SURFACE PREPARATION GUIDE

INDUSTRIAL COATINGS

Concrete and Metal Surfaces

A.W. Chesterton Company

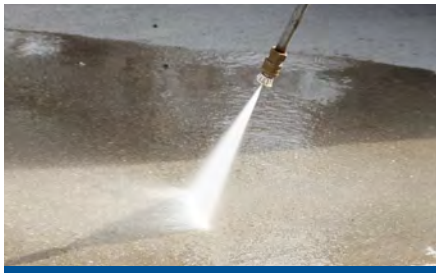
The Importance of Surface Preparation

Selecting the right high-performance coating for your application need is vital. But the proper preparation of the substrate surface is just as important to achieve long-term successful results. This is especially crucial when you are repairing eroded, abraded, or damaged equipment or structures. Surface preparation methods range from chemical cleaning and tool cleaning, to pressure water cleaning and abrasive blast cleaning. Read the real-life customer stories in this book to learn how.

In this ebook, you will learn important steps to prepare and check the surface of metals and concrete before applying the coating.

Read about:

1. Substrate cleanliness standards
2. Surface contamination steps
3. Blasting: choosing a media type
4. Concrete: determine surface roughness
5. Checking humidity levels before the coating application



"Surface preparation is the process of treating the surface of a substance in order to increase its adhesion to coatings. The single most important function that influences coating performance is the quality of surface preparation."

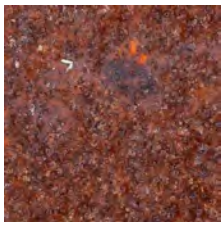
Source: Corosionpedia

SUBSTRATE CLEANLINESS STANDARDS

Substrate Cleanliness Standards

Before an industrial coating is applied to eroded, abraded, and corroded metal surfaces, the substrate surface must be adequately cleaned of loose material (dirt, rust, mill scale, and flaking), sticky material (oils, grease), as well as streaks, stains, and other anomalies. An unprepared or poorly-prepared metal substrate often significantly impacts the bonding strength of the coating and, ultimately, the cost of the project and the reliability of the equipment.

When requesting a quote from a coatings applicator, you need to specify the level of substrate cleanliness desired as part of achieving a successful coating project.



SOLVENT CLEANING
SP 1 / ISO 8504

Loosely-adhering material: **100%**
Tightly-adhering material: **100%**
Stains, streaks, shadows: **100%**

INDUSTRIAL BLAST CLEANING
SP 14 / NACE #8

Loosely-adhering material: **0%**
Tightly-adhering material: **10%**
Stains, streaks, shadows: **100%**

BRUSH OFF
SP 7 / NACE #4 / SA 1

Light Blast Cleaning; Sweep Blast
Loosely-adhering material: **0%**
Tightly-adhering material: **100%**
Stains, streaks, shadows: **100%**

COMMERCIAL BLAST CLEANING
SP 6 / NACE #3 / SA 2

Thorough Blast Cleaning
Loosely-adhering material: **0%**
Tightly-adhering material: **0%**
Stains, streaks, shadows: **33%**

SUBSTRATE CLEANLINESS STANDARDS

Target Standards for Coating Applications

Before applying industrial coatings to metal substrates, ARC Coating Specialists recommend achieving the cleaning standards below for success.

NEAR WHITE BLAST CLEANING
SP 10 / NACE #2 / SA 2.5

Very Thorough Blast Cleaning

Loosely-adhering material: **0%**

Tightly-adhering material: **0%**

Stains, streaks, shadows:
SP 10 **5%**, Sa 2 ½ **15%**

Typically accomplished via abrasive blasting or mechanical tools

WHITE METAL BLAST CLEANING
SP 5 / NACE #1 / SA 3

Blast Clean to Visibly Clean Steel

Loosely-adhering material: **0%**

Tightly-adhering material: **0%**

Stains, streaks, shadows: **0%**

Typically accomplished via abrasive blasting or mechanical tools

Some coatings use technologies which require less substrate preparation and therefore can be completed faster. ARC's BX5 Ultra Fast Curing Coating, for example, will adhere to minimally prepared surfaces. It will also adhere effectively to damp surfaces.

SURFACE CONTAMINATION STEPS

After cleaning but prior to applying the coating, you will want to conduct one or more tests for salt and sulfate, both of which can impact the long-term adherence of the coating.

1 Bresle Salts Contamination Test: ISO 8502-6 & ISO 8502-9

When salts could be present on the substrate, you should test for salts contamination. Left undetected and in unacceptably high levels, salts can induce a concentration or osmotic, gradient. This can induce rapid permeation of moisture through the film causing the coating to blister due to corrosion underneath.

1. Apply patch to surface ensuring a complete seal.
2. Fill syringe with 3 ml of de-mineralized water and inset into the foam perimeter of the patch and inject the water into the test area of the patch.
3. Without removing the needle withdraw and re-inject the solution four times.
4. Remove the syringe from the patch and test the conductivity of the solution.

2 Sulfate Contamination Test

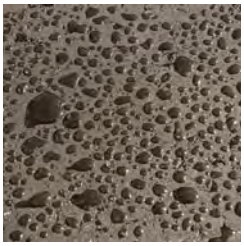
This is a qualitative test to determine if sulfates are present on the substrate surface. Sulfate ions on the surface react with the barium iodate present in the test strips, liberating Iodate ions. The sulfate concentration is then measured via visual comparison of the color of the measurement solution with the color card provided in the test kit.

3 pH Test

After physically preparing the concrete surface the pH test needs to be conducted. The pH test is designed to test the acidity of the concrete that is about to be coated. Naturally concrete is caustic with a pH of around 12. If the pH test indicate that the concrete is acidic it is an indication that further decontamination is needed to remove soluble acids that are present.

1. Place several drops of distilled or deionized water on a clean surface of concrete to form a puddle approximately 1 in. (25 mm) in diameter.
2. Allow the puddle to set for about 1 minute.
3. Dip the pH paper into the water.
4. Remove the pH paper immediately and compare with standard pH chart to determine pH reading.

SURFACE CONTAMINATION STEPS CONT.



4 Oil Contamination Test/Water Bead Test

The oil contamination test is designed to determine if there residual oil/grease contamination on the concrete. Concrete is naturally porous and absorbs water. This is a qualitative test.

1. Pour a few drops of water on a dry section of the concrete.
2. If the water is absorbed into the concrete, then the concrete is suitable to be coated.
3. If the water beads up on the surface of the concrete, then this is an indication of oil/grease contamination. Further cleaning of the concrete surface is required.
4. Repeat water bead test until pass results are achieved.

METAL AND CONCRETE SUBSTRATES

BLASTING: CHOOSING A MEDIA TYPE

Abrasive blasting propels a high-pressure stream of abrasive material against a substrate to roughen surfaces and remove surface contaminants. The blasting material or media type ranges from mild to highly abrasive.

The following chart shows the common types of blast media and the properties of each.

Media Type	Description Best/Use	Grit Size Range	Hardness	Shape	Surface Profile	Speed	Recyclability
Aluminum Oxide	Extremely sharp and long-lasting, best used for etching and profiling	Very Coarse to Extra Fine	8 – 9 Mohs	Angular	High Etch	Fast	High
Garnet	Industrial gemstone mineral best used for coating adhesion or where grit transfer is needed	Very Coarse to Fine	7 – 8 Mohs	Varies	High Etch	Fast	Medium
Silicon Carbide	Hard, aggressive cutting media, best used on hard surfaces	Very Coarse to Extra Fine	9 – 9.5 Mohs	Angular	Very High Etch	Very fast	High
Steel Shot*	Carbon steel best for polishing and smoothing surfaces	Medium to Ultra-Fine	40 – 51 HRC	Sphere	No Etch	Medium	Very High
Steel Grit*	Carbon steel best for aggressive cleaning and fast stripping	Super Coarse to Medium	40 – 65 HRC	Angular	High Etch	Medium to Fast	Very High

**Do not use steel shot or grit when blasting stainless steels*

Case Studies

Aluminum Smelter Vertical Mill Mixer

Challenge

Goals

- To refurbish 12 vertical mill mixers that required maintenance bi-monthly at a cost of $1.9K/M
- Extend the MTBR to > 9 months to reduce downtime and maintenance cost

Root Cause

The high temperature caustic mix in mills were abrading and damaging the fiberglass and rubber linings from the OEM. Additionally, the lining adhesive dis-bonded and delamination occurred. The metal substrate corroded.

Worn mill after failure of rubber and fiberglass.

Solution

Preparation

- Pressure wash and decontaminate surfaces
- Grit blasted to Sa 2.5 with 3 mil (75 µm) profile

Application

1. Apply ARC BX1* in lower section
2. Apply ARC BX2* in upper section
3. Smooth out irregularities with ARC 858
4. Topcoat with ARC 855 to reduce friction and protect against corrosion

Application of ARC BX1, BX2, and 855 coatings.

Results

Total applied cost ARC (12 mixers):	**$ 47K**

Client Reported After 24 Months

Extended MTBR of mills to >18 months vs. 2 months

First year savings:	$ 89K
1st year maintenance cost avoidance: (based on 12 mixers)	$136K
Total Savings:	**$178 K**

First mill after repair ready for delivery.

$=USD

*ARC BX1 is the "Bulk" package size of ARC 890
*ARC BX2 is the "Bulk" package size of ARC 897

Coal Chute (Square to Round Transition)

Challenge

Issue

Ceramic tile lasts 4 – 6 months in this application before cracking and delamination occurs. Exposed steel wears through and requires weld repair before re-tiling. Previous patch material lasts <7 days.

Goals

- Extend patch repair to >30 days
- Reduce maintenance cycle time to <12 hours

Root Cause

Brittle fracture failure of ceramic tiles results from impact of coal up to 10 cm (4 inch) diameter. Acidic wash water corrodes steel.

Damage to existing ceramic tiles caused unscheduled shutdown and loss of production.

Solution

Preparation

- Grind down residual ceramic epoxy with power tool
- Decontaminate surface with solvent (MEK)
- Grit blasted to Sa 2.5 with 3 mil (75 µm) profile

Application

1. Apply ARC BX5 at 120 – 200 mils (3 – 5 mm) to steel and cover up onto the ceramic tile
2. Apply ARC S2 at 12 mils (300 µm)

Installation of ARC BX5.

Results

Client Reported

- ARC repairs completed in eight hours
- ARC solution provided over six months service before a touch-up was required
- Due to success client has selected ARC coatings as "patch repair" for all tile-lined chutes and lines

ARC BX5 with ARC S2 topcoat cures rapidly, allowing fast return to service of chute.

$=USD

Dry Dock Water Pump

Challenge

Issue

The pump performed inefficiently, and increased downtime and maintenance. However, the lead time for a new pump was eight months and would also require modification to piping system.

Goal

Rebuild a 1949 pump to near new in less than two months with no modification to piping.

Root Cause

Severe corrosion/erosion in volute, backplate, and other wear parts as well as irreparable impeller with broken blade.

Cast Steel pump built in 1949 with a diameter of 2,5 meter, 30 m^3/minute.

Solution

Preparation

Pressure wash and decontaminate surfaces

Grit blast to Sa 2.5 with 3 mil (75 µm) profile

Application

1. Rebuild volute and parts using ARC 858
2. Machine to tolerance as required
3. Apply ARC BX1* and ARC BX2* and MX1 to high wear areas
4. Apply 2 coats ARC 855 total DFT of 1000 µm
5. Apply 2 coats ARC S2 total DFT of 500 µm to outside of pump

Thorough surface preparation.

Results

Breakdown of Costs	
New pump lead time:	8 months
New Chinese pump:	€ 110K
Modified piping and suction:	€ 250K
Total estimated installed costs (new):	**€360K**
Lead time on repairs:	4 weeks
New cast balanced impeller:	- € 17K
Cost of total ARC repairs:	- € 78K
Total ARC solution costs :	**- € 95K**
Total cost avoidance :	**€265K**
Lead time reduction:	7 months

Multiple ARC products used to address various wear levels and surface enhancement.

€ = Euro

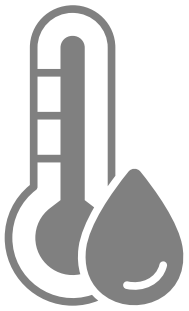
*ARC BX1 is the "Bulk" package size of ARC 890
*ARC BX2 is the "Bulk" package size of ARC 897

Marine — Dredge Pump
ARC 855, BX1*, BX2* and S2 Coatings

DETERMINE SURFACE HUMIDITY CONDITIONS

Checking Relative Humidity with the Dew Point Chart

When coating a substrate (either metals or concrete), the surface temperature must be a least 3ºC (5ºF) above the determined dew point. To determine dew point at various temperatures and relative humidity values, please refer to the Dew Point Chart below.



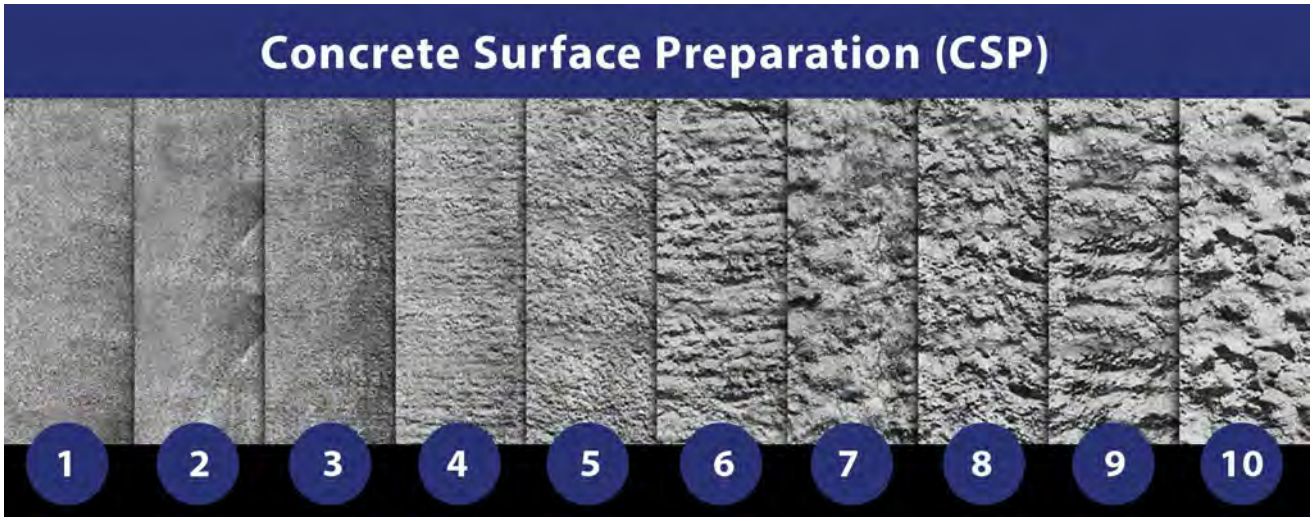
Ambient Temperature (degrees)	Percentage (%) Relative Humidity																		
	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
110	110	108	106	104	102	100	98	95	93	90	87	84	80	76	72	65	60	51	41
105	105	103	101	99	97	95	93	91	88	85	83	80	76	72	67	62	55	47	37
100	100	99	97	95	93	91	89	86	84	81	78	75	71	67	63	58	52	44	32
95	95	93	92	90	88	86	84	81	79	76	73	70	67	63	59	54	48	40	32
90	90	88	87	85	83	81	79	76	74	71	68	65	62	59	54	49	43	36	32
85	85	83	81	80	78	76	74	72	69	67	64	61	58	54	50	45	38	32	
80	80	78	77	75	73	71	69	67	65	62	59	56	53	50	45	40	35	32	
75	75	73	72	70	68	66	64	62	60	58	55	52	49	45	41	36	32		
70	70	68	67	65	63	61	59	57	55	53	50	47	44	40	37	32			
65	65	63	62	60	59	57	55	53	50	48	45	42	40	36	32				
60	60	58	57	55	53	52	50	48	45	43	41	38	35	32					
55	55	53	52	50	49	47	45	43	36	38	36	33	32						
50	50	48	46	45	44	42	40	38	36	34	32								
45	45	43	42	40	39	37	35	33	32										
40	40	39	37	35	34	32													
35	35	34	32																
32	32																		

DETERMINE SURFACE ROUGHNESS

Unprepared or poorly prepared concrete significantly impacts the bonding strength of the coating to the concrete substrate. It is imperative that a good surface profile is achieved to maximize the performance of the coating system. The desired profile can be achieved via abrasive blasting or mechanical grinding of the concrete surface.

Chesterton/ARC coating experts can help you determine the right coating for the surface and the level of preparation required for best performance of the coating selected.

The CSP is a standardized measure of the roughness of a surface as defined by the International Concrete Repair Institute (ICRI).



Visual representation of increasing surface roughness from CSP 1 to 10.

Petrochemical Neutralization Basin

Challenge

Issue

Severe corrosion to failing acid brick lined concrete basin resulted in leaks and environmental fines.

Goal

Avoid future fines and return basin to chemical resistant status.

Root Cause

Sulfuric and hydrochloric acids degrading mortar and grout lines

Basin in petrochemical complex

Solution

Preparation

Old acid brick was removed as well as damaged concrete.

Surfaces abrasive grit blasted and alkaline washed

Application

1. Cementitious mortar used to re-surface damaged concrete
2. All surfaces coated with 2 coats of ARC CS4 at 15-20 mil (375-500 µm)/coat to outside of pump

Surface preparation

Results

Client Reported

Repairs carried out over 2 week period.

Basin operated for 6+ years before repairs were required.

Acid brick estimate	$ 150,000
ARC lining	$ 47,000
Savings	**$ 103,000**

ARC CS4 final application

CHECKING MOISTURE CONTENT

The moisture content of concrete can have a significant effect on coating adhesion. The following three methods offer quantitative and qualitative methods to establish to what degree moisture vapor transmission or moisture content is present to the degree it can impact long term coating performance.

TEST 1: Calcium Chloride Test

This is a quantitative test involving a pre-measured amount of calcium chloride and a dome/cover used for sealing a specific area above the calcium chloride container.

1. Prepare concrete for coating (i.e., grind, grit blast etc.). There must be no contamination on the concrete.
2. Record the starting weight of the calcium chloride container.
3. Open the calcium chloride container and remove the lid.
4. Place the open dish on the concrete floor.
5. Place the dome over the calcium chloride container and ensure a proper seal.
6. Let the test sit on the concrete for 72 hours.
7. At the end of the testing period, re-weigh the calcium chloride container and record the weight gain.

Use the formula below to calculate the Moisture Vapor Emission Rate (MVER) of the concrete floor.

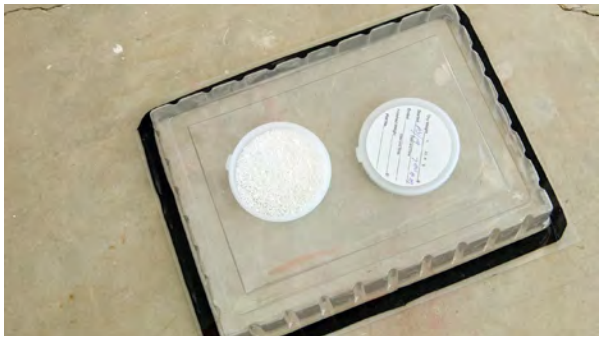
MVER = 118.932 X Gain/Time

MVER = Moisture Vapor Emission Rate

Gain = Weight gain of calcium chloride crystals in grams

Time = Exposure time in hours

The result is expressed as "pounds," which is the weight of water emitted as vapor over a 1,000 sq. foot area. If MVER is less than or equal to 3 lbs., the concrete can be coated. For values higher than 3 lbs. consult ARC Application Engineering.



TEST 2: Relative Humidity Test

This check is performed at time of application. The qualitative test is performed by sealing an insulated box against the concrete surface. The relative humidity is measured after 16 to 24 hours. If the relative humidity is 75% or less, then the concrete has an acceptable moisture content of 5% or less.

TEST 3: Plastic Sheet Test

This is a qualitative test to determine whether or not moisture exist in the concrete.

1. Place a large plastic sheet on the concrete area to be coated
2. Tape down the perimeter of the sheet
3. Leave in place undisturbed for 24 to 48 hours
4. Inspect the sheet for moisture

CONCRETE SUBSTRATE COATING TIPS

- Don't coat concrete when the surface temperature is rising or under direct radiant heat.
- As a rule, allow concrete to cure 28 days prior to coating.
- Exposed/rusted rebar should be removed/repaired and coated prior to coating concrete.
- When chemical attack and permeation is expected to be more than a surface effect, we recommend core sampling for a section analysis to determine depth of demolition.
- **All concrete should be prepared in the same way using abrasive blasting or grinding. Acid etching should NEVER be used.**

ACHIEVING COATING SUCCESS

The best coating on a poorly prepared surfaced is likely to fail early. Hopefully, this book has provided you with a map for successful surface preparation.

The most effective, long-lasting coating projects combine solid surface preparation with the correct, high performance coating for the specific application. For help on selecting that coating, as well as other coating applications expertise, reach out to your local Chesterton office about ARC coatings solutions or contact our ARC Application Engineering group.

For more information on coating preparation or for assistance with refurbishing equipment or structures, contact Chesterton at:

chesterton.com

ARC Industrial Coatings, a brand of A.W. Chesterton Company, has achieved a nearly four-decade proven global track record of enhancing critical industrial equipment and structures. ARC coatings are carefully engineered using the latest technologies and advanced material formulations—from ceramic bead reinforcement to nanotechnology—to withstand the most challenging environments. ARC's highly experienced engineering staff is constantly at work on new, innovative coating solutions to meet the needs of highly specific application environments.

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