interpass temperature are also needed for massive or rigid parts and when cracking actually occurs. Determine the preheat necessary for each job by consulting the Preheat Recommendations table on page 32 of this guide.

NEVER OVERHEAT MANGANESE STEEL. KEEP INTERPASS TEMPERATURES BELOW 500°F (260°C). Avoid prolonged and concentrated heat input in any single area. Overheating manganese steel can lead to a brittle condition.

Surfacing cast iron parts requires special procedures.

HOW TO APPLY PREHEAT

Preheating is done with gas or oil torches, ovens, or electrical heating devices, depending upon the size of the part and the equipment available.

It does no good to heat a part, then let it cool before welding. Always be sure the area to be surfaced is at the specified temperature when starting to weld.

Checking the temperature of the part during welding may be needed to be sure it has not cooled.

Interpass temperature is the temperature of the surface when welding all layers except the first layer. It is just as important and should usually be as high as the preheat temperature. NEVER OVERHEAT MANGANESE STEEL. KEEP INTERPASS TEMPERATURES BELOW 500°F (260°C).

PATTERN OF DEPOSIT

Using an appropriate bead pattern can help move more material and extend the equipment life. Here are a few general rules:

- The best pattern is usually the one most economical to apply.
- Since pattern affects shrinkage stresses, it can be used to help control distortion and cracking tendencies.
- A pattern with openings between beads is practical when the openings fill with the abrasive material in service.
- On jobs like crusher rolls, beads placed on the rolls across the flow of material help pull the material through the rolls.
- Beads placed parallel to the flow of abrasive material smooth the flow to reduce wear.

BUILDUP

Badly worn surfaces are normally rebuilt to within 3/16 in. - 3/8 in. (4.8 mm - 9.5 mm) of original size before hardfacing.

Admixture and Cooling Rate

Small beads made with small electrodes and low currents have fast cooling rates and low admixture of base metal into weld metal. Using two layers reduces admixture in the final layer.

Welding Edges

Molten metal, slag, and granular submerged arc flux tends to spill off the edges, particularly when the part is hot. Eliminate spillage by surfacing the edges first before the part becomes hot or else clamp copper bars or flux dams along the edges. Run beads along the edge rather than perpendicular to it for smooth welds.

TO OBTAIN THE DESIRED WEAR RESISTANCE, CONTROL ALLOY CONTENT AND COOLING RATE

How to Control Alloy Content

Carbon and alloy content are controlled by both procedures and admixture. Admixture of the electrode metal to the base plate has a very important effect on the wear resistance of the weld deposit. Effective weld metal composition is listed for deposits having the recommended number of weld passes. Lincore self-shielded wires and Wearshield stick electrodes produce consistent weld metal composition despite procedure variations within full normal ranges. A single layer of a highly abrasion resistant material, like Wearshield 60 or Lincore 60-O will not be nearly as abrasion resistant (due to dilution) as a second layer. Lincoln® SHS® electrodes and wires can produce high abrasion resistance in the first layer.

How to Control Cooling Rate

Although cooling rate affects wear resistance of some deposits, it is much more important for the control of spalling, cracking and distortion. Therefore, a slow cooling rate may be required even if it reduces wear resistance.

Methods of controlling cooling rate include the following:

- Preheating is the most effective way of slowing the cooling rate.
- Heat input from welding slows cooling by raising the temperature of the part.
- Insulating the hot part immediately after welding with dry sand, lime, glass fiber blanket, etc. slows cooling. This method helps minimize residual cooling stresses, weld cracking and distortion but does not affect wear resistance of most deposits. Remember also, large parts pull heat away from the weld more quickly than small parts. They naturally cool the weld faster.

Lincore self-shielded wires and Wearshield stick electrodes produce consistent weld metal composition despite procedure variations within full normal ranges

TO AVOID WELD SPALLING

Spalling is the breaking of weld metal particles away from the base metal or previous hardfacing layers. Particle size varies from small chips to large pieces right down to the base metal. Spalling normally occurs only in service.

1.

Prepare the Surface

As in production welding, hardfacing welds must have a sound crack-free bond with the base metal. Therefore, clean the surface and repair cracks and surface damage.

2.

Avoid Underbead Cracking

Rapid cooling from welding temperature can cause brittle, crack-sensitive, heat-affected zones in some types of base metal. These zones tend to crack in service causing spalling. To avoid this problem, preheat as specified.

3.

Apply a Layer of Austenite Before Depositing Hardfacing

This can be Type 309 stainless or highly alloyed austenitic manganese, such as Wearshield 15CrMn stick electrode or Lincore 15CrMn flux-cored wire. Standard austenitic manganese, such as Wearshield Mangjet stick electrode or Lincore M flux-cored wire, may not provide enough alloy for austenite in a single layer over carbon or low alloy steel.

4.

Limit Deposit Thickness

Thick hardfacing deposits build up shrinkage stresses resulting in a greater tendency for spalling. Do not use more hardfacing layers than specified for each type deposit. If thicker deposits are required, utilize more buildup before hardfacing. Peen each layer of thick buildup deposits to relieve stresses.

TO AVOID UNDERBEAD CRACKING

Underbead cracks are small cracks that can occur in the heat affected zone of the base metal under the weld. The cracks do not usually show on the surface, but can cause spalling or cracking of the part in service.

Occurrence of underbead cracking depends primarily upon the carbon and alloy content of the base metal. See the preheat section below for specific preheat recommendations. Use of the non-low hydrogen electrodes — Wearshield 60, Wearshield ABR and Wearshield MM — may require 100–300°F (40–150°C) higher preheat than the other Lincoln Electric buildup or hardfacing materials. However, welding with these electrodes on hot buildup layers usually eliminates potential problems.

The easiest way to prevent underbead cracking is to slow the cooling rate by preheating. Always be sure the part is at least up to room temperature [70–100°F (20–40°C)] before welding. Use higher preheats if specified for your particular base metal below. When the base metal analysis is known, you can determine recommended preheat more closely using the Preheat Calculator available at lincolnelectric.com

Completing all buildup and hardfacing without long delays is recommended to keep the part hot. This minimizes danger of cracking and reduces the potential need for additional preheating.

Submerged arc welding, particularly with the Spreadarc™ attachment, is a high heat input process. It heats the part, slows the cooling rate and reduces underbead cracking problems. Spreadarc is not recommended on manganese steel.

PREHEAT RECOMMENDATIONS

Low Carbon Steel (to approx. 0.30%C)

1. Slightly hardenable. Preheat 70–300°F (21–149°C).
2. Preheat heavy parts of over .20%C to 200–300°F (93–149°C). Use the higher temperature for massive, rigid or complex parts.

Medium Carbon Steel (approx. 0.30 to 0.45%C)

1. Moderately hardenable, especially in large parts and heavy sections.
2. Preheat to 300–500°F (149–260°C). Use the higher temperature for higher carbon contents and for large, rigid or complex parts.

High Carbon Steel (approx. over 0.45%C)

1. Highly hardenable and crack sensitive in all sizes and shapes. Preheat to 500–800°F (260–427°C). Use the higher temperatures for the higher carbon contents and for large, rigid or complex shapes.
2. When carbon content is near .80%, deposit a buttering layer with Excalibur 7018 or a mild steel submerged arc flux and electrode prior to depositing buildup or hardfacing layers. The buttering layer minimizes underbead cracking danger and provides a good bond between base metal and hardfacing deposits.

The easiest way to prevent underbead cracking is to slow the cooling rate by preheating.

Low Alloy Steel

1. Varies from medium hardenable to highly hardenable depending upon carbon and alloy content. Preheat to 100–500°F (38–260°C). Use the higher temperatures for higher carbon and alloy contents and for large, rigid or complex shapes.
2. Preheat temperatures up to 800°F (427°C) or a buttering layer may be required if the carbon content is over .35%C.

Manganese Steel (12-14% Manganese)

1. Not hardenable or crack-sensitive. Preheat is not required for thinner sections.
2. Preheat massive or highly rigid parts to 100–200°F (38–93°C). Prolonged heating over 500°F (260°C) can cause embrittlement of the manganese steel.
3. On small parts, avoid high localized heating by using a skip welding technique.

Cast Iron

Extremely crack sensitive. The heat-affected zone may be full of cracks even with preheat temperatures of 1200–1400°F (650–760°C). Therefore, hardfacing cast iron is often uneconomical. If it must be welded, follow the standard cast iron welding precautions in Lincoln Electric Publication C8.10.

TO AVOID STRESS FAILURE OF THE PART

Some parts contain high retained internal stresses. When the welding stresses are added to these retained stresses, the part can break. This is stress failure.

Such failure can occur near the weld or at any weak point in the part. Look for this possibility when hardfacing the following types of parts:

- Highly rigid parts. Massive parts and complex shapes are inherently rigid
- Shrink-fit parts
- Some large castings, particularly when they are made of medium to high carbon steel or medium carbon low alloy steels
- Parts hardened by heat treatment

Stress failure can be avoided with the following steps:

1. Preheat slowly to the high side of the temperature range as previously specified for the particular type of base metal. As much as possible, this preheat should be uniform throughout the part.
    - Shrink-fit parts must be preheated to expand them until they are loose. Manganese steel requires a lower temperature because it has a high coefficient of expansion
    - Parts which were hardened by heat treatment should be pack or controlled atmosphere annealed. Slow cool until the specified preheat temperature is reached
2. Arrange the welding schedule so it can be completed without any interruptions.
3. The part should be slowly and uniformly cooled. This can be done by covering the part with a glass fiber blanket or some other insulating material or by cooling in a furnace.

TO AVOID WELD CRACKING—PRODUCTS DESIGNED FOR BUILD-UP

Lincoln Electric hardfacing products designed for buildup applications have good resistance to cross cracking and are not restricted with regard to deposit thickness. These products include Wearshield BU, Lincore BU-G, Lincore M, Lincore 30-S with 801 flux, Lincore 33, Wearshield 15CrMn, Lincore 15CrMn and Lincolnweld H-535/L-60 (low alloy procedure).

Special precautions, however, should be taken with any buildup or hardfacing product on applications that are inherently crack sensitive. These applications include the surfacing of high carbon or alloy steels, previously surfaced parts and highly stressed parts. The surfacing of heavy cylinders, massive parts and parts having complex shapes are all examples of applications producing high internal stresses that may result in delayed cracking.

- These applications may require one or more of the following precautions:
- Higher preheat temperature [400–500°F (200–260°C)]
- Higher interpass temperatures
- Controlled slow cooling between passes and/or layers and after completion of the welding
- Minimizing layer thickness. Very severely stressed parts may require an intermittent or final drawing operation at 800–900°F (427–482°C)

TRANSVERSE OR CROSS CRACKING

The third and sometimes the second Wearshield ABR or Lincore 50 layer and all "Severe Abrasion" type deposits are designed to cross crack. This is beneficial because the cracking relieves stresses which can otherwise cause spalling or distortion. This cross cracking does not harm the wear resistance of the deposit.

In other types of deposits, cross cracking can be a problem. It generally occurs in parts which are massive, rigid or of complex shape. If this cross cracking must be minimized, preheat to 1200°F (650°C). The preheating found necessary to prevent underbead or stress failure cracking will also minimize weld cross cracking.

LONGITUDINAL OR CENTER-LINE CRACKING

This cracking is associated with poor bead shape. It is caused by ta concave bead shape, that is, a high ratio of bead height to bead width.

If Center-Line Cracking is a Problem:

- When welding with stick or Lincore flux-cored electrodes, use a stringer bead or minimum weaving technique and low current
- Be sure fillet welds are slightly convex
- In submerged arc surfacing when using Spreadarc attachment, center-line cracking does not often occur. This is because the high heat input of the process assures sufficiently slow cooling
- In other submerged arc jobs this cracking can sometimes occur. If it does, decrease the step-over (or increase the bead overlap) enough to remelt the center of the previous bead, or adjust bead shape
- For submerged arc jobs on roundabouts, be sure you set the correct electrode displacement distance and angle

TO AVOID DISTORTION PROBLEMS

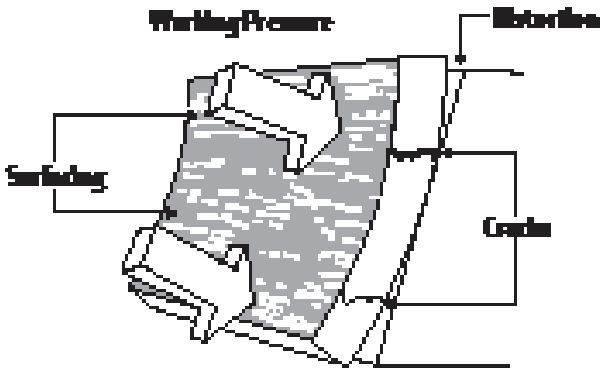
Distortion in welding is caused principally by the unbalanced stresses which result from the expansion of the metal during heating and contraction during cooling. These stresses and their effects are uneven both in strength and direction. They depend on many factors.

In many cases the small amount of resultant distortion does not affect the performance of the part. Consequently, no more precaution than clamping the part in position for welding is needed. In some cases the part is hardfaced oversize to allow for the distortion. It is then machined or ground to size. This method is most often used on parts which must be machined or ground to finish before using.

In some cases the part is allowed to distort, and it is straightened while still hot enough to bend without cracking.

In those cases where the distortion will ruin the usability of the part, the distortion forces must be controlled. Use one or a combination of the following methods. Generally, a study of the part to be surfaced and the equipment available will determine the best method to use.

CROSS-CRACKING DEPOSIT



Methods of Controlling Distortion:

1. Preforming

Use with flat pieces and other relatively thin and simply shaped parts.

- Bend, form, or clamp the part with the proper preset before welding. The distortion forces will then pull the part back to its original shape

2. Counterbalance the Stresses

Use with parts which cannot be straightened after welding. Be sure the increased rigidity will not cause underbead cracking.

- Weld or clamp two similar parts back to back. Alternate the welding from one part to the other
- Weld or clamp the part to a strongback, fixture or platen

3. Limit the Temperature of the Part

This is an effective method, particularly when high rigidity can cause cracking.

- Distribute the heat evenly by first welding one area, then welding a different area as the first cools
- Reduce the heat input by using a procedure with low current
- Remove some of the heat by blowing air, circulating water through the part, or clamping a water-cooled copper jacket to the part
- Substitute properly welded inserts rather than making thick welds

4. Relieve the Stresses

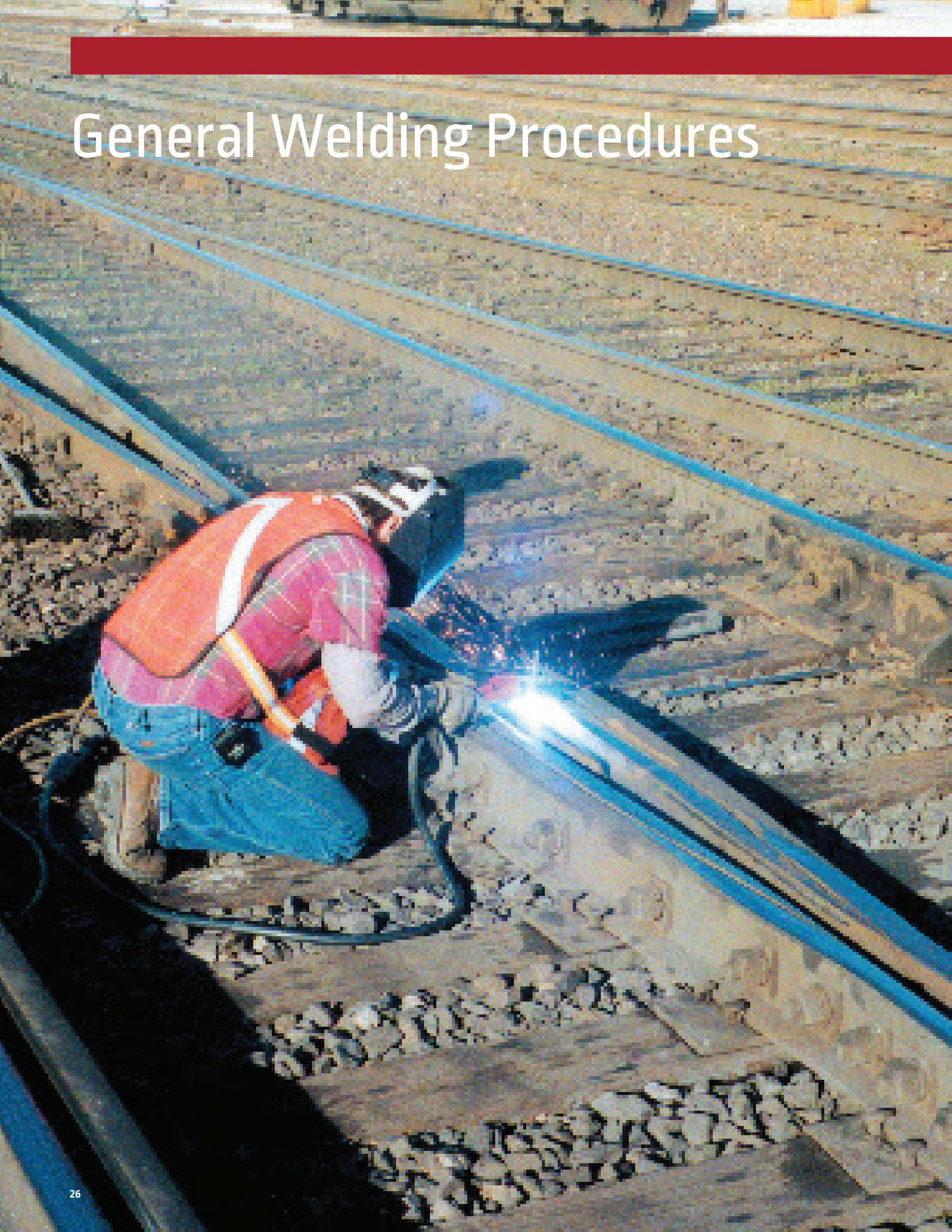
Stress relieve very large parts, rigid shapes, shrink-fit parts, and other highly stressed pieces

- Peen each layer during cooling. This is most effective with Severe Impact and Abrasion-plus-Impact-type deposits
- Preheat the entire part slowly and uniformly to expand the part prior to welding. Generally 150–200°F (66–93°C) is sufficient for manganese steel. Preheat carbon or low alloy steel to 300–500°F (149–260°C)

5. Cross-Cracking Deposit

The "Severe Abrasion" type deposits are designed to cross crack on cooling. These cracks minimize distortion by relieving the stresses.

General Welding Procedures



MANUAL COVERED ELECTRODES

There is an optimum current for every application. Use this guide to help find the best setting for a particular Wearshield electrode and application.

TABLE 1

Electrode Size in. (mm)	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)	3/16 (4.8)	1/4 (6.4)
DC+/AC (Amps)	80–100	90–165	140–220	175–260	210–325
Deposition Rate lb/Hr (kg/hr)	1.2–2.0 (.54–.90)	2.1–2.8 (.95–1.3)	2.7–3.8 (1.2–1.7)	3.7–5.0 (1.7–2.3)	4.9–6.9 (2.2–3.1)

Wearshield hardfacing electrodes may be used on flat, vertical and sometimes overhead surfaces. In the flat position, the excellent Wearshield arc operation will permit weaving the electrode up to 1/2 in. (12.7mm) wide. When welding on vertical surfaces, deposit a stringer bead along the bottom of the area to be surfaced and build on that bead to cover the entire surface. Overhead applications require smaller diameter electrode, low operating currents and special welding techniques to prevent weld metal dripping. Wide weaves are not recommended with any hardfacing electrodes and, in particular, not with manganese steel electrodes or base metals.

As in any welding type, proper plate preparation is necessary for good results. Small diameter electrodes and low currents are recommended when welding on manganese steel castings. Procedures and techniques that will prevent overheating the manganese base plate are necessary to prevent cracking spalling, and embrittlement.

LINCORE® OPEN ARC SELF-SHIELDED ELECTRODES

Table 2 lists typical parameters for the Lincore Open Arc Electrodes.

TABLE 2 - LINCORE TYPICAL OPERATING PROCEDURES

Direct Current Electrode Positive (DC+)[1]

Electrode Size in. (mm)	.045 (1.1)	1/16 (1.6)	5/64 (2.0)	7/64 (2.8)
WFS in/min (m/min)	200–600 (5.1–15.2)	150–450 (3.8–11.4)	125–250 (3.2–6.4)	90–175 (2.3–4.4)
Amps	85–250	125–350	190–400	280–420
Volts	21–31	24–33	25–32	26–32
ESO in. (mm)	3/4 –1-1/8 (19–29)	7/8–1-3/4 (22–45)	1-1/4–1-3/4 (32–45)	1-1/2–2-3/4 (38–70)
Deposition Rate lb/Hr (kg/hr)	3.6–12.3 (1.5–5.6)	4.8–16.6 (2.2–7.5)	7.0–15.1 (3.2–6.9)	8.4–16.5 (3.8–7.5)
Melt-Off Rate lb/Hr (kg/hr)	4.3–13.1 (2.0–5.9)	5.9–17.4 (2.7–7.9)	8.0–15.8 (3.6–7.2)	10.6–19.6 (4.8–8.9)

Individual electrode sheets contain precise information relative to procedure and deposition rates. Small diameter Lincore semiautomatic electrodes can be used on vertical surfaces by depositing a stringer bead along the bottom of the area to be surfaced. A copper chill bar may be necessary to support this bead. Subsequent beads are deposited along the previous bead top surface until the area to be surfaced is covered.

Lincore semiautomatic electrodes are designed for optimum operator appeal and require no external shielding. It is possible to use these electrodes with Lincolnweld 801 or 802 flux for a further reduction in smoke and spatter.

[1] *Constant voltage power supplies are recommended but constant current may also be used.*

LINCORE OPEN ARC SELF-SHIELDED ELECTRODES OPERATING CHARACTERISTICS

When Lincore electrodes are used properly, the resulting smooth, uniform weld bead is fully covered (except Lincore 50, 60-O and 65-O), with easily removed slag and depositions rates are significantly higher than with manual (stick) welding.

TABLE 3 - OPERATING CHARACTERISTICS

Increasing Wire Feed Speed (amps)	Increasing Voltage (volts)	Increasing Electrical Stickout (ESO)	Decreasing Electrical Stickout (ESO)
Increases Deposition Rate Increases Penetration Increases Heat Input	Wider and Flatten Bead Excessive Voltage Results in Porosity	Increases Melt-Off Rate Excessively Long Stickout Results in Increased Spatter	Excessively Short Stickout Results in Porosity

LINCORE SUBMERGED ARC ELECTRODES

A good starting point for general operating procedures when welding with submerged arc flux and the Lincore electrodes would be in the middle of the operating range.

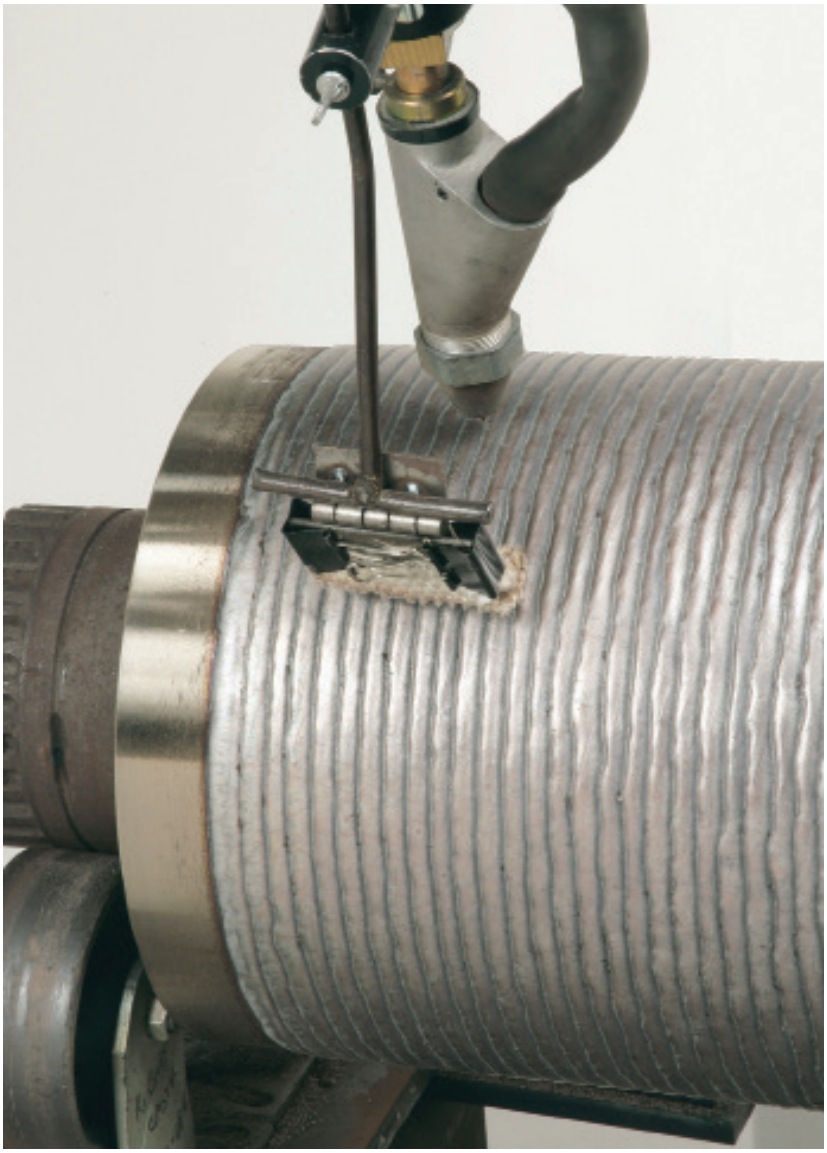
TABLE 4 - TYPICAL PARAMETERS

Electrode Size in. (mm)	3/32 (2.4)	1/8 (3.2)	5/32 (4.0)
WFS in/min (m/min)	50–140 (1.3–3.6)	48–90 (1.2–2.3)	40–65 (1.0–1.7)
Amps	250–450	350–625	475–800
Volts	25–28	26–30	26–30
ESO in. (mm)	1-1/4 (32)	1-1/2 (38)	1-1/2 (38)
Deposition Rate lb/Hr (kg/hr)	6.5–17.5 (2.9–8.0)	9.5–22.1 (4.3–10.0)	13.1–27.3 (6.0–12.4)
Melt-Off Rate lb/Hr (kg/hr)	6.6–17.8 (3.0–8.1)	9.7–22.6 (4.4–10.3)	13.4–27.9 (6.1–12.7)

CIRCUMFERENTIAL SUBMERGED ARC HARDFACING

In circumferential hardfacing, 3 in. (76mm) diameter and larger cylindrical objects are rotated under the welding head. The welds differ from those made in the flat position in that the flux and molten metal tends to sag or spill off the work.

To prevent spilling or bead distortion, the weld must freeze as it passes the vertical center of the work. This requires the proper electrode displacement distance as listed in Table 6 and the proper wire feed speed and voltage from Table 4. Speed must also be controlled to make small beads of the proper shape.



A faster, smaller bead tends to freeze quicker than a slow bead.

TEMPERATURE CONTROL

The temperature of the work should be kept below 700°F (370°C) for easy slag removal and control of spilling. In addition to depositing small beads and using air jets or internal water cooling (when practical), temperature can be controlled by depositing a stringer bead.

APPROXIMATE DISPLACEMENT (D) OF THE ELECTRODE

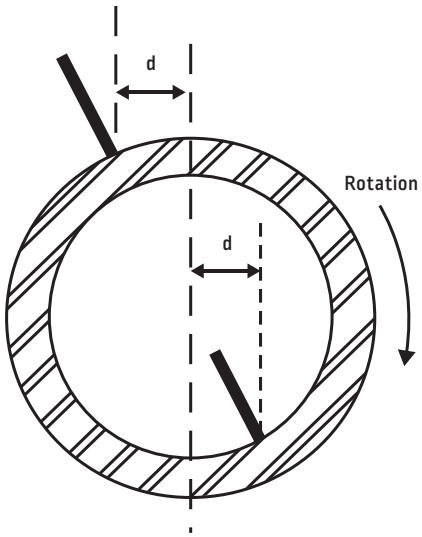


TABLE 5

Girth Diameter in. (mm)	Electrode Position 'd' (Inches Ahead of Vertical Center) in. (mm)
3–18 (76–457)	3/4–1 (19–25)
18–36 (457–914)	1-1/4– 1-1/2 (31–38)
36–48 (914–1219)	1-1/2–2 (38–51)
48–72 (1219–1828)	2.0–2-1/2 (51–63)
over 72 (1824)	2.0–2-1/2 (51–63)

NEUTRAL HARDFACING FLUX CHARACTERISTICS

Lincolnweld® 880
The fine mesh size is economical to use. Use with most hardfacing semiautomatic and automatic Lincore electrodes.

Lincolnweld 801
Darker in color, larger mesh size. Use with most hardfacing semiautomatic and automatic Lincore electrodes.

Lincolnweld 802
Use with electrodes containing Ti, V, Cb, Mo or W alloys. May be used in place of 801 flux.

OVERLAP

The amount that one bead overlaps the adjacent bead affects both admixture of base metal into weld metal — greater overlap reduces admixture — and appearance of the finished weld. Control overlap by adjusting the amount of longitudinal travel with each revolution.

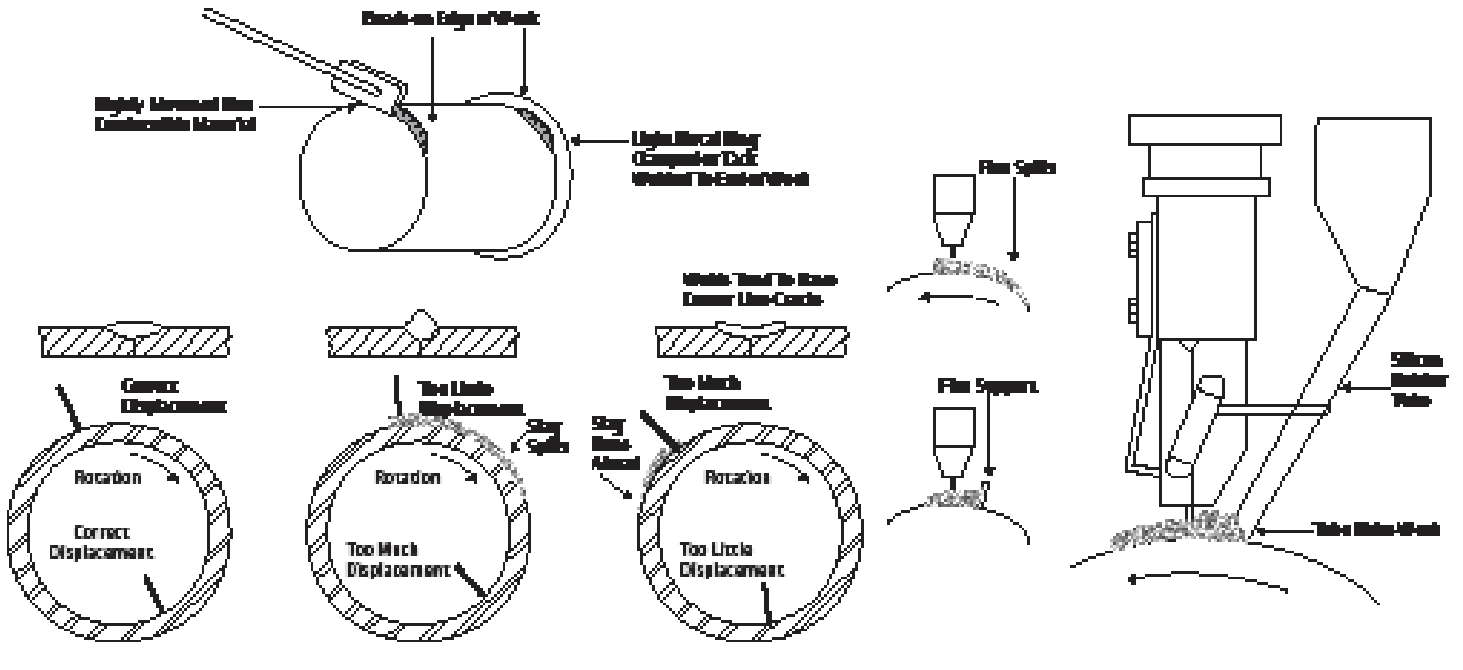
Longitudinal travel is accomplished either by spiraling the bead or indexing the welding head across the work after each complete revolution (stepover). Unless a lathe with a slow screw feed mechanism or a very low speed travel carriage is available, the stepover method is recommended.

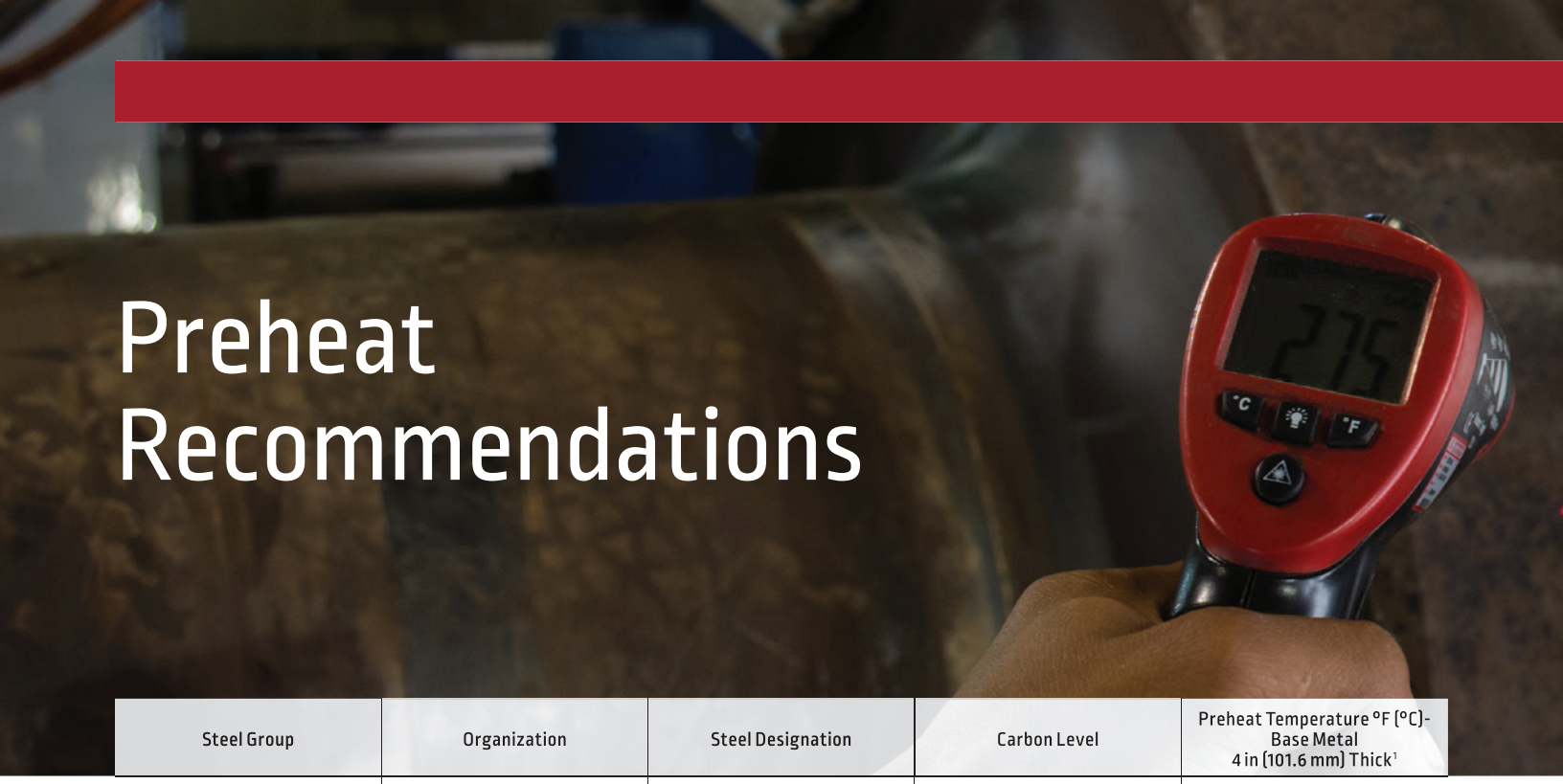
For automatic stepover, mount a limit switch that is operated by a cam type trip on the rotating fixture. Connect the limit switch into the travel carriage motor circuit so the motor runs when the switch is operated. The distance moved is controlled by the size of the cam and speed of the travel motor. A time delay can be used in place of the cam. Slag must be removed before each bead makes a complete revolution.

OVERLAP WELDING CURRENTS & VOLTAGES

Diameter in. (mm)	Current (amps)
3–6 (76–152)	250–350[1]
6–12 (76–304)	300–400
12–18 (304–457)	350–500
over 18 (457)	std. hardfacing procedures (single electrode or Twin-Arc®)

[1] *Voltage Range is 24-32 volts.*



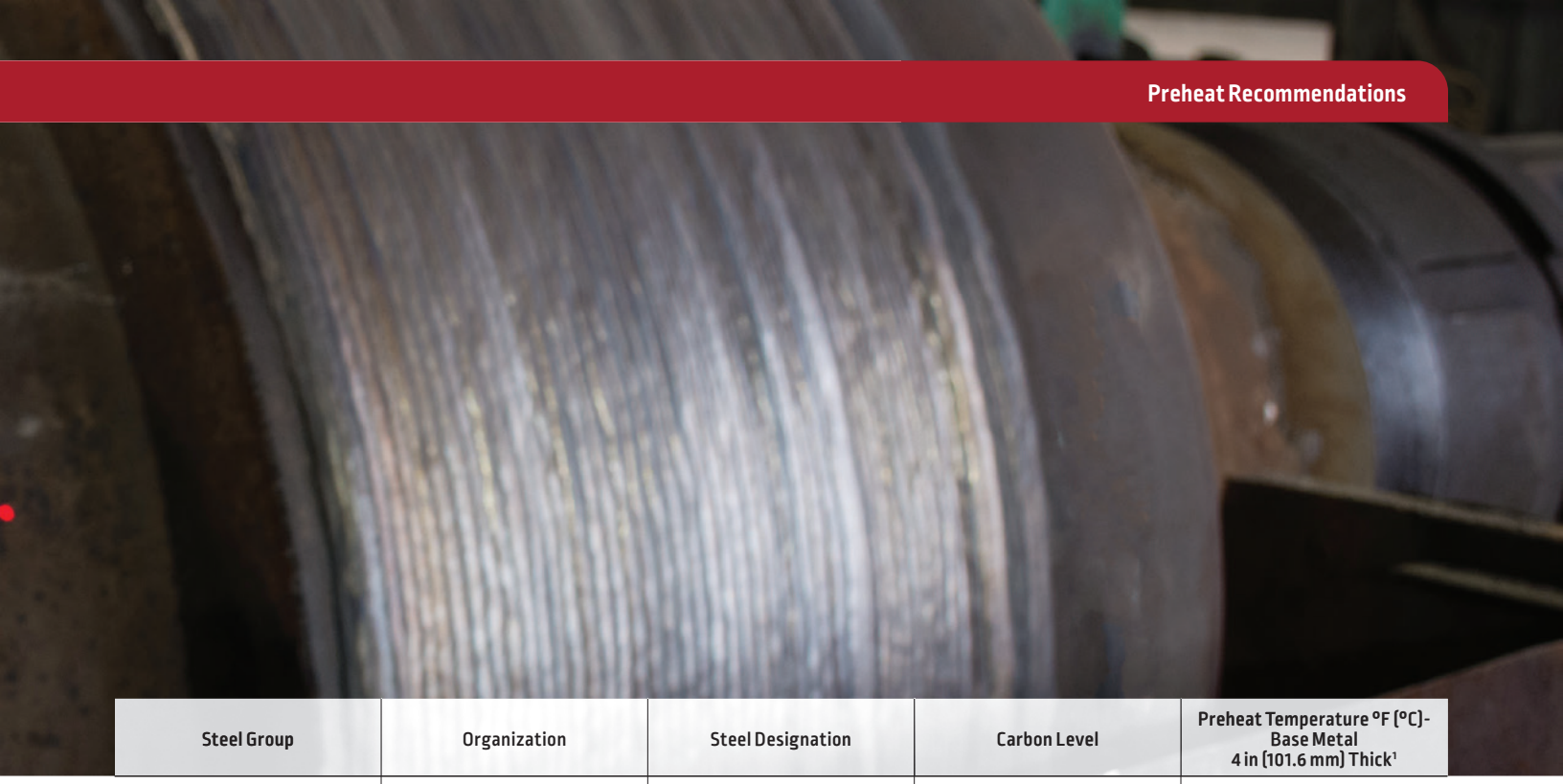


Preheat Recommendations

Steel Group	Organization	Steel Designation	Carbon Level	Preheat Temperature °F (°C)- Base Metal 4 in (101.6 mm) Thick[1]
Carbon Steels	AISI-SAE	1015	0.13–0.18	150 (66)
		1020	0.18–0.23	150 (66)
		1030	0.28–0.34	200 (93)
		1040	0.37–0.44	300 (149)
		1080	0.75–0.88	600 (316)
Carbon-Manganese Steels	AISI-SAE	1330	0.28–0.33	250 (161)
		1335	0.33–0.38	300 (149)
		1340	0.38–0.43	350 (177)
		1345	0.43–0.48	400 (204)
		1345H	0.42–0.49	400 (204)
Molybdenum Steels	AISI-SAE	4027H	0.24–0.30	250 (121)
		2032H	0.29–0.35	300 (149)
		4037H	0.34–0.41	350 (177)
		4042H	0.39–0.46	400 (204)
		4047H	0.44–0.51	450 (232)
Chrome Molybdenum Steels	AISI-SAE	4118	0.17–0.23	250 (121)
		4130	0.27–0.34	300 (149)
		4135	0.32–0.39	400 (204)
		4145	0.41–0.49	500 (260)
		4145H	0.42–0.49	500 (260)
Ni-Chrome Molybdenum & Ni-Moly Steels	AISI-SAE	4340	0.38–0.43	500 (260)
		4615	0.18–0.18	250 (121)
		4620	0.17–0.22	250 (121)
		4720H	0.17–0.23	300 (149)
		4820H	0.17–0.23	300 (149)

[1] *These suggested preheats are recommended when Low Hydrogen processes are used on base metals that are 4" thick. Lower preheats could be used on thinner material while higher preheats would be necessary on thicker materials. When using non-Low Hydrogen processes increase suggested preheats by 300°F (149°C).*

"The steels shown on the chart are only partially representative of the steels used in the manufacture of earth moving and other machinery. A Preheat Calculator available from The Lincoln Electric Co. makes it possible to figure suggested preheats for other steels based upon the chemistry of the steel and the thickness of the parts to be surfaced."



Steel Group	Organization	Steel Designation	Carbon Level	Preheat Temperature °F (°C)- Base Metal 4 in (101.6 mm) Thick[1]
Chromium Steels	AISI-SAE	5015	0.12–0.17	200 (93)
		5046	0.43–0.48	450 (232)
		5115	0.13–0.18	200 (93)
		5145	0.43–0.48	450 (232)
		5160	0.56–0.64	550 (288)
Austenitic Manganese & Chrome-Ni Steels[2]	ASTM	11-14% Mn	0.5–1.3	Preheat only to remove chill from base material
		302	0.15 Max	
		309	0.20 Max	
		310	0.25 Max	
		347	0.08 Max	
Carbon Steel Plate - Structural Quality	ASTM	A36	0.27 Max	250 (121)
		A131 Gr. B	0.21 Max	200 (93)
		A284 Gr. C	0.29 Max	250 (121)
		A678 Gr. B[3]	0.20 Max	200 (93)
High Strength Low Alloy Steels – Structural Quality	ASTM	A131-H.S.	0.18 Max	350 (177)
		A242 Type 2	0.20 Max	200 (93)
		A441	0.22 Max	200 (93)
		A588 Gr. B	0.20 Max	300 (149)
		A633 Gr. E	0.22 Max	250 (121)
Alloy & Pressure Vessel Quality Steels	ASTM	A514 Gr. F (3)	0.10–0.21	350 (177)
		A514 Gr. H (3)	0.12–0.21	300 (149)
		A514 Gr. Q (3)	0.14–0.21	550 (288)
		A514 Gr. 70	0.35 Max	300 (149)
		A514 Gr. 70	0.30 Max	250 (121)

[2] *"It is sometimes advisable to preheat large, thick 11 to 14% Manganese parts prior to welding. Use a maximum of 200°F. preheat. (Do not exceed 500°F (260°C) interpass temperature). Check base metal with magnet. 11 to 14% Manganese and the ASTM 300 series of chrome-nickel steels are NOT magnetic."*

[3] *Q & T Steels*

PRODUCTS

Why Lincoln Electric Alloys

Sourcing Alloy Consumables from Lincoln Electric is a smart choice.

LEADING QUALITY CONTROL

Our standard manufacturing Quality Assurance System includes some checks other suppliers simply do not perform:

- A full time steel analyst works closely with the mill to verify that mill output matches Lincoln Electric tolerances
- Our specs on incoming green rod from the mill are tighter than AWS requirements
- We test each end of every coil of green rod, ensuring consistency in product chemistry, mechanical properties and operation
- An Optical Electron Spectrometer tests each incoming sample for 30 chemical elements
- X-Ray Flourescence tests verify proper surface treatment

CONSISTENT ARC CHARACTERISTICS

Attention to quality translates directly into stable, consistent behavior at the arc:

- Feeding
- Placement
- Surface treatment
- Hydrogen levels

AVAILABLE CUSTOM FORMULATIONS FOR YOUR APPLICATION

Do you seek a wire to address changing materials? New qualifications? Poor fitup? Faster travel speeds? Talk to us. We can help.

PROVEN PERFORMANCE ADVANTAGES

- Less downtime due to lower contact tip wear
- Greater arc stability resulting from more constant feed force
- Less spatter made possible with more controlled chemical composition

WELDABILITY

Customer testing confirms great operator ratings for:

- Puddle control
- Edge wetting
- Bead appearance

A SOLUTIONS BASED APPROACH

As a comprehensive welding supplier, Lincoln Electric can supply a complete system that, used together, delivers better results — faster travel speeds, lower spatter, better bead appearance, control over burnthrough

- Premium welding wire
- Modular, adaptable welding equipment
- Welding waveform-driven processes like Rapid X®, Surface Tension Transfer® (STT®)
- Robotic systems
- Additive manufacturing, press automation, tube bending, laser systems, plasma cutting systems and more
- Fume control, personal protection equipment and welding education

Hardfacing Product Offering

BUILD UP

FCAW-G

Lincore BU-G

FCAW-S

Lincore BU

Lincore 33

SMAW

Wearshield BU

SAW

Lincore 30-S

Lincore 20

Lincore 4130

Lincore 32-S

Lincore 35-S

METAL-TO-METAL

FCAW-G

Lincore 55-G

Lincore M7-G

FCAW-S

Lincore 40-O

Lincore 55

Lincore T&D

SMAW

Wearshield MI

SAW

Lincore 40-S

Lincore 42-S

Lincore 102W

Lincore 102HC

Lincore 410

Lincore 410NiMo

Lincore 420

Lincore 420-S

Lincore 423CR-S

Lincore 420HC-S

Lincore 423Cr

Lincore 423L

Lincore 423N

Lincore 96-S

HIGH IMPACT/ LOW ABRASION

FCAW-G

Lincore M

FCAW-S

Lincore 15CrMn

Lincore FROG MANG®

Lincore Super Rail™

SMAW

Wearshield Mangjet

Wearshield 15CrMn

Wearshield FROG MANG

Wearshield Super Rail

IMPACT AND ABRASION

FCAW-S

Lincore 50

Lincore 57-G

SMAW

Wearshield 44

Wearshield ABR

Wearshield ME

SEVERE ABRASION/LOW IMPACT

FCAW-S

Lincore Ticore

Lincore Ultra K

GMAW-C

Lincore 60-G

Lincore 70-G

FCAW-S

Lincore 60

Lincore 65-0

SMAW

Wearshield 60

FCAW-S

Lincoln® Guardian™ CF

Lincoln Guardian HB

Lincoln SHS® 9192U

Lincoln SHS 9500U

Lincoln SHS 9700U

Lincoln SHS 9800U

PTAW

Lincoln SHS 9290P

SMAW

Lincoln SHS 9700E

Lincoln SHS 9800E

Blue Max 2100

THSP HVOP

Lincoln SHS 7574HV

Lincoln SHS 8000HV

Lincoln SHS 9172HV

WIRE ARC SPRAY

Lincoln SHS 7570W

Lincoln SHS 8000W

Lincoln SHS 9172W

SPECIALTY

Cobalt, Nickel Filler Metals, Hardfacing Fluxes

COBALT SMAW

Lincoln WT-1

Lincoln WT-12

Lincoln WT-21

Lincoln WT-6

COBALT GTAW

Lincoln WT-1

Lincoln WT-12

Lincoln WT-21

Lincoln WT-6

SMAW

Blue Max® 2100

NEUTRAL FLUX

Lincolnweld 801®

Lincolnweld 802™

Alloy Flux

FLUX

Lincolnweld H-560™

Lincolnweld A-96-S

Lincolnweld H-535™

Build Up Consumables

Welding wires and electrodes classified as Build Up are ideal for 'building up' or adding dimension to tools made of carbon and low alloy steels. Typically, Build up consumables are used as an underlying pass or layer on carbon steel parts prior to applying a hardfacing pass or layer. Build up consumables are typically designed to exhibit good compressive strength under heavy loading. Build up weld deposits are generally crack free, machinable and can be flame cut. Deposit thickness for build up consumables is often unlimited.

CATEGORY					INDUSTRY						
Build Up	Sub-Category Metal-To-Metal	Sub-Category Caster Rolls	Product Family	Rockwell Hardness (R_C) As-Welded[F] (Work Hardened)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●			**Lincore BU**	78–90 (86–98) (Rockwell R_B)	●		●	●		●	
●					●		●	●		●	
●					●		●	●		●	
●					●		●	●		●	
●	●		**Lincore 33**	1 Layer: 14–30 (28–34), 2 Layers: 26–32 (32–36), 3 Layers: 25–34 (35–38)	●	●	●	●		●	
●					●	●	●	●		●	
●					●	●	●	●		●	
●					●	●	●	●		●	
●					●	●	●	●		●	
●			**Lincore BU-G**	As Welded: 21–33 (40–42)	●		●	●		●	
●					●		●	●		●	
●					●		●	●		●	
●			**Wearshield BU**	1 Layer: 15–20 2 Layers: 18–23 3 Layers: 23–28	●		●	●		●	
●					●		●	●		●	

APPLICATIONS							
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/Gas	Weld Position
Crane, Kiln, Mine Car, Shovel, Rolls, Tractor	FCAW-S	ED031115	5/64 (2.0)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED022064	5/64 (2.0)	50 (22.7)	Coil		Flat, Horizontal
		ED022065	7/64 (2.8)	50 (22.7)	Coil		Flat, Horizontal
		ED022069	7/64 (2.8)	125 (11.3)	Accutrak Drum		Flat, Horizontal
Undercarriage parts, Bark, Bucket, Crane, Crusher Hammer, Cutter & Teeth, Drag, Drums, Ingot, Kiln, Loader, Logging, Mine Car/Wheel, Mix, Open Hearth, Plate, Rail, Roll, Shovel, Tractor	FCAW-S	ED011237	5/64 (2.0)	14 (6.4)	Coil		Flat, Horizontal
		ED031116	0.045 (1.1)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED031117	1/16 (1.6)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED031118	5/64 (2.0)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED011238	5/64 (2.0)	50 (22.7)	Coil		Flat, Horizontal
		ED011240	7/64 (2.8)	50 (22.7)	Coil		Flat, Horizontal
Bark, Crane, Cutter & Teeth, Kiln, Roll, Plate, Loader, Logging, Mine Car/Wheel, Open Hearth, Shovel, Drums, Rail, Tractor	FCAW-G	ED029079	0.045 (1.1)	25 (11.3)	Plastic Spool	75-90% Argon/ Balance CO2; 98% Argon/2% O2	Flat, Horizontal
		ED037318	1/16 (1.6)	50 (22.7)	Fiber Spool		Flat, Horizontal
		ED029080	1/16 (1.6)	25 (11.3)	Plastic Spool		Flat, Horizontal
Bark, Crane, Cutter & Teeth, Kiln, Roll, Plate, Loader, Logging, Mine Car/Wheel, Open Hearth, Shovel, Drums, Rail, Tractor	SMAW	ED021991	5/32 (4.0)	10 (4.5)	Carton		Flat, Horizontal
		ED021993	3/16 (4.8)	10 (4.5)	Carton		Flat, Horizontal

CATEGORY					INDUSTRY						
Build Up	Sub-Category Metal-To-Metal	Sub-Category Caster Rolls	Product Family	Rockwell Hardness (R_c) As-Welded[c] (Work Hardened)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●			Lincore 30-S (Metal-cored)	6 layers w/801 or 802: 27 6 layers w/860: 27	●		●	●		●	
●					●		●	●		●	
●					●		●	●		●	
●					●		●	●			
●			Lincore 20 (Metal-Cored)	23–28	●		●	●		●	
●					●		●	●		●	
●					●		●	●		●	
●					●		●	●			
●		●	Lincore 4130 (Metal-Cored)	23–28	●		●	●		●	
●		●			●		●	●		●	
●		●			●		●	●		●	
●		●			●		●	●			
●		●	Lincore 8620 (Metal-Cored)	16–20	●		●	●		●	
●		●			●		●	●		●	
●	●		Lincore 32-S	2 Layers w/802: 28, 2 Layers on 4140 w/802: 33	●		●	●		●	
●					●		●	●		●	
●			Lincore 35-S	39	●		●	●		●	
●					●		●	●		●	
●	●				●		●	●		●	
●					●		●	●		●	
●					●		●	●		●	

APPLICATIONS							
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/Gas	Weld Position
Crane, Cut/Teeth, Ingot, Kiln, Roll, Logging, Mine Car, Shovel, Rail, Shovel, Tractor	SAW	ED011200	3/32 (2.4)	50 (22.7)	Coil	Lincolnweld 801, 802	Flat, Horizontal, Circumferential
		ED015889	1/8 (3.2)	50 (22.7)	Coil		Flat, Horizontal, Circumferential
		ED011199	3/32 (2.4)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
		ED015891	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
Crane, Cut/Teeth, Ingot, Kiln, Roll, Logging, Mine Car, Shovel, Rail, Shovel, Tractor	SAW	EDS18565	3/32 (2.4)	50 (22.7)	Coil	Lincolnweld 801, 802	Flat, Horizontal, Circumferential
		EDS18566	1/8 (3.2)	50 (22.7)	Coil		Flat, Horizontal, Circumferential
		ED018569	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
		EDS18570	5/32 (4.0)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
Used for 4130 type rolls , Crane, Kiln, Mine Car/Wheel, Rail, Roll, Shovel, Tractor	SAW	ED015265	3/32 (2.4)	50 (22.7)	Coil	Lincolnweld 801, 802	Flat, Horizontal, Circumferential
		ED015266	1/8 (3.2)	50 (22.7)	Coil		Flat, Horizontal, Circumferential
		ED015532	3/32 (2.4)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
		ED015405	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
Used for 8620 type rolls, Crane, Kiln, Roll, Mine Car, Shovel, Tractor	SAW	ED020788		50 (22.7)	Coil	Lincolnweld 801, 802	Flat, Horizontal, Circumferential
		ED020791		600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
Build up on 4140 drill stems, Brake/ Drum, Crane, Kiln, Mine Car, Rail, Roll, Shovel, Tractor	SAW	ED025656	3/32 (2.4)	300 (136.1)	Speed-Feed® Drum	Lincolnweld 802	Flat, Horizontal, Circumferential
		ED025131	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
Crane, Ingot, Kiln, Mine Car, Shovel, Rail, Shovel, Tractor	SAW	ED019880	3/32 (2.4)	50 (22.7)	Coil	Lincolweld 801, 802	Flat, Horizontal, Circumferential
		ED019881	1/8 (3.2)	50 (22.7)	Coil		Flat, Horizontal, Circumferential
		ED019883	3/32 (2.4)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
		ED019884	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
		ED019885	5/32 (4.0)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential

Metal-to-Metal

Products in this category are low alloy steels designed for rebuilding of carbon or low alloy parts used in applications involving non-lubricated rolling or sliding metal-tometal wear. These high impact hardfacing products offer good compressive strength, hardness and wear resistance for build up or overlay. Not intended to be used as an underbase for subsequent hardfacing. Proper preheat and interpass temperatures can help make the application of multiple layers easy.

CATEGORY				INDUSTRY						
Metal-To-Metal	Sub-Category: Caster Rolls	Product Family	Rockwell Hardness (Rc) As-Welded (Work Hardened)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●						●	●	●	●	
●	●	Lincore 102HC	54–60			●	●	●	●	
●						●	●	●	●	
●				●		●	●			
●				●		●	●			
●	●	Lincore 102W	48–54	●		●	●			
●				●		●	●			
●				●		●	●			
●						●	●	●	●	
●		Lincore 40-O	1 Layer: 36, 2 Layers: 41, 3 Layers: 38			●	●	●	●	
●						●	●	●	●	
●						●	●	●	●	
●		Lincore 40-S	3 or more Layers: 39-42			●	●	●	●	
●						●	●	●	●	
●						●	●	●	●	
●	●	Lincore 410	27–32			●	●	●	●	
●						●	●	●	●	

APPLICATIONS							
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/ Gas	Weld Position
Auger, Bar, Blade, Blast Furnance, Blower, Bucket, Bulldozer, Cement, Coke, Crush, Cut, Door, Drag, Dredge, Hammer, Hoist, Kiln, Mill, Mine Car, Mix, Mixer, Pipe Bend, Pipeline, Plate, Plow, Power Generation, Pump, Rail, Roll, Sand, Scrape, Screen, Shovel, Sinter, Tamper, Teeth, Tractor, Wheel	SAW	ED026085	1/8 (3.2)	50 (22.7)	Coil	Lincolnweld 802, 801	Flat,Horizontal, Circumferential
		ED026086	3/32 (2.4)	600 (272.2)	Speed-Feed® Drum		Flat,Horizontal, Circumferential
		ED026087	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum		Flat,Horizontal, Circumferential
Brake, Crane, Drive, Extrusion, Mill, Pump, Drum, Roll, Shovel, Tractor	SAW	ED018578	1/8 (3.2)	50 (22.7)	Coil	Lincolnweld 802, 801	Flat,Horizontal, Circumferential
		ED018580	3/32 (2.4)	600 (272.2)	Speed-Feed® Drum		Flat,Horizontal, Circumferential
		ED018581	1/8 (3.2)	600 (272.2)	Coil		Flat,Horizontal, Circumferential
		ED018582	5/32 (4.0)	600 (272.2)	Speed-Feed® Drum		Flat,Horizontal, Circumferential
Bark, Bucket, Crane, Crush, Drag, Drive, Hammer, Ingot, Kiln, Logging, Mine Car, Mix, Open Hearth, Power, Power Generation, Rail, Roll, Shovel, Teeth, Tractor, Wheel	FCAW-S	ED031119	5/64 (2.0)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED025907	5/64 (2.0)	50 (22.7)	Coil		Flat, Horizontal
		ED025907	5/64 (2.0)	50 (22.7)	Coil		Flat, Horizontal
Bark, Bucket, Crane, Crush, Drag, Drive, Hammer, Ingot, Kiln, Logging, Mine Car, Mix, Open Hearth, Power, Power Generation, Rail, Roll, Shovel, Teeth, Tractor, Wheel	SAW	ED015892	1/8 (3.2)	50 (22.7)	Coil		Flat,Horizontal, Circumferential
		ED015909	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum	Lincolnweld 802, 801	Flat,Horizontal, Circumferential
Brake, Crane, Drive, Drum, Extrusion, Kiln, Mine Car, Power Generation, Rail, Roll, Shovel, Tractor, Wheel	SAW	ED018583	3/32 (2.4)	50 (22.7)	Coil		Flat,Horizontal, Circumferential
		ED018588	5/32 (4.0)	600 (272.2)	Speed-Feed® Drum	Lincolnweld 802, 801	Flat,Horizontal, Circumferential

CATEGORY				INDUSTRY						
Metal-To-Metal	Sub-Category: Caster Rolls	Product Family	Rockwell Hardness (Rc) As-Welded (Work Hardened)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●		Lincore 410NiMo	32–40			●	●	●	●	
●						●	●	●	●	
●	●					●	●	●	●	
●						●	●	●	●	
●						●	●	●	●	
●		Lincore 42-S	1 Layer: 40			●	●	●	●	
●						●	●	●	●	
●		Lincore 420-S	46–50			●	●	●	●	
●						●	●	●	●	
●	●					●	●	●	●	
●						●	●	●	●	
●		Lincore 420HC-S	51–55				●	●		
●	●						●			
●							●			
●							●			
●	●					●	●	●	●	
●	●	Lincore 423Cr-S	41–47			●	●	●	●	
●	●	Lincore 423L	41–47			●	●	●	●	
●	●	Lincore 423N				●	●	●	●	
●	●					●	●	●	●	
●	●	Lincore 423N-G				●	●	●	●	
●	●					●	●	●	●	

APPLICATIONS							
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/ Gas	Weld Position
Brake, Crane, Drive, Drum, Extrusion, Kiln, Mine Car, Power Generation, Rail, Roll, Shovel, Tractor, Wheel	SAW	ED018589	3/32 (2.4)	50 (22.7)	Coil	Lincolnweld 802, 801	Flat, Horizontal, Circumferential
		ED018590	1/8 (3.2)	50 (22.7)	Coil		Flat, Horizontal, Circumferential
		EDS18591	5/32 (4.0)	50 (22.7)	Coil		Flat, Horizontal, Circumferential
		ED018593	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
		ED018594	5/32 (4.0)	600 (272.2)	Speed-Feed Drum		Flat, Horizontal, Circumferential
Auger, Brake, Crane, Drive, Drum, Extrusion, Kiln, Mill, Mine Car, Power , Power Generation, Pulverizer, Rail, Roll, Scarrifier, Shovel, Teeth, Tractor, Wearplate, Wheel	SAW	ED029264	1/8 (3.2)	1/8 (3.2)	Speed-Feed Drum	Lincolnweld 802, 801	Flat, Horizontal, Circumferential
		ED029161	1/8 (3.2)	600 (272.2)	Speed-Feed Drum	Lincolnweld 802, 801	Flat, Horizontal, Circumferential
Brake, Crane, Drive, Drum, Extrusion, Kiln, Mine Car, Power Generation, Rail, Roll, Shovel, Tractor, Wheel	SAW	ED037238	3/32 (2.4)	50 (22.7)	Spool	Lincolnweld 802, 801	Flat, Horizontal, Circumferential
		ED037239	3/32 (2.4)	600 (272.2)	Speed-Feed Drum		Flat, Horizontal, Circumferential
		ED037271	1/8 (3.2)	50 (22.7)	Spool		Flat, Horizontal, Circumferential
		ED037272	1/8 (3.2)	600 (272.2)	Speed-Feed Drum		Flat, Horizontal, Circumferential
Caster rolls and backup rolls when water spray causes pitting on tool steel deposits	SAW	ED037315	3/32 (2.4)	50 lb (22.7)	Coil	Lincolnweld 802, 801	Flat, Horizontal, Circumferential
		ED037313	1/8 (3.2)	50 lb (22.7)	Coil		Flat, Horizontal, Circumferential
		ED037314	3/32 (2.4)	600 (272.2)	Speed-Feed Drum		Flat, Horizontal, Circumferential
		ED037312	1/8 (3.2)	600 (272.2)	Speed-Feed Drum		Flat, Horizontal, Circumferential
		ED018557	1/8 (3.2)	600 (272.2)	Speed-Feed Drum		Flat, Horizontal, Circumferential
Brake, Crane, Drive, Drum, Extrusion, Kiln, Car, Power Generation, Rail, Roll. Shovel, Tractor, Wheel	SAW	ED037273	1/8 (3.2)	600 (272.2)	Speed-Feed Drum	Lincolnweld 802	Flat, Horizontal, Circumferential
Brake, Crane, Drive, Drum, Extrusion, Kiln, Mine Car, Power Generation, Rail, Roll, Shovel, Tractor, Wheel	SAW	ED018551	1/8 (3.2)	600 (272.2)		Lincolnweld 802	Flat, Horizontal, Circumferential
Brake, Crane, Drive, Drum, Power Generation, Rail, Roll	SAW	ED036012	1/8 (3.2)	50 lb (22.7)	Spool	Lincolnweld 802	Flat, Horizontal, Circumferential
		ED036013	1/8 (3.2)	600 (272.2)	Speed-Feed Drum		Flat, Horizontal, Circumferential
Brake, Crane, Drive, Drum, Power Generation, Rail, Roll	SAW	ED037543	1/16 (1.6)	25 (11.3)	Spool	Lincolnweld 802	Flat, Horizontal, Circumferential
		ED037544	1/16 (1.6)	450 (204.1)	Speed-Feed Drum		Flat, Horizontal, Circumferential

CATEGORY				INDUSTRY						
Metal-To-Metal	Sub-Category: Caster Rolls	Product Family	Rockwell Hardness (Rc) As-Welded (Work Hardened)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●		Lincore 55	1 Layer: 50–59 (53–62), 2 Layers: 50–60 (56–62)	●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●		Lincore 55-G	1 Layer: 50–51 2 Layers: 53–54 4 Layers: 54–55	●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●		Lincore M7-G	1 Layer: 50–51 2 Layers: 53–54 4 Layers: 54–55	●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●				●	●	●	●	●	●	
●		Lincore 96-S	48–54		●	●	●	●	●	
●	●				●	●	●	●	●	
●					●	●	●	●	●	
●		Lincore T & D	48–55, Tempered at 540°C (1000°F): 55–65		●	●	●	●	●	
●					●	●	●	●	●	
●		Wearshield MI	1 Layer: 50 2 or More Layers: 54		●	●	●		●	
●					●	●	●		●	
●					●	●	●		●	

APPLICATIONS							
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/ Gas	Weld Position
Bark, Blade, Blower, Brake, Crane, Crush, Drag, Drive, Drum, Exevate, Extrusion, Hammer, Ingot, Kiln, Loader, Logging, Mill, Mine Car, Mix, Open Hearth, Plate, Power, Power Generation,Rail, Roll, Shovel, Sinter, Teeth, Tractor, Wheel	FCAW-S	ED012777	5/64 (2.0)	14 (6.4)/56 (25.4)	Coil/Master Carton		Flat, Horizontal
		ED031120	0.045 (1.2)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED031121	1/16 (1.6)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED031122	5/64 (2.0)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED011278	5/64 (2.0)	50 (22.7)	Coil		Flat, Horizontal
		ED011280	7/64 (2.8)	50 (22.7)	Coil		Flat, Horizontal
		ED037254	0.045 (1.2)	10 (4.5)			Flat, Horizontal
Bark, Blade, Blower, Brake, Crane, Crush, Drag, Drive, Drum, Exevate, Extrusion, Hammer, Ingot, Kiln, Loader, Logging, Mill, Mine Car, Mix, Open Hearth, Plate, Power, Power Generation,Rail, Roll, Shovel, Sinter, Teeth, Tractor, Wheel	FCAW-G	ED036444	0.045 (1.1)	10 (4.5)	Plastic Spool	75-90% Argon/ Balance CO_2 98% Argon/ 2% O_2	Flat, Horizontal, Vertical
		ED028176	0.045 (1.1)	25 (11.3)	Plastic Spool		Flat, Horizontal, Vertical
		ED028177	1/16 (1.6)	25 (11.3)	Plastic Spool		Flat, Horizontal, Vertical
		ED031475	0.045 (1.1)	500 (226.8)	Accu-Trak® Drum		Flat, Horizontal, Vertical
		ED032661	1/16 (1.6)	500 (226.8)	Accu-Trak® Drum		Flat, Horizontal, Vertical
		ED037409	0.045 (1.1)	25 (11.3)	Plastic Spool		Flat, Horizontal, Vertical
		ED037410	0.045 (1.1)	500 (226.8)	Accu-Trak® Drum		Flat, Horizontal, Vertical
		ED037525	1/16 (1.6)	200 (90.7)	Accu-Trak® Drum		Flat, Horizontal, Vertical
Bark, Blade, Blower, Brake, Crane, Crush, Drag, Drive, Drum, Exevate, Extrusion, Hammer, Ingot, Kiln, Loader, Logging, Mill, Mine Car, Mix, Open Hearth, Plate, Power, Power Generation,Rail, Roll, Shovel, Sinter, Teeth, Tractor, Wheel	FCAW-G	ED037470	1/16 (1.6)	25 (11.3)	Plastic Spool	75-90% Argon/ Balance CO_2 98% Argon/ 2% O_2	Flat, Horizontal, Vertical
		ED037476	0.045 (1.1)	25 (11.3)	Plastic Spool		Flat, Horizontal, Vertical
		ED037477	0.045 (1.1)	50 (22.7)	Coil		Flat, Horizontal, Vertical
		ED037565	1/16 (1.6)	50 (22.7)	Coil		Flat, Horizontal, Vertical
Crane, Drive, Extrusion, Kiln, Mine Car, Power Generation, Rail, Roll, Shovel, Tractor, Wheel	SAW	ED018574	3/32 (2.4)	600 (272.2)	Speed-Feed® Drum	Lincolnweld 802, 801	Flat, Horizontal, Circumferential
		ED018575	1/8 (3.2)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
		ED018576	5/32 (4.0)	600 (272.2)	Speed-Feed® Drum		Flat, Horizontal, Circumferential
Auger, Brake, Crane, Drive, Drum, Extrusion, Kiln, Mill, Mine Car, Ore, Power Generation, Pulverizer, Rail, Roll, Scarrifier, Shovel, Teeth, Tractor, Wearplate, Wheel	FCAW-S	ED031134	1/16 (1.6)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED037818	1/16 (1.6)	50 (22.7)	Fiber Spool		Flat, Horizontal
Brake, Bucket, Concrete, Crane, Drive, Drum, Extrusion, Mix, Pump, Rails, Roll, Shovel, Teeth, Tractor	SMAW	ED022003	1/8 (3.2)	10 (4.5)	Carton		Flat, Horizontal, Overhead
		ED022005	5/32 (4.0)	10 (4.5)	Carton		Flat, Horizontal, Overhead
		ED022007	3/16 (4.8)	10 (4.5)	Carton		Flat, Horizontal, Overhead

High Impact/Low Abrasion

High Impact / Low Abrasion wires and electrodes are austenitic manganese alloys that produce tough, high-strength weld deposits that work harden under impact. These products are typically used for joining, repairing or building up manganese steel parts that are joined together, or for joining manganese to carbon steel. Common applications include railroad frogs, impact hammers, rotors and rock crusher rolls. Deposit thickness for many of these High Impact / Low Abrasion consumables is unlimited and the deposit can be flame cut.

CATEGORY			INDUSTRY						
Abrasion & Impact	Product Family	Rockwell Hardness (Rc) As-Welded (Work Hardened)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●	Lincore 15CrMn	18–22 (40–50)	●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●	Lincore FROG MANG®	18–22 (40–50)		●	●	●	●	●	
●				●	●	●	●	●	
●				●	●	●	●	●	
●	Lincore M	18–28 (30–48)	●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●	Lincore Super Rail™	N/A			●			●	
●					●			●	
●					●			●	
●					●			●	

APPLICATIONS						
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Weld Position
Bar, Bucket, Crush, Cut, Drag, Dredge, Hammer, Mix, Open Hearth, Plate, Power Generation, Pump, Rail, Roll, Screen, Shovel, Teeth, Wheel	FCAW-S	ED031126	5/64 (2.0)	25 (11.3)	Steel Spool	Flat, Horizontal
		ED022060	5/64 (2.0)	50 (22.7)	Coil	Flat, Horizontal
		ED022061	7/64 (2.8)	50 (22.7)	Coil	Flat, Horizontal
		ED022068	7/64 (2.8)	125 (11.3)	Speed-Feed® Drum	Flat, Horizontal
		ED037492	1/16 (1.6)	33 (14.9)	Steel Spool	Flat, Horizontal
Railroad Frog Tracks	FCAW-S	ED034485	5/64 (2.0)	9 (4.1), 36 (16.3)	Plastic Spool/ Master Carton	Flat, Horizontal
		ED026106	1/16 (1.6)	25 (11.3)	Steel Spool	Flat, Horizontal
		ED026105	5/64 (2.0)	25 (11.3)	Steel Spool	Flat, Horizontal
Bar, Bucket, Crush, Cut, Drag, Dredge, Hammer, Mix, Open Hearth, Plate, Power Generation, Pump, Rail, Roll, Screen, Shovel, Teeth, Wheel	FCAW-S	ED031128	0.045 (1.1)	25 (11.3)	Steel Spool	Flat
		ED031129	1/16 (1.6)	25 (11.3)	Steel Spool	Flat
		ED031130	5/64 (2.0)	25 (11.3)	Steel Spool	Flat
		ED011160	5/64 (2.0)	50 (22.7)	Coil	Flat
		ED011164	7/64 (2.8)	50 (22.7)	Coil	Flat
		ED011163	7/64 (2.8)	125 (56.7)	Speed-Feed Drum	Flat
		ED011162	7/64 (2.8)	600 (272.2)	Speed-Feed Drum	Flat
Rail	FCAW-S	ED035353	1/16 (1.6)	36 (16.3)	Carton	Flat, Horizontal
		ED034800	5/64 (2.0)	36 (16.3)	Carton	Flat, Horizontal
		ED035354	1/16 (1.6)	25 (11.3)	Spool	Flat, Horizontal
		ED034801	5/64 (2.0)	25 (11.3)	Spool	Flat, Horizontal

CATEGORY			INDUSTRY						
Abrasion & Impact	Product Family	Rockwell Hardness (Rc) As-Welded (Work Hardened)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●	Wearshield 15CrMn	18–24 (40–50)	●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●	Wearshield FROG MANG®	20–30 (40–50)	●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●	Wearshield Mangjet®	2 Layers: 18 (47)	●	●	●	●	●	●	
●			●	●	●	●	●	●	
●			●	●	●	●	●	●	
●	Wearshield Super Rail™	N/A			●			●	

APPLICATIONS						
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Weld Position
Bar, Bucket, Crush, Cut, Drag, Dredge, Hammer, Mix, Open Hearth, Plate, Power Generation, Pump, Rail, Roll, Screen, Shovel, Teeth, Wheel	SMAW	ED021980	1/8 (3.2)	10 (4.5)	Carton	Flat, Horizontal, Overhead
		ED021982	5/32 (4.0)	10 (4.5)	Carton	Flat, Horizontal, Overhead
		ED021984	3/16 (4.8)	10 (4.5)	Carton	Flat, Horizontal, Overhead
Bar, Bucket, Crush, Cut, Drag, Dredge, Hammer, Mix, Open Hearth, Plate, Power Generation, Pump, Rail, Roll, Screen, Shovel, Teeth, Wheel	SMAW	ED033134	5/32 (4.0)	10 (4.5)	Carton	Flat, Horizontal, Overhead
		ED033135	3/16 (4.8)	10 (4.5)	Carton	Flat, Horizontal, Overhead
		ED033133	1/4 (6.4)	36 (16.3)	Carton	Flat, Horizontal, Overhead
Bar, Bucket, Crush, Cut, Drag, Dredge, Hammer, Mix, Open Hearth, Plate, Power Generation, Pump, Rail, Roll, Screen, Shovel, Teeth, Wheel	SMAW	ED021976	5/32 (4.0)	50 (22.7)	Carton	Flat, Horizontal, Overhead
		ED021978	3/16 (4.8)	50 (22.7)	Carton	Flat, Horizontal, Overhead
		ED021979	1/4 (6.4)	50 (22.7)	Carton	Flat, Horizontal, Overhead
Rail	SMAW	ED035352	3/16 (4.8)	10 (4.5)	Can	Flat, Horizontal

Impact and Abrasion

Products in this category are iron-based chromium carbide alloys designed for applications subject to abrasion accompanied by impact from rock, ore, clay, sand or cement, including digging or crusher surfaces or parts that must maintain sharp cutting edges. These products can be applied in multiple layers and may cross check crack. Metal-to- Earth hardfacing products can be used on carbon, low alloy, manganese, stainless and cast iron parts.

CATEGORY					INDUSTRY						
Abrasion & Impact	(Sub) Severe Abrasion Metal-To-Earth	Product Family	Rockwell Hardness (Rc) As-Welded (Work Hardened)	Mass Loss (ASTM G-65)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●		**Wearshield 44**	1 Layer: 42, 2 Layers: 47, 4 Layers: 48		●	●	●	●	●	●	
●					●	●	●	●	●	●	
●		**Lincore 50**	1 Layer: 34–37, 2 Layers: 44–48, 3 Layers: 48–52		●	●	●	●	●	●	
●					●	●	●	●	●	●	
●					●	●	●	●	●	●	
●					●	●	●	●	●	●	
●					●	●	●	●	●	●	
●					●	●	●	●	●	●	
●					●	●	●	●	●	●	
●	●	**Lincore 57-G**	56–59	0.36	●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●		**Wearshield ABR**	1 Layer: 24–53, 2 Layers: 28–53		●	●	●	●	●	●	
●					●	●	●	●	●	●	
●					●	●	●	●	●	●	
●		**Wearshield ME**	1 Layer: 49, 2 Layers: 59, 3 Layers: 59		●	●	●	●	●	●	
●					●	●	●	●	●	●	
●					●	●	●	●	●	●	

APPLICATIONS							
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/ Gas	Weld Position
Auger, Bar, Blade, Bucket, Bulldozer, Concrete, Crush, Cut, Cut, Drag, Dredge, Hammer, Hoist, Ingot, Kiln, Mine Car, Mix, Pipeline, Plate, Plow, Power Generation, Pump, Roll, Scrape, Shovel, Shred, Teeth, Teeth, Tractor, Wheel	SMAW	ED024940	1/8 (3.2)	10 (4.5)/40 (18.1)	Carton/ Master Carton		Flat, Horizontal
		ED024941	5/32 (4.0)	10 (4.5)	Carton/ Master Carton		Flat, Horizontal
Auger, Bar, Blade, Bucket, Bulldozer, Concrete, Crush, Cut, Cut, Drag, Dredge, Hammer, Hoist, Ingot, Kiln, Mine Car, Mix, Pipeline, Plate, Plow, Power Generation, Pump, Roll, Scrape, Shovel, Shred, Teeth, Teeth, Tractor, Wheel	FCAW-S	ED031123	0.045 (1.1)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED031124	1/16 (1.6)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED031125	5/64 (2.0)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED017825	5/64 (2.0)	50 (22.7)	Coil		Flat, Horizontal
		ED011275	7/64 (2.8)	50 (22.7)	Coil		Flat, Horizontal
		ED011274	7/64 (2.8)	125 (56.7)	Speed-Feed Drum		Flat, Horizontal
		ED037261	1/16 (1.6)	10 (4.5)	Plastic Spool		Flat, Horizontal
		ED037270	0.045 (1.1)	10 (4.5)	Plastic Spool		Flat, Horizontal
Auger, Bar, Blade, Blast Furnance, Blower, Bucket, Bulldozer, Cement, Coke, Crush, Cut, Door, Drag, Dredge, Hammer, Hoist, Kiln, Mill, Mine Car, Mix, Mixer, Pipe Bend, Pipeline, Plate, Plow, Power Generation, Pump, Rail, Roll, Sand, Scrape, Screen, Shovel, Sinter, Tamper, Teeth, Tractor, Wheel	GMAW-C	ED037297	1/16 (1.6)	10 (4.5)	Plastic Spool	75-90Ar/ Bal CO_2	Flat, Horizontal
		ED037298	1/16 (1.6)	25 (11.3)	Plastic Spool		Flat, Horizontal
		ED037296	1/16 (1.6)	500 (227)	Accu-Trak Drum		Flat, Horizontal
Auger, Bar, Blade, Bucket, Bulldozer, Concrete, Crush, Cut, Cut, Drag, Dredge, Hammer, Hoist, Ingot, Kiln, Mine Car, Mix, Pipeline, Plate, Plow, Power Generation, Pump, Roll, Scrape, Shovel, Shred, Teeth, Teeth, Tractor, Wheel	SMAW	ED021996	1/8 (3.2)	10 (4.5)/40 (18.1)	Carton/ Master Carton		Flat, Horizontal, Vertical, Overhead
		ED021996	5/32 (4.0)	10 (4.5)/40 (18.1)	Carton/ Master Carton		Flat, Horizontal, Vertical, Overhead
		ED022000	3/16 (4.8)	10 (4.5)/40 (18.1)	Carton/ Master Carton		Flat, Horizontal, Vertical, Overhead
Auger, Bar, Blade, Bucket, Bulldozer, Concrete, Crush, Cut, Cut, Drag, Dredge, Hammer, Hoist, Ingot, Kiln, Mine Car, Mix, Pipeline, Plate, Plow, Power Generation, Pump, Roll, Scrape, Shovel, Shred, Teeth, Teeth, Tractor, Wheel	SMAW	ED023323	1/8 (3.2)	10 (4.5)/40 (18.1)	Carton/ Master Carton		Flat, Horizontal
		ED023324	5/32 (4.0)	10 (4.5)/40 (18.1)	Carton/ Master Carton		Flat, Horizontal
		ED023325	3/16 (4.8)	10 (4.5)/40 (18.1)	Carton/ Master Carton		Flat, Horizontal

Severe Abrasion/Low Impact

Products in this category are iron-based with a large amount of chromium carbides in a hard matrix. These alloys are designed for severe sliding abrasion accompanied by low or moderate impact. These products are designed to exhibit stress-relieved cross-check cracking. They can be used on carbon, low alloy, manganese, stainless and cast iron parts. Deposit thicknesses are generally limited to two to four layers.

CATEGORY					INDUSTRY						
Severe Abrasion/ Low Impact	(Sub) Severe Abrasion Metal-To-Earth	Product Family	Rockwell Hardness (Rc)	Mass Loss (ASTM G-65)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●	●	Lincore 70-G (Metal-Cored)	60-70		●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●	Lincore 60-O	55–60		●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●	Lincore 65-O	1 Layer: 57, 2 Layers: 60, 4 Layers 64		●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●		Lincore Ticore	57–64			●	●	●		●	
●		Lincore Ultra K™	56–62			●	●	●		●	

APPLICATIONS

Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/ Gas	Weld Position
Auger, Bar, Blade, Blast Furnance, Blower, Bucket, Bulldozer, Cement, Coke, Crush, Cut, Door, Drag, Dredge, Hammer, Hoist, Kiln, Mill, Mine Car, Mix, Mixer, Pipe Bend, Pipeline, Plate, Plow, Power Generation, Pump, Rail, Roll, Sand, Scrape, Screen, Shovel,Sinter, Tamper, Teeth, Tractor, Wheel	GMAW-C	ED036455	0.045 (1.1)	10 (4.5)	Plastic Spool	75-90Ar/ Bal CO_2	Flat, Horizontal
		ED029936	0.045 (1.1)	12 (5.4)	Plastic Spool		Flat, Horizontal
		ED037243	0.045 (1.1)	10 (4.5)	Plastic Spool		Flat, Horizontal
		ED037244	0.045 (1.1)	33 (14.9)	Plastic Spool		Flat, Horizontal
		ED037245	1/16 (1.6)	10 (4.5)	Plastic Spool		Flat, Horizontal
		ED037246	1/16 (1.6)	33 (14.9)	Plastic Spool		Flat, Horizontal
		ED037247	3/32 (2.3)	33 (14.9)	Plastic Spool		Flat, Horizontal
		ED037248	7/64 (2.8)	55 (24.9)	Coil		Flat, Horizontal
Auger, Bar, Blade, Blast Furnance, Blower, Bucket, Bulldozer, Cement, Coke, Crush, Cut, Door, Drag, Dredge, Hammer, Hoist, Kiln, Mill, Mine Car, Mix, Mixer, Pipe Bend, Pipeline, Plate, Plow, Power Generation, Pump, Rail, Roll, Sand, Scrape, Screen, Shovel,Sinter, Tamper, Teeth, Tractor, Wheel	FCAW-S	ED031131	0.045 (1.1)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED031132	1/16 (1.6)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED031133	5/64 (2.0)	25 (11.3)	Steel Spool		Flat, Horizontal
		ED037262	0.045 (1.1)	10 (4.5)	Steel Spool		Flat, Horizontal
		ED037263	1/16 (1.6)	10 (4.5)	Steel Spool		Flat, Horizontal
		ED037493	5/64 (2.0)	500 (2226.8)	SpeedFeed® Drum		Flat, Horizontal
		ED019887	5/64 (2.0)	50 (22.7)	Coil		Flat, Horizontal
		ED019888	7/64 (2.8)	50 (22.7)	Coil		Flat, Horizontal
Auger, Bar, Blade, Blast Furnance, Blower, Bucket, Bulldozer, Cement, Coke, Crush, Cut, Door, Drag, Dredge, Hammer, Hoist, Kiln, Mill, Mine Car, Mix, Mixer, Pipe Bend, Pipeline, Plate, Plow, Power Generation, Pump, Rail, Roll, Sand, Scrape, Screen, Shovel,Sinter, Tamper, Teeth, Tractor, Wheel	FCAW-S	ED026076	1/8 (3.2)	50 (22.7)	Coil		Flat, Horizontal
		ED026077	7/64 (2.8)	50 (22.7)	Coil		Flat, Horizontal
		ED026082	1/8 (3.2)	500 (2226.8)	SpeedFeed® Drum		Flat, Horizontal
		ED026083	7/64 (2.8)	500 (2226.8)	SpeedFeed® Drum		Flat, Horizontal
Crush, Hammer, Plate, Wheel	FCAW-S	ED035628	5/64 (2.0)	25 (11.3)	Coil		Flat, Horizontal
Auger, Crush, Hammer, Plate, Wheel	FCAW-S	ED034802	1/8 (3.2)	600 (272.2)	SpeedFeed® Drum		Flat, Horizontal

CATEGORY					INDUSTRY						
Severe Abrasion/ Low Impact	(Sub) Severe Abrasion Metal-To-Earth	Product Family	Rockwell Hardness (Rc)	Mass Loss (ASTM G-65)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●		Lincore Ultra R™				●	●	●		●	
●						●	●	●		●	
●	●	Wearshield® 60	1 Layer: 57–60, 2 Layers: 60–62		●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●	●				●	●	●	●	●	●	
●		Lincoln Guardian CF	58–62	0.22				●			
●		FE GRIP			●		●		●	●	
●					●		●		●	●	
●		Lincoln Guardian™ HB	57–59	0.32				●			
●		Lincoln SHS		0.2	●				●	●	
●		Lincoln SHS 7574HV		0.13	●		●		●	●	
●		Lincoln SHS 8000HV		0.07	●		●		●	●	
●					●		●		●	●	
●		Lincoln SHS 8000W		0.18	●					●	
●					●					●	
●		Lincoln SHS 9172HV			●		●		●	●	
●				0.07	●		●		●	●	
●		Lincoln SHS 9172W		0.17	●		●		●	●	
●	●	Blue Max 2100			●	●	●	●	●	●	
●	●				●	●	●	●	●	●	

APPLICATIONS							
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/Gas	Weld Position
Auger, Crush, Hammer, Plate, Wheel	FCAW-S	ED035367	1/8 (3.2)	50 (22.7)	SpeedFeed® Drum		Flat, Horizontal
		ED035368	1/8 (3.2)	500 (2226.8)	SpeedFeed® Drum		Flat, Horizontal
Auger, Bar, Blade, Blast Furnance, Blower, Bucket, Bulldozer, Cement, Coke, Crush, Cut, Door, Drag, Dredge, Hammer, Hoist, Kiln, Mill, Mine Car, Mix, Mixer, Pipe Bend, Pipeline, Plate, Plow, Power Generation, Pump, Rail, Roll, Sand, Scrape, Screen, Shovel, Sinter, Tamper, Teeth, Tractor, Wheel	SMAW	ED022010	1/8 (3.2)	10 (4.5)	Carton		Flat, Horizontal
		ED022011	5/32 (4.0)	10 (4.5)	Carton		Flat, Horizontal
		ED022012	3/16 (4.8)	10 (4.5)	Carton		Flat, Horizontal
Hardbanding applications	FCAW-S	ED035668	1/16 (1.6)	33 (15)	Spool		Flat, Horizontal, Circumferential
Paper, power Gent, Pulp, Wheel	THSP ASP	ED037597	1/16 (1.6)	25 (11.3)			Flat, Horizontal, Circumferential
		ED037598	1/16 (1.6)	400 (181.4)			Flat, Horizontal, Circumferential
Hardbanding applications	FCAW-S	ED035667	1/16 (1.6)	33 (15)	Spool		Flat, Horizontal, Circumferential
Paper, Power, Power generation, Pulp	Wire Arc Spray	ED035664	1/16 (1.6)	25 (11.3)	Spool PLW		N/A
Mine Car, Paper, Power, Power generation, Pulp, Wheel	THSP HVOF	ED035730	+15/-35	25 (11.3)	Pail		N/A
Mine Car, Paper, Power, Power generation, Pulp, Wheel	THSP HVOF	ED35732	+15/-35	10 (4.5)	Bottle		N/A
		ED035733	+15/-35	25 (11.3)	Bottle		N/A
Tubes, Pulp, Paper	Wire Arc Spray	ED035665	1/16 (1.6)	25 (11.3)	Spool		N/A
		ED035972	1/16 (1.6)	400 (181.4)	SpeedFeed Drum		N/A
Mine Car, Paper, Power, Power generation, Pulp, Wheel	THSP HVOF	ED035734	+15/-35	10 (4.5)	Bottle		N/A
		ED035735	+15/-35	25 (11.3)	Bottle		N/A
Screen, Paper, Power, Power Generation, Pulp	Wire Arc Spray	ED035666	1/16 (1.6)	25 (11.3)	Spool PLW		N/A
Auger, Cruah, Hammer, Join, Plate, Pulp & paper, Chemical, Power Gen	SMAW	ED032298	3/32 (2.3)	10 (4.5)	Can		Flat, Horizontal
		ED032299	1/8 (3.2)	10 (4.5)	Can		Flat, Horizontal

CATEGORY					INDUSTRY						
Severe Abrasion/ Low Impact	(Sub) Severe Abrasion Metal-To-Earth	Product Family	Rockwell Hardness (Rc)	Mass Loss (ASTM G-65)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●		Lincoln SHS 9192U					●	●		●	
●							●	●		●	
●							●				
●							●	●		●	
●							●	●		●	
●							●	●		●	
●							●	●		●	
●							●	●		●	
●		Lincoln SHS 9700P	71–74	0.08			●	●		●	
●							●	●		●	
●		SHS 9294P					●	●		●	
●		Lincoln SHS® 9500U	58–62	0.22			●	●		●	
							●	●		●	
●		Lincoln SHS 9700E	67–70	0.13	●		●		●	●	
●					●		●		●	●	
●		Lincoln SHS 9700U	67–70	0.13	●		●		●	●	
●					●		●		●	●	
●					●		●		●	●	
●					●		●		●	●	
●					●		●		●	●	
●					●		●		●	●	
●					●		●		●	●	
●					●		●		●	●	
●		Lincoln SHS 9800U	68–71	0.12				●	●		
●								●	●		
●								●	●		
●								●	●		
●								●	●		
●								●	●		
●								●	●		
●								●	●		
●		Lincoln SHS 9800E						●	●		
●								●	●		

APPLICATIONS							
Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Flux/Gas	Weld Position
Auger, Crush, Hammer, Plate	FCAW-S	ED035663	0.045 (1.1)	33 (15)	Spool		Flat, Horizontal
		ED037277	1/16 (1.6)	30 (13.6)	Spool		Flat, Horizontal
		ED037278	1/16 (1.6)	400 (181)	SpeedFeed Drum		Flat, Horizontal
		ED035661	3/32 (2.4)	55 (25)	Coil		Flat, Horizontal
		ED035660	7/64 (2.8)	55 (25)	Coil		Flat, Horizontal
		ED037595	1/16 (1.6)	50 (22.7)			
		ED037614	3/32 (2.4)	500 (226.8)			
		ED037615	7/64 (2.8)	500 (226.8)			
Crush, Hammer, Plate	PTAW	ED035724	+15/-180	10 (4.5)	Bottle		Flat, Horizontal
		ED035725	+15/-180	25 (11.3)	Bottle		Flat, Horizontal
Crush, Hammer, Plate	PAW	ED037599	+15/-180	10 (4.5)	Bottle		Flat, Horizontal
Screen, Paper, Power , Power Generation, Pulp	FCAW-S	ED035749	0.045 (1.1)	33 (15)	Spool		Flat, Horizontal
		ED037275	1/16 (1.6)	45 (20)	Fiber Spool		Flat, Horizontal
Screen, Paper, Power , Power Generation, Pulp	SMAW	ED035669	5/32 (4.0)	10 (4.5)	Carton		Flat, Horizontal
		ED037653	1/8 (3.2)	10 (4.5)	Carton		Flat, Horizontal
Screen, Paper, Power, Power Generation, Pulp	FCAW-S	ED037276	1/16 (1.6)	33 (15)	Spool		Flat, Horizontal
		ED035658	0.045 (1.1)	33 (15)	PLW Spool		Flat, Horizontal
		ED035657	1/16 (1.6)	33 (15)	Spool		Flat, Horizontal
		ED035655	3/32 (2.4)	55 (25)	Spool		Flat, Horizontal
		ED035654	7/64 (2.8)	55 (25)	Coil		Flat, Horizontal
		ED037594	1/16 (1.6)	400 (181.4)	SpeedFeed Drum		Flat, Horizontal
		ED037616	3/32 (2.4)	500 (226.8)	SpeedFeed Drum		Flat, Horizontal
		ED035857	7/64 (2.8)	500 (226.8)	SpeedFeed Drum		Flat, Horizontal
Auger, Crush, Hammer, Plate, Power Generation	FCAW-S	ED035650	0.045 (1.1)	25 (11.3)	Spool		Flat, Horizontal
		ED035648	1/16 (1.6)	33 (15)	Spool		Flat, Horizontal
		ED035858	1/16 (1.6)	50 (22.7)	Spool		Flat, Horizontal
		ED035646	3/32 (2.4)	55 (25)	Coil		Flat, Horizontal
		ED035645	7/64 (2.8)	55 (25)	Coil		Flat, Horizontal
		ED035859	1/16 (1.6)	400	SpeedFeed Drum		Flat, Horizontal
		ED035860	3/32 (2.4)	500 (226.8)	SpeedFeed Drum		Flat, Horizontal
		ED035924	7/64 (2.8)	500 (226.8)	SpeedFeed Drum		Flat, Horizontal
		ED035973	7/64 (2.8)	280 (127)	SpeedFeed Drum		Flat, Horizontal
Auger, Crush, Hammer, Plate, Power Generation	SMAW	ED037651	5/32 (4.0)	10 (4.5)	Can		Flat, Horizontal
		ED037652	1/8 (3.2)	10 (4.5)	Can		Flat, Horizontal

Submerged Arc Welding Fluxes for Hardfacing

Lincoln Electric granular submerged arc flux is designed to produce sizeable weld deposits with exceptional quality and bead appearance on a variety of flat and horizontal welding applications, including general fabrication, offshore, wind tower pressure vessel and maintenance and repair activities like hardfacing. Great attention is paid to the details in manufacturing including exhaustive quality control over consistent chemistry and particulate size.

CATEGORY			INDUSTRY						
Flux	Product Family	Rockwell Hardness (R_c) As-Welded (Work Hardened)	Chemical Processing	General Fabrication	Heavy Fabrication	Maintenance and Repair	Power Generation	Structural	
●	Lincolnweld A-96-S	Range 48-54			●		●		
●	Lincolnweld 801®	See Wire	●	●	●	●	●	●	
●			●	●	●	●	●	●	
●	Lincolnweld 802™	Range 24-45	●	●	●	●	●	●	
●			●	●	●	●	●	●	
●	Lincolnweld H-535™	Range 52-61			●		●		
●	Lincolnweldw H-560™	See Wire			●				

	APPLICATIONS							
	Common Use	Weld Process	Part Number	Dia. In (mm)	Pkg Wt. lbs (kg)	Package Type	Classification	Weld Position
	Modified Type 420 stainless deposit	SAW	ED031860	N/A	60 (27.2)	Plastic Bag		Flat, Horizontal, Circumferential
	Roll Rebuilding, Idlers, Drive Sprockets, Mill Buckets	SAW	ED019588	N/A	50 (22.7)	Plastic Bag	EN 760-S A F1; EN 760- S A FB 2	Flat, Horizontal, Circumferential
			ED023403	N/A	550 (249.5)	Steel Drum	EN 760-S A F1; EN 760- S A FB 2	Flat, Horizontal, Circumferential
	For Roll Rebuilding with wires containing certain alloys	SAW	ED032800	N/A	50 (22.7)	Plastic Bag	EN 760-S A CS 1; EN 760- S A CS 2	Flat, Horizontal, Circumferential
			ED023365	N/A	450 (204.1)	Steel Drum	EN 760-S A CS 1; EN 760- S A CS 2	Flat, Horizontal, Circumferential
	Drive/Drums, Mix, Crush Bar, Open Hearth, Mill, Blade	SAW	ED027865	N/A	2700 (1224.7)	Plastic Bag		Flat, Horizontal, Circumferential
	Concrete, Mix, Drive, Extrusion	SAW	ED036785	N/A	100 (45.4)	Plastic Bag		Flat, Horizontal, Circumferential

FEATURED PRODUCTS

Engage in preventative maintenance — apply severe abrasion alloys to the wear surfaces of your equipment

KEY ● Best Use ⟷ Range of Use

MATCH A LINCOLN ELECTRIC HARDFACING PRODUCT TO YOUR WEAR TYPE

Weld Process	Product	Severe Abrasion with Low Impact (Metal-To-Earth)	Abrasion & Impact	Metal-to-Metal	High Impact
FCAW-S	Lincoln SHS 9192U	●			
FCAW-S	Lincoln SHS 9800U	●			
FCAW-S	Lincoln SHS 9800E	●			
FCAW-S	Lincoln SHS 9700U	●			
SMAW	Lincoln SHS 9700E	●			
FCAW-S	Lincore 70-G	●			
Hardbanding	Lincoln Guardian CF	●			
Hardbanding	Lincoln Guardian HB	●			
FCAW-S	Lincoln SHS 9500U	●			
FCAW-S	Lincore 65-O	●			
GMAW-C	Lincore 60-G				
FCAW-S	Lincore 60-O				
SMAW	Wearshield 60				
SMAW	Wearshield ME		●		
GMAW-C	Lincore 57-G				
FCAW-S	Lincore 50				
SMAW	Wearshield 44				
SMAW	Wearshield ABR				
GMAW-C	Lincore M7-G				
FCAW-S	Lincore T&D				
FCAW-S	Lincore 55				
FCAW-G	Lincore 55-G				
SMAW	Wearshield MI				
SMAW	Lincore 42-S				
FCAW-S	Lincore 40-O				
SMAW	Lincore 40-S				
FCAW-S	Lincore 15CrMn				
SMAW	Wearshield 15CrMn				
FCAW-S	Lincore FROG MANG				
SMAW	Wearshield FROG MANG				
FCAW-G	Lincore M				
SMAW	Wearshield MANGJET				
FCAW-S	Lincore Super Rail				
SMAW	Wearshield® Super Rail				

COMPARE FCAW SELF-SHIELDED
HARDFACING PRODUCTS
(Hardness and Abrasion Resistance)

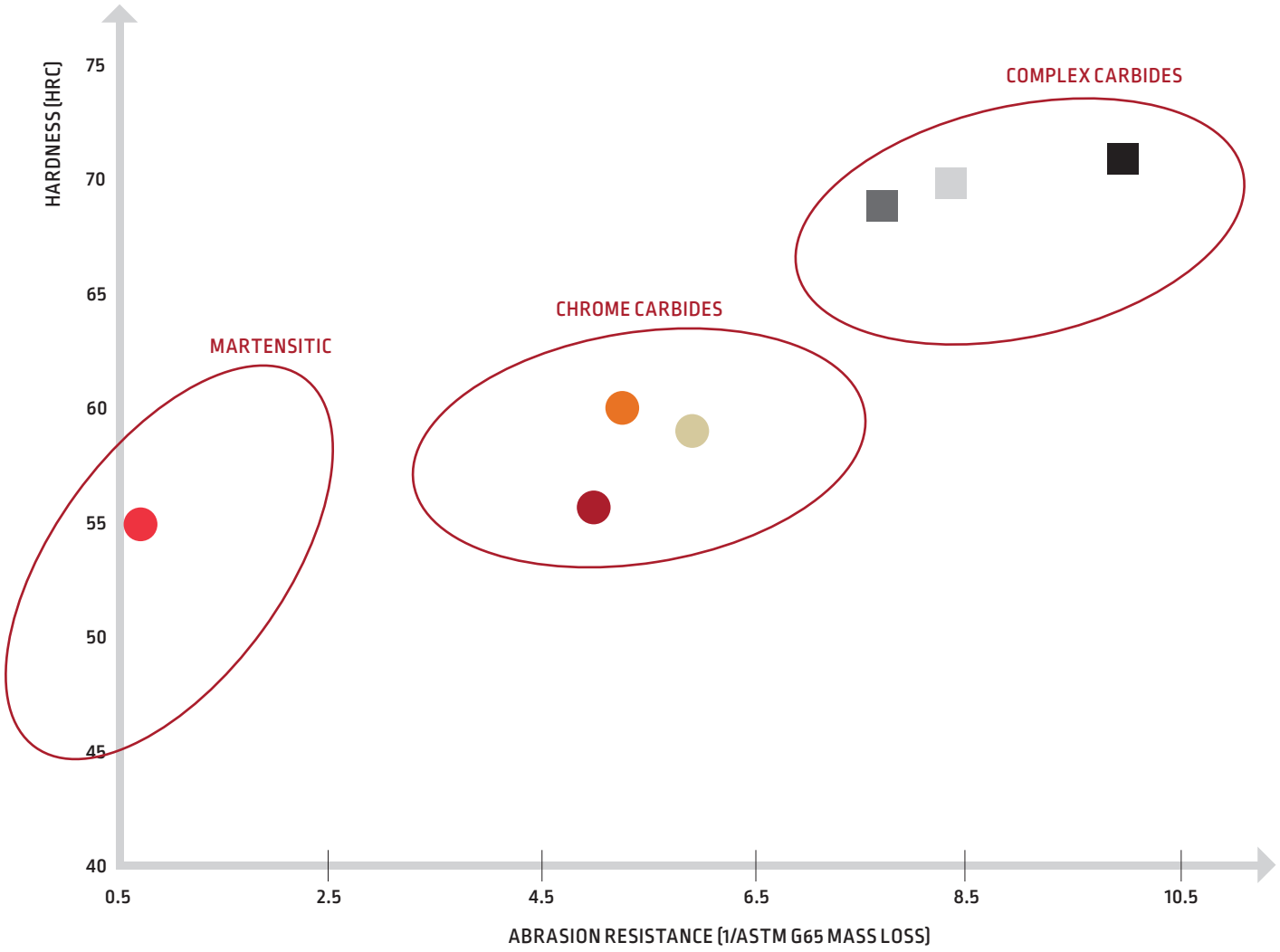
KEY

LINCORE

- Lincore 60-O
- Lincore 55
- Lincore 65-O
- Lincore Ultra K

LINCOLN SHS

- Lincoln SHS 9192U
- Lincoln SHS 9700
- Lincoln SHS 9800



RESOURCES

Looking for Alloy Lot Certification? Lincoln Electric has You Covered.

Q1 LOT® CERTIFICATION

ALL Lincoln Electric welding consumables undergo multiple quality checks as part of our standard quality assurance system.

Analysis of the nose and tail sections of every green rod coil to assure that material meets the mill spec as well as Lincoln Electric's more stringent requirements. These and other checks throughout the manufacturing process are meant to assure end-to-end consistency in:

- Product chemistry
- Mechanical properties
- Feedability and operation
- Traceability to the date of manufacture, line, shift and operator

Obtain a Q1 Certificate of Conformance and Certificate of Actual Chemistry at the web-based Lincoln Electric Certificate Center, including SAW wire and flux combination certificates.

Q2 LOT® CERTIFICATION

ALL Lincoln Electric Stainless Steel, Nickel and Special Alloy welding consumables have available LOT SPECIFIC records of:

- In-process testing and manufacturing
- Actual and deposit composition test results of the finished product
- Traceability to the date of manufacture, line, shift and operator

Obtain Q2 ACTUAL LOT CERTIFICATION OF TESTED LOT CONTROLLED MATERIALS at the web-based Lincoln Electric Certificate Center.

Q3 LOT® CERTIFICATION

For Military and Nuclear certification and customers with special testing requirements or requirements for archived records for a specific shipment.

- Product is made to order per customer's requirements
- Certified Material Test Reports and all manufacturing records are archived
- Actual Certificate of Conformance and Certificate of Actual Chemistry is delivered to the customer.

Common Package Types

BOTTLE

Code: BO

Weight: 10

CARTON

Code: CT

Weight: 10, 10/40

EASY-OPEN CAN

Code: EO

Weight: 8/24 and 10/30, 10/40

COIL

Code: C

Weight: 14/56, 50, 55, 60

ACCU-TRAK® DRUM

Code: AD

Weight: 500

PLASTIC BAG

Code: B

Weight: 50

PLASTIC SPOOL

Code: SP

Weight: 1, 2, 10, 16, 25

PLASTIC SPOOL (VACUUM FOIL BAG)

Code: SP

Weight: 25, 30, 33

SPEED-FEED DRUM

Code: D

Weight: 500, 600

STEEL SPOOL

Code: SSP

Weight: 25,33

STEEL SPOOL (PRECISION LAYER WOUND)

Code: SSP (PLW)

Weight: 33

TUBE

Code: T

Weight: 10/10 and 10/30

Contact

- Contact your local Lincoln Electric sales representative
- Call our National Alloy Sales office at 1-800-638-1458

Safety Data Sheets (SDS) and Certificates of Conformance are available on our website at www.lincolnelectric.com

FUMES AND GASES can be hazardous to your health.

- Fumes from the normal use of this product contain significant quantities of potentially hazardous compounds. See consumable product label/insert.
- Keep your head out of the fumes.
- Use enough ventilation and local exhaust to keep fumes and gases from your breathing zone and the general area.
- An approved respirator should be used unless exposure assessments are below applicable exposure limits.

TEST RESULTS

Test results for mechanical properties, deposit or electrode composition and diffusible hydrogen levels were obtained from a weld produced and tested according to prescribed standards, and should not be assumed to be the expected results in a particular application or weldment. Actual results will vary depending on many factors, including, but not limited to, weld procedure, plate chemistry and temperature, weldment design and fabrication methods. Users are cautioned to confirm by qualification testing, or other appropriate means, the suitability of any welding consumable and procedure before use in the intended application.

CUSTOMER ASSISTANCE POLICY

The business of Lincoln Electric is manufacturing and selling high quality welding equipment, automated welding systems, consumables, and cutting equipment. Our challenge is to meet the needs of our customers, who are experts in their fields, and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for information or technical information about their use of our products. Our employees respond to inquiries to the best of their ability based on information and specifications provided to them by the customers and the knowledge they may have concerning the application. Our employees, however, are not in a position to verify the information provided or to evaluate the engineering requirements for the particular weldment, or to provide engineering advice in relation to a specific situation. Accordingly, Lincoln Electric does not warrant or guarantee or assume any liability with respect to such information or communications. Moreover, the provision of such information or technical information does not create, expand, or alter any warranty on our products. Any express or implied warranty that might arise from the information or technical information, including any implied warranty of merchantability or any warranty of fitness for any customers' particular purpose or any other equivalent or similar warranty is specifically disclaimed.

Lincoln Electric is a responsive manufacturer, but the definition of specifications, and the selection and use of specific products sold by Lincoln Electric is solely within the control of, and remains the sole responsibility of the customer. Many variables beyond the control of Lincoln Electric affect the results obtained in applying these types of fabrication methods and service requirements.

Subject to Change – This information is accurate to the best of our knowledge at the time of printing. Please refer to www.lincolnelectric.com for any updated information.

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