HARDFACING INFORMATION

What is Hardfacing and where is it used?

'Hardfacing is the process of depositing, by one of various welding techniques, a layer or layers of metal of specific properties on certain areas of metal parts that are exposed to wear'.
By expanding this definition a little further, it can be seen that hardfacing has more to offer than most other wear prevention treatments:

1. It is performed by welding. Thus it is part of a well established practice with which people are familiar. There are very few new skills to be learned and in the vast majority of cases, existing equipment can be employed.

2. A layer or layers of metal can be deposited. This means that hardfacing provides protection in depth. It can be applied in a thickness required to give long lasting protection.

3. Metal of specific properties is deposited. There are a wide variety of deposit types available, each specifically designed to withstand certain forms of wear and service conditions.

4. Hardfacing is applied only to specific areas of metal parts that are exposed to wear. There is often no need to protect the entire surface of a component from wear. Hardfacing can be applied selectively and in different thicknesses to suit the exact requirements of a piece of equipment, thereby proving a most economical way of combating wear.

According to the American Welding Society, 'hard surfacing" or hardfacing is defined as;
'The deposition of filler metal on a metal surface to obtain the desired properties and/or dimensions', the desired properties being those that will resist abrasion, heat and corrosion.

A further definition of hardfacing is: "The application of hard, wear-resistant material to the surface of a component by welding, spraying or allied welding process for the main purpose of reducing wear or loss of metal by abrasion, impact, erosion, galling and cavitation". It also applies where corrosion and elevated temperatures are present with one or more of the above service conditions.

Hardfacing is a particular form of surfacing that excludes the application of materials primarily for corrosion prevention or resistance to high temperature scaling or the application of low hardness, low friction over-lays to prevent galling - eg. bronze surfacing. It also excludes the hardening of surfaces solely by heat treatments such as flame hardening, or nitriding.

A wide range of Cobalarc electrode and wire products are available for the three main types of hardfacing applications carried out in industry;

1. **Build-up or re-building applications.**
2. **Hard surfacing or overlay applications.**
3. **Both build-up and overlay applications.**

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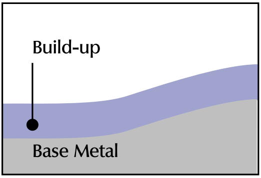
HARDFACING INFORMATION

What is Hardfacing and where is it used?

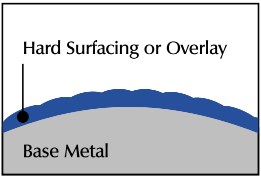
1. **Build-up or re-building applications**
   - Used to return the part or component to its original dimensions.

   eg. Mangcraft, Ferrocraft 61etc.



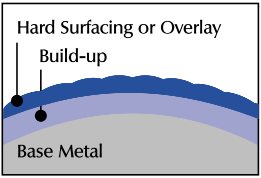
2. **Hard Surfacing or overlay applications.**
   - Used by itself to give a component added resistance to wear.

   eg. Cobalarc 650 and Coarseclad-G.



3. **Build-up and overlay applications.**

   Build-up and overlay can be used together to re-build a part to its original size and protect the contact surface from further wear. Some alloys can serve as both a build-up and overlay deposit, such as Cobalarc Mang Nickel-O wire which is recommended for heavy build up. During service the final layers of Mang Nickel-O can work harden under heavy impact to form a wear resistant overlay.



"Buttering layers" or "buffer layers" are a form of build-up or intermediate layer, deposited prior to the application of an overlay or hard surfacing deposit. See the **"Use of buffer layers"** for further details.

Hardfacing (or build-up and or overlay) is therefore used in two main areas:

1. **For the build-up or rebuilding** of worn components to their original size and shape using suitable build-up or build-up and overlay alloys as described above.

2. **The overlay or hard surfacing** of new, or as new, components to protect them from wear during service. High alloy welding consumables are available for overlay applications which offer far better wear resistance than the original component material. Despite the higher price of these welding consumables the working life of the component can be extended by over twice that of the original component. Further more, if overlays are used as part of a preventative maintenance program the original component can be manufactured from a less expensive base material.

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HARDFACING INFORMATION

Why should Hardfacing be carried out?

1. **Hardfacing extends the life of worn components and equipment:**
   - Build-up or hard surfacing can extend the life of a component by as much as 250% compared to that of a new or non hardfaced component.

2. **Hardfacing increases the operating efficiency of equipment by reducing downtime:**
   - Hardfaced components last longer, cause fewer shutdowns or stoppages and therefore increase the operating efficiency of the equipment.

3. **Hardfacing reduces overall costs:**
   - The cost of refurbishing a worn component is typically 50 - 75% of the cost of a new component.

4. **Hardfaced parts can be manufactured from cheaper base metals:**
   - A part which is hard surfaced before use can often be manufactured from a cheaper base metal than one which is not designed to be hard surfaced before use.

5. **Hardfacing minimise the inventory of spare parts:**
   - If worn parts are usually refurbished there is no need to keep high stock holdings.

How to choose the right hardfacing consumable

Hardfacing alloy selection and correct welding procedures are best determined by answering the following four questions:

1. What is the base metal of the component?
2. What welding process is to be used?
3. What type of wear is being experienced?
4. What finish is required?

1. What is the base metal of the component?

Knowing the base metal composition of the component is important in deciding what welding consumable to use and what welding procedure to adopt.
The most common ferrous base metals used fall into two broad classifications:

- ▲ **Carbon and low alloy steels.**
- ▲ **Austenitic Manganese steels.**

Carbon and low alloy steels. Carbon and low alloy steels are strongly magnetic and can easily be distinguished from austenitic manganese steels which are non-magnetic. There are many types of carbon and low alloy steels used in equipment manufacture. They are not easy to distinguish from one another but must be identified in order to establish accurate preheat, interpass, welding consumable, cooling rate and stress relief requirements.

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How to choose the right hardfacing consumable

Generally speaking as alloy content increases base metals become more difficult to weld and the use of correct preheat and interpass temperatures and slow cooling become more critical. Please refer to the **Welding of Steels** in this handbook.

Austenitic manganese steels. These high manganese (typically 14%) steels are strong and tough and as such are often used in the manufacture of components subject to both abrasion and extreme impact. Unique to manganese steels, they can be work hardened during high impact service to yield a component which is hard and abrasion resistant on the surface and yet tough, strong and ductile underneath. Unlike carbon and low alloy steels, manganese steels are rarely preheated; in fact base metal temperature during welding must be kept below approximately 300°C to avoid embrittlement. Welding practices such as step welding, water spraying or "welding in water" are often carried out to avoid base metal embrittlement. Manganese steels are an excellent base for the application of chromium white iron hard surfacing deposits such as Cobalarc Coarseclad-G, -O.

2. What welding process is to be used?

The welding processes most commonly used today for hardfacing are:

1. Manual Metal Arc Welding
2. Flux Cored Arc Welding
3. Submerged Arc Welding

Other processes such as oxy-acetylene welding and gas tungsten arc (GTA or TIG) welding are more often used for specialist hardfacing applications because of their low deposition rates.

Factors to be considered when selecting a suitable welding process / consumable include:

- ▲ Welding equipment available.
- ▲ Operator skills available.
- ▲ Welding location - indoors or outdoors.
- ▲ Size and shape of component and area to be hardfaced.
- ▲ Welding position - can component be moved to allow downhand welding?
- ▲ Availability of hardfacing consumables.

1. Manual Metal Arc Welding.

The most common type of welding process used with a wide range of extruded and tubular welding electrodes available for build-up and hard surfacing applications as well as for joining applications.

The most common types of manual electrodes are those designated as A4 and A1 types in Australian/New Zealand Standard AS/NZS 2576 - Welding Consumables for Build-up and wear resistance.

A1 type = Tubular electrodes with no alloy contribution from the flux coating, eg. Cobalarc 9.

A4 type = Low carbon steel rod with an alloy additive flux coating, eg. Cobalarc 350.

Note: See Consumables Classification Charts in this Pocket Guide for an explanation of AS/NZS 2576.

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HARDFACING INFORMATION

How to choose the right hardfacing consumable

2. Flux Cored Arc Welding.

A semi-automatic process which is a variant of the gas metal arc welding process, where a continuous tubular electrode (instead of a solid wire) is used to provide the build-up or hard surfacing deposit.

The most common types of tubular wires are those designated as B5 and B7 types in AS/NZS 2576.

B5 type = Tubular wires which are used with an external gas shielding, eg. Cobalarc Coarseclad-G.

B7 type = Tubular wires which are self shielding or require no external shielding gas, eg. Cobalarc Coarseclad-O.

Because of the high level of build-up and hard surfacing carried out "on site" or out-of-doors self shielded (B7 type) wires are the most popular. Self shielded wires are also called open arc wires because the welding arc is visible during welding.

The flux cored arc welding process has become increasingly popular for build-up and hardfacing applications because of the flexibility in alloy selection and wire size and the high deposition rates achievable in practice.

3. Submerged Arc Welding.

Commonly used in the automatic mode, with either:

- An alloy additive tubular wire/strip and neutral flux (B1 type in AS/NZS 2576),
- An alloy additive solid wire/strip and neutral flux (B2 type in AS/NZS 2576),
- An alloy additive solid wire/strip with an alloy additive flux (B3 type in AS/NZS 2576) or,
- A low carbon steel wire/strip with an alloy additive flux (B4 type in AS/NZS 2576)

The submerged arc welding process is commonly used to build-up or hard surface large components automatically. The B1 type wire / flux combination is the most popular option used because of the flexibility in alloy types available in a tubular wire.

3. What type of wear is being experienced

In selecting a build-up or hard surfacing alloy the aim is to provide the best solution to the specific wear problem at hand. This solution is usually arrived at by considering a combination of factors including; past experience, a knowledge of the wear types experienced, a knowledge of welding alloy wear performance and verification through practical tests. It would be easier to select a welding consumable for a particular application if the component was always subjected to the one set of wear conditions. Unfortunately this is never the case, with wear modes differing from one component to another and from one application to another.

Experience has shown that there are three major types of wear:

- ▲ **Metal-to-metal wear,**
- ▲ **Abrasive wear,**
- ▲ **Environmental wear.**

A detailed treatment of these wear types is beyond the scope of this handbook, please refer to Australian/New Zealand Standard AS/NZS 2576.

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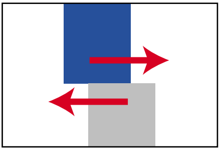
How to choose the right hardfacing consumable

3. What type of wear is being experienced cont.

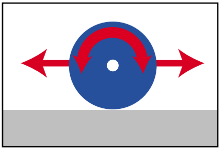
The three major types of wear can be further sub-divided into;

▲ Metal-to-metal wear:

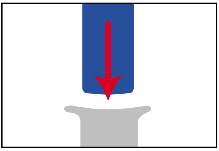
1. Adhesive or sliding wear:
In sliding wear, friction occurs between two surfaces which are in intimate contact.



2. Rolling wear:
In rolling wear, contact stresses are often high and wear occurs by a fatigue mechanism.

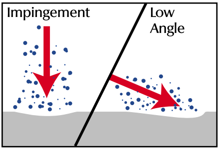


3. Impact wear:
In impact wear, parts encounter repeated impact which can cause brittle fracture or gross plastic deformation.



▲ Abrasive wear:

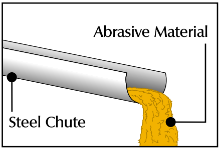
1. Erosion:
In erosive wear, parts encounter high velocity fluids (liquids or gaseous) with or without solid particles. The two major types of erosion experienced are:



1A. Solid particle erosion:
Wear of a part by the action of solid particles impinging on the surface.

1B. Liquid droplet and cavitation erosion:
Wear of a part by the action of liquid droplets or bubbles on the surface.

2. Low stress (scratching) abrasion:
In low stress abrasion, the abrasive particles, which are usually small and unconstrained, scratch the surface continuously to cause wear. The particles are not fractured or ground up during service.



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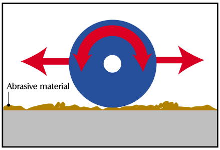
How to choose the right hardfacing consumable

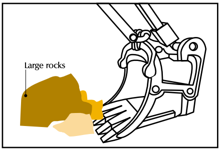
What type of wear is being experienced cont.

▲ Abrasive wear:



3. High stress (grinding) abrasion:

In high stress abrasion, the abrasive particles, which are initially small (rocks < 50mm in diameter), are fractured or ground-up during service.



4. Gouging abrasion:

In gouging abrasion, the abrasive particles, which are usually large (rocks > 50mm in diameter), gouge or groove the surface during service.

▲ Environmental wear:

Corrosion and elevated temperatures can combine with the abrasive wear mechanisms detailed above to exacibate the wear of a component. A detailed treatment of environmental wear mechanisms is beyond the scope of this handbook, please refer to AS/NZS 2576.

Limiting Service Conditions

Table 1. is a guide to selecting the appropriate Cobalarc hardfacing product based on the wear types identified from a specific application. The severity of loading, impact and temperature on a component must be considered along with the main wear mechanisms identified in order to select an appropriate Cobalarc hardfacing product.

In **Table 1**. the service conditions of load, impact and temperature are graded as follows:

Loading:

● ● ● = **HIGH loading** where there is ***gross*** deformation of the wear surface,
● ● = **MODERATE loading** where there is ***some*** local deformation of the wear surface,
● = **LOW loading** where there is ***no*** local deformation of the wear surface.

Impact:

HIGH = **HIGH impact** causing fracture or plastic deformation of the wear surface,
LOW = **LOW impact** causing ***no*** fracture or plastic deformation of the wear surface.

Temperature:

< 200°C - Service temperatures from ambient to 200°C,
> 200°C < 500°C - Service temperatures greater than 200°C and less than 500°C,
> 500°C - Service temperatures greater than 500°C.

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Cobalarc Product Selection by Wear Type - Table 1:

Cobalarc product	Limiting service conditions*			WEAR TYPE							
				Metal-to-metal			Abrasive wear				
	Loading	Impact	Temp.	Sliding	Rolling	Impact	Solid particle erosion	Liquid droplet erosion	Low stress abrasion	High stress abrasion (Grinding)	Gouging abrasion
Cobalarc Mangcraft, Cobalarc Mang Nickel-O	●●●	HIGH	<200°C	---	---	R	---	---	---	R	R
Cobalarc Austex,	●●●	HIGH	<500°C	---	R	R	---	---	---	---	---
Cobalarc 350, Cobalarc 350-G, -O,	●●●	HIGH & LOW	<200°C	R	R	R	---	---	---	---	---
Cobalarc Toolcraft	●●●	LOW	<500°C	R	R	R	---	---	---	R	---
Cobalarc 650, 750 Cobalarc 650-G, -O Cobalarc 850-O†	●●●	HIGH	<200°C	---	---	---	R	---	R	R	R

* See previous page for limiting service condition definitions.

R = Recommended.

HR = Highly Recommended.

† Cobalarc 850-O is not recommended for high impact applications

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HARDFACING INFORMATION

Cobalarc Product Selection by Wear Type - Table 1:

Cobalarc product	Limiting service conditions*			WEAR TYPE							
				Metal-to-metal			Abrasive wear				
	Loading	Impact	Temp.	Sliding	Rolling	Impact	Solid particle erosion	Liquid droplet erosion	Low stress abrasion	High stress abrasion (Grinding)	Gouging abrasion
Cobalarc CR70, Coarseclad-G, -O	●●	HIGH	<500°C	---	---	---	R	R	HR	HR	HR
Cobalarc 9,	●●	HIGH	<500°C	---	---	---	R	R	HR	HR	HR
Cobalarc Borochrome Cobalarc Fineclad-O	●●	LOW	<500°C	---	---	---	R	HR	HR	HR	R
Cobalarc 4,	●	LOW	<200°C	---	---	---	HR	R	HR	R	R
Bronzecraft AC-DC	●●	LOW	<200°C	R	R	R	---	---	---	---	---
Comweld Manganese Bronze and Comweld Comcoat C	●	LOW	<200°C	R	R	---	---	---	---	---	---
Comweld Nickel Bronze and Comweld Comcoat N	●●●	HIGH	<200°C	HR	R	R	R	R	R	---	---

* See previous page for limiting service condition definitions.

R = Recommended. HR = Highly Recommended.

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Cobalarc Applications by Industry Sector

AGRICULTURAL EQUIPMENT

APPLICATION	Cobalarc electrode	Cobalarc wire
▲ Slasher Blades	Toolcraft	Cobalarc 650-G, -O
▲ Tools and Drill Bits	Toolcraft	-
▲ Scarifier Points	Cobalarc 750, Cobalarc 9	Cobalarc 850-O
▲ Plough Shares	Cobalarc CR70	Cobalarc Coarseclad-G, -O
▲ Ammonia Injector Knives	Cobalarc 9, Cobalarc 4	
▲ Subsoiler teeth	Cobalarc CR70, Cobalarc 4	Cobalarc Coarseclad-G, -O
▲ Ripper Shanks	Cobalarc 9	
▲ Furrow Shovels	Cobalarc 9	
▲ Post Hole Augers	Cobalarc 9	
▲ Pilot bit	Cobalarc Toolcraft	
▲ Rollers and Tractor Machine Parts	Cobalarc 350	Cobalarc 350-G, -O
▲ Root Cutters	Cobalarc CR70, Cobalarc 9	Cobalarc Coarseclad-G, -O

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HARDFACING INFORMATION

Cobalarc Applications by Industry Sector

EARTHMOVING, MINING, CRUSHING & QUARRYING

APPLICATION	Cobalarc electrode		Cobalarc wire	
	Build-up	Hard Surfacing	Build-up	Hard Surfacing
▲ Track Pads	Cobalarc 350		Cobalarc 350	-
▲ Rippers	---	Cobalarc 9	---	Cobalarc Coarseclad
▲ Grouser Bars	Cobalarc 350	Cobalarc 650	Cobalarc 350	Cobalarc 650
▲ Loader Buckets	---	Cobalarc 9	---	Cobalarc Coarseclad
▲ Idlers and Idler Rolls	Cobalarc 350	-	Cobalarc 350	-
▲ Teeth and Points	---	Cobalarc 9	---	Cobalarc Coarseclad
▲ Drilling Augers	---	Cobalarc CR70, Cobalarc 9	---	Cobalarc Coarseclad
▲ Crusher Jaws*, Crusher Cones*, Crusher Roll Shells*, Gyratory Crusher Mantle*	Cobalarc Mangcraft,	Cobalarc CR70, Cobalarc 9	Cobalarc Mang Nickel,	Cobalarc Coarseclad
▲ Hammer Mill Hammers*	Cobalarc Mangcraft,	Cobalarc CR70, Cobalarc 9	Cobalarc Mang Nickel,	Cobalarc Coarseclad
▲ Impact Breaker Bars*	Cobalarc Mangcraft,	Cobalarc CR70, Cobalarc 9	Cobalarc Mang Nickel,	Cobalarc Coarseclad
▲ Fan Blades	---	Cobalarc 9, Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Pug Mill Paddles	---	Cobalarc 9, Cobalarc 4	---	
▲ Sizing Screens		Cobalarc CR70, Cobalarc Borochrome		Cobalarc Coarseclad, Cobalarc Fineclad
▲ Chutes	---	Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Kiln Trunnions	Cobalarc 350	Cobalarc 650	Cobalarc 350	Cobalarc 650

* Manufactured from austenitic manganese steel

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Cobalarc Applications by Industry Sector

SUGAR INDUSTRY

APPLICATION	Cobalarc electrode		Cobalarc wire	
	Build-up	Hard Surfacing	Build-up	Hard Surfacing
▲ Cane Crushing Rolls	---	Cobalarc CR70, Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Preliminary Cane Leveller or Kicker Blades	---	Cobalarc 9, Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Cane Shredder Hammer	Ferrocraft 7016, Ferrocraft 61		Supre-Cor 5	
▲ Scraper, Trash and Return Plates	Cobalarc Austex	Cobalarc CR70, Cobalarc 9, Cobalarc Borochrome	Autocraft 309LSi	Cobalarc Coarseclad Cobalarc Fineclad
▲ Shredder Grid Bars	Cobalarc Austex	Cobalarc CR70, Cobalarc 9	Autocraft 309LSi	Cobalarc Coarseclad
▲ Cane Preparation Knives	---	Cobalarc 9, Cobalarc Toolcraft	---	Cobalarc Coarseclad
▲ Spiky Feed Rolls	Cobalarc Austex	Cobalarc CR70, Cobalarc 9	Autocraft 309LSi	Cobalarc Coarseclad
▲ Cane Harvester Base Cutters and Elevator Rolls	---	Cobalarc 9	---	Cobalarc Coarseclad

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Cobalarc Applications by Industry Sector

DREDGING INDUSTRY

APPLICATION	Cobalarc electrode		Cobalarc wire	
	Build-up	Hard Surfacing	Build-up	Hard Surfacing
▲ Carbon Steel Pump Casings	Cobalarc 350	Cobalarc CR70, Cobalarc Borochrome	Cobalarc 350	Cobalarc Coarseclad, Cobalarc Fineclad
▲ Manganese Steel Pump Casings	Cobalarc Mangcraft,	Cobalarc CR70, Cobalarc Borochrome	Cobalarc Mang Nickel,	Cobalarc Coarseclad, Cobalarc Fineclad
▲ Dredge Pump Impellers	---	Cobalarc Borochrome, Cobalarc CR70	---	Cobalarc Fineclad, Cobalarc Coarseclad
▲ Dredge Pump Side Plates	---	Cobalarc Borochrome, Cobalarc 9	---	Cobalarc Fineclad
▲ Manganese Steel Dredge Cutter Heads and Teeth		Cobalarc Borochrome, Cobalarc 9		Cobalarc Fineclad
▲ Dredge Bucket Lips	---	Cobalarc Borochrome, Cobalarc 9	---	Cobalarc Fineclad
▲ Pipeline Ball Joints	---	Cobalarc Borochrome, Cobalarc 9	---	Cobalarc Fineclad
▲ Ladder Roll Bearing Box	Cobalarc 350	---	Cobalarc 350	
▲ Dredge Ladder Rolls	Cobalarc 350	Cobalarc 650	Cobalarc 350	Cobalarc 650
▲ Dredge Pump Inlet Nozzle	---	Cobalarc Borochrome, Cobalarc CR70	---	Cobalarc Fineclad, Cobalarc Coarseclad
▲ Bucket Pins		Cobalarc 650		Cobalarc 650
▲ Carbon Steel Lower Tumblers		Cobalarc 650		Cobalarc 650
▲ Manganese Steel Lower Tumblers	Cobalarc Mangcraft,	Cobalarc Mangcraft,	Cobalarc Mang Nickel,	Cobalarc Mang Nickel,

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Cobalarc Applications by Industry Sector

CEMENT, BRICK & CLAY INDUSTRIES

APPLICATION	Cobalarc electrode		Cobalarc wire	
	Build-up	Hard Surfacing	Build-up	Hard Surfacing
▲ Kiln Trunnions	Cobalarc 350		Cobalarc 350	---
▲ Screw Flight Shaft Bearings, Hangers and Pins	---	Cobalarc CR70	---	Cobalarc Coarseclad Cobalarc Fineclad
▲ Drag Chain Links	---	Cobalarc CR70	---	Cobalarc Coarseclad Cobalarc Fineclad
▲ Cage Bars	Cobalarc Austex	Cobalarc 9		Cobalarc Fineclad
▲ Manganese Steel Mill Hammers	Cobalarc Austex, Cobalarc Mangcraft	Cobalarc 9	Cobalarc Mang Nickel	Cobalarc Coarseclad
▲ Bag Packer Screws	---	Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Slurry Tank Agitator Shaft	---	Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Muller Tyres	Cobalarc Austex, Weldall	Cobalarc CR70 Cobalarc 9		Cobalarc Coarseclad
▲ Pug Mill Auger Flights	---	Cobalarc Borochrome Cobalarc 9 Cobalarc 4	---	Cobalarc Fineclad
▲ Pug Mill Knives	---	Cobalarc 4	---	
▲ Feeder Blades	---	Cobalarc 4	---	
▲ Shredder Cones	---	Cobalarc 9 Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Shredder Knives	---	Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Brick Pin Assembly	---	Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Roll Crusher Teeth	---	Cobalarc 9	---	Cobalarc Coarseclad

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Cobalarc Applications by Industry Sector

IRON AND STEEL INDUSTRY

APPLICATION	Cobalarc electrode		Cobalarc wire	
	Build-up	Hard Surfacing	Build-up	Hard Surfacing
▲ Blast Furnace Bells	---	---	---	Cobalarc Coarseclad (burden area)
▲ Coke Chutes	---	Cobalarc 9, Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Coke Oven Pusher Shoes	---	Cobalarc 9, Cobalarc Borochrome	---	Cobalarc Fineclad
▲ Coupling Boxes	Cobalarc 350	Cobalarc 650, Cobalarc 750	Cobalarc 350	Cobalarc 650,
▲ Screw Conveyors	---	Cobalarc CR70, Cobalarc 9	---	Cobalarc Coarseclad
▲ Grizzly Bars and Fingers		Cobalarc CR70, Cobalarc 9		Cobalarc Coarseclad
▲ Pig Iron Casting Machine Rails	---	Cobalarc 650, Cobalarc Toolcraft	--- Cobalarc 350	Cobalarc 650, Cobalarc 850
▲ Wobblers	Cobalarc 350	Cobalarc 650, Cobalarc 750		Cobalarc 650
▲ Ingot Buggy Wheels and Tracks	---	---	Cobalarc 350	Cobalarc 650
▲ Sand Slinger Cups Inlet Nozzle	---	Cobalarc Borochrome, Cobalarc CR70	---	Cobalarc Coarseclad, Cobalarc Fineclad

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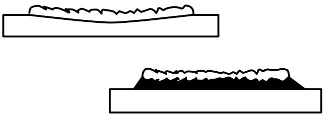
USE OF BUFFER LAYERS

The term buffer layer is used to describe the presence of an intermediate deposit between the base material and the actual hardfacing deposit and in a number of cases is both desirable and necessary.

1. Hardfacing on a soft material for high load service.

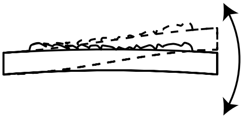
When a hardfacing deposit is placed on a softer base materials there is a tendency for it to "sink in" under high loading. To overcome this a strong, tough layer is deposited onto the base materials prior to hardfacing.



2. Hardfacing on components subject to heavy Impact/Flexing.

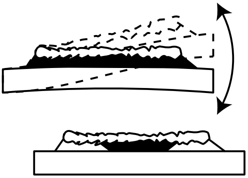
When a component is subjected to heavy impact and/or flexing there is the possibility that relief checks which are common in the higher hardness range of hardfacing products will act as stress concentrators and propagate through to the base materials, particularly where the base material is a high strength steel.

The use of a suitable buffer layer between the base and hardfacing deposit will overcome this problem.



3. Hardfacing over Partly Worn Components.

In many instances components which have been hardfaced and put into service wear unevenly and when presented for hardfacing again there are areas of the original hardfacing deposit still existing. For the softer, multilayer deposits and/or deposits which have not fractured under impact, hardfacing can be re-applied directly. However for fractured and very hard deposits it is necessary they be removed by grinding, gouging etc. prior to re-hardfacing. If this is not possible the use of buffer layer will secure the existing hardfacing and provide a tough base for subsequent hardfacing layers.



NOTE: When applying buffer layers, particularly on 11-14% manganese steel or the higher strength base materials ensure that the buffer layer extends beyond the hardfacing deposit. This will overcome the possible propagation of relief checks or cracks occurring along the edge of the hardface deposit.

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HARDFACING INFORMATION

HARDFACING DEPOSIT PATTERNS

The amount of hard surfacing and the pattern of coverage will be determined by a number of factors including the function of the component, service conditions and the state of repair. The three main patterns used are:-

1. Continuous Coverage.

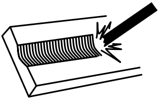
Is used for re-building and hardfacing parts that have a critical size or shape, such as rolls, shafts, tracks, crusher jaws and cones. It is also required on parts subject to a high degree of fine abrasion or erosion. Typical examples would be pump and fan impellers, sand chutes, valve seats, mixer paddles and dredge bucket lips. Sufficient over-lapping of each bead is necessary to ensure adequate coverage.


CORRECT

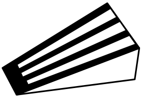

INCORRECT

2. Stringer Beads.

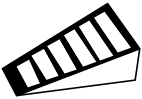
Other than complete coverage, stringer beads are widely used for many applications including, ripper teeth, buckets/bucket teeth, rock chutes, sheep foot tempers etc.



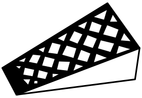
For teeth working in coarse rocky conditions the bead is deposited in the direction of the material travel, allowing the large lumps of rock etc. to slide along the top of the hardfacing bead.



In fine sandy conditions the stringer beads should be transverse (across) the path of material travel, this allows the fine materials to compact between the beads and so give self protection.



For conditions where there is a combination of coarse and fine material the "checker" or "waffle" pattern is generally used.



3. Dot Pattern.

For less critical areas such as the sides/ends of buckets, shovels etc. the dot pattern is used. It is useful in keeping the heat input down, particularly for the 11%-14% austenitic manganese steels. The dot size is generally 15-20mm diameter by 8mm high and placed at about 50mm centres.

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HARDFACING INFORMATION

Cobalarc Product Selection by Alloy Type and Application

Group 1. Steel Products	Alloy Type	AS/NZS class	Description & Applications
Cobalarc Mangcraft, Cobalarc Mang Nickel-O	Austenitic manganese steels.	1215-A4 1215-B7	**Tough, work hardens on impact.** Crusher jaws, rolls, mantles, ball mill liners.
Cobalarc Austex,	Austenitic stainless steels.	1315-A4	**Tough, corrosion and heat resistant.** Forms strong welds between dissimilar irons / steels. Tramway rails, crossings, bearings at medium temperatures, tractor track grousers, anvils, pneumatic tools, shredder bars.
Cobalarc 350, Cobalarc 350-G, -O,	Low carbon martensitic steels.	1435-A4 1435-B5/7	**Excellent compressive strength and metal-to-metal wear resistance.** Re-building and surfacing of clutch parts, railway points and crossings, track components.
Cobalarc Toolcraft	Tool steels.	1560-A4	**Strong, secondary hardening characteristics.** Machine tools, lathe tools, shears, drills, guillotine blades, cutting knives, punches, dies, metal forming tools.
Cobalarc 650, Cobalarc 750, Cobalarc 650-G, -O, Cobalarc 850-O	High carbon martensitic steels.	1855-A4 1860-A4 1855-B5/B7 1865-B7	**Hard, relatively in-expensive, good general abrasion resistance.** Surfacing of post-hole augers, earth scoops, conveyor screws, drag line buckets, pump housings, subsoiler teeth, scarifier points, plough shears.

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HARDFACING INFORMATION

Cobalarc Product Selection by Alloy Type and Application

Group 2. Chromium White Irons	Alloy Type	AS/NZS class	Description & Applications
Cobalarc CR70, Cobalarc Coarseclad-G,-O	Austenitic chromium carbide irons.	2355-A4 2360-B5/B7	**Strong, high level of chromium carbides for excellent abrasion resistance. Ideal for gouging (coarse) abrasion conditions.** Crusher cones and mantles, swing hammers, grizzly bars, scarifier points, shovel teeth, earthmoving buckets and sugar harvesting and milling equipment.
Cobalarc 9,	Complex chromium carbide irons.	2460-A1	**Strong, high level of complex carbides for excellent abrasion resistance. Ideal for wide range of abrasion conditions with relatively high impact loading.** Sizing screens, ball mill liner plates, dredge pump impellers, crusher jaws, pug mill paddles, agricultural implements, scrapers, fan blades, bucket lips and side plates.
Cobalarc Borochrome, Cobalarc Fineclad-O	Martensitic chromium carbide irons.	2560-A4 2565-B7	**Strong, high level of chromium carbides for excellent abrasion resistance. Ideal for low stress scratching (wet or dry) abrasion conditions with relatively low impact loading.** Wet applications in mining and crushing industries, agricultural implements, sand slingers, cement chutes, fan blades and slurry pump components.

Group 3. Tungsten Carbide Composites	Alloy Type	AS/NZS class	Description & Applications
Cobalarc 4,	Tungsten carbide granules in an iron rich matrix.	3460-A1	**Hard, tungsten carbide (WC) iron deposit resistant to severe abrasion and low impact loading.** **Ideal for earth cutting and boring applications.** Rock drills, ditcher teeth, ripper points, oil drill collars auger blades and teeth, oil well drills, bulldozer end bits.

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HARDFACING INFORMATION

Cobalarc Product Selection by Alloy Type and Application

Group 4. Copper Alloys	Alloy Type	AS/NZS class	Description & Applications
Bronzecraft AC-DC,	Phosphor bronze	6200-A2	**Good bearing properties, wear & corrosion resistant.** Medium load bearings, crankpress, transmission housings, pump rotors.
Comweld Manganese Bronze, Comweld Comcoat C	High tensile brass.	6300-C1 6300-C1	**Low friction bearing characteristics, wear and corrosion resistant.** Light load bearings, Hydraulic rams and pistons.
Comweld Nickel Bronze, Comweld Comcoat N	Nickel bronze (9-13% Ni).	6400-C1 6400-C1	**Low friction bearing characteristics, work hardenable, corrosion resistant.** Gear teeth, cams, bearings, percussion heads, slides, service where work hardening is required.

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HARDFACING INFORMATION

Costing Information:

Based on the fact that the decision to hardface is an economic one, that is, to extend the working life of a component (ie. rebuild rather than replace), then the calculation of the true cost of hardfacing the component is important.

Points to consider in calculation of an estimated cost include:-

1. **Volume of build-up of hardsurfacing deposit required.**
2. **Cost of welding consumables.**
3. **Preparation prior to welding (including grinding, preheat etc.).**
4. **Post weld requirements (heat treatment, grinding, machining etc.).**
5. **Power, labour and overhead costs.**

Other important factors relating to the selection of the welding process/consumable are:-

1. **Deposition rate (kg of weld metal / hr).**
2. **Deposition efficiency (%).**
3. **Operating factor or Duty cycle (%).**

Cost Calculations:

WELDING ELECTRODE OR WIRE COST ; A ($ per kg of weld metal deposited):

$$\frac{\text{Electrode or Wire Price (\$ / kg)}}{\text{Deposition Efficiency * (\%)}} = \mathbf{A\ (\$ / kg)}$$

FLUX COST ; B (SAW only) ($ per kg of weld metal deposited):

$$\frac{\text{Flux Price (\$ / kg) x Consumption Rate (kg / hr)}}{\text{Deposition Rate (kg / hr)}} = \mathbf{B\ (\$ / kg)}$$

POWER COST; C ($ per kg of weld metal deposited);

$$\frac{\text{Cost of power (\$ / kWhr) x Volts x Amps}}{\text{Deposition Rate (kg / hr)}} = \mathbf{C\ (\$ / kg)}$$

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HARDFACING INFORMATION

COSTING INFORMATION:

LABOUR COST; D ($ per kg of weld metal deposited):

$$\frac{\text{Labour Cost (\$ / hr) x Deposition Rate (kg / hr)}}{\text{Operating Factor* (\%)}} = \text{D (\$ / kg)}$$

OVERHEAD COST; E ($ per kg of weld metal deposited):

$$\frac{\text{Overhead cost (\$ / hr) x Deposition Rate (kg / hr)}}{\text{Operating Factor* (\%)}} = \text{E (\$ / kg)}$$

Total cost; F ($ per kg of weld metal deposited):

F ($ / kg) = A + B + C + D + E

Total cost (TC) of hardfacing the steel component:

TC ($) = Volume of Build-up or hard surfacing deposit (cm^3) x F x 0.008

*Deposition Efficiencies and Operating Factors for Hardfacing Cost Calculations:

Process	Deposit Efficiency (%)	Typical Operating Factor (%)
MMAW	60 - 75	15 - 20
FCAW†	80 - 90	25 - 30
SAW	90 - 95#	35 - 40

† Semi-automatic operation.
# SAW wire only.

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