



COATING INSPECTION PRACTICES

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PRIMARY CAUSES OF COATING FAILURES

It is estimated that 90% of all premature coating failures are caused either by inadequate/ improper surface preparation or improper application.

Preventive Steps for Coating Failure

- Have a coating specification on hand for the CM representative, Inspectors, Contractors etc.
- Review Expectations with all Parties prior to awarding bid and again prior to starting the project
- Inspect the quality of the work as it proceeds
- Use high quality, inspection instruments verified for accuracy

CAUSES OF COATING FAILURES

- Not designed for the service environment
- Inadequate surface preparation (1st)
- Poor application techniques or conditions
- Improper Mixing of Materials
- Improper-Formulation (Uncommon)
- Improper Handling or Storage (i.e. Temp.)

Basic Inspection Check Points

- Pre-surface Preparation Inspection
- Surface Preparation Inspection
- Coating Mixing, Thinning and Application Inspection
- Final Visual Inspection
- Holiday/Pinhole Detection

Surface Preparation & Coating Life

□ MANY FACTORS AFFECT THE LIFE OF A COATING:

1. Residues or oil, grease, rust, and soil which can prevent adhesion or mechanical bonding of the paint to the surface
2. Residues of various chemical salts, which can induce corrosion. (osmotic blistering)
3. Mil Scale which is cathodic to the steel and attacks it.

Surface Preparation & Coating Life

4. Anchor Pattern, which may be so rough that peaks are formed which are impossible to adequately protect with paint, or which is not rough enough, possibly causing coating failure because of a loss of adhesion.
5. Sharp ridges, burrs, edges, or cuts from mechanical equipment, which prevents adequate film thickness of coatings over the irregularities.
6. Surface condensation which if painted over, may result in blistering or delamination failure
7. Old coating which may have poor adhesion, may be incompatible, or may be too deteriorated for recoating.

Pre-Surface Preparation Inspection

- ▣ **Verify Removal of Grease/Oil Contamination prior to Abrasive Blast Cleaning**
 - **Visual Examination of pipe etc.**
 - **Water break test (distilled water in a plastic spray bottle is sprayed upon any suspected surface) If oil or grease is present it will bead up on the surface.**
 - **Black light detection, when required and feasible (A hand held battery powered black light can detect the presence of hydrocarbons by fluorescing a bluish green color.)**

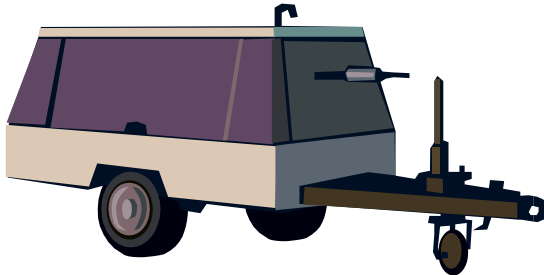
- ▣ **SSPC-SP1, “Solvent Cleaning”**
 - **Clean contaminated area with a solvent and white lint free rags (cotton)**
 - **Visual verification of cleanliness (retest)**

Surface Preparation Inspection

- Ensure Blasting Sand or Grit is dry and in its original packaging with no contaminates



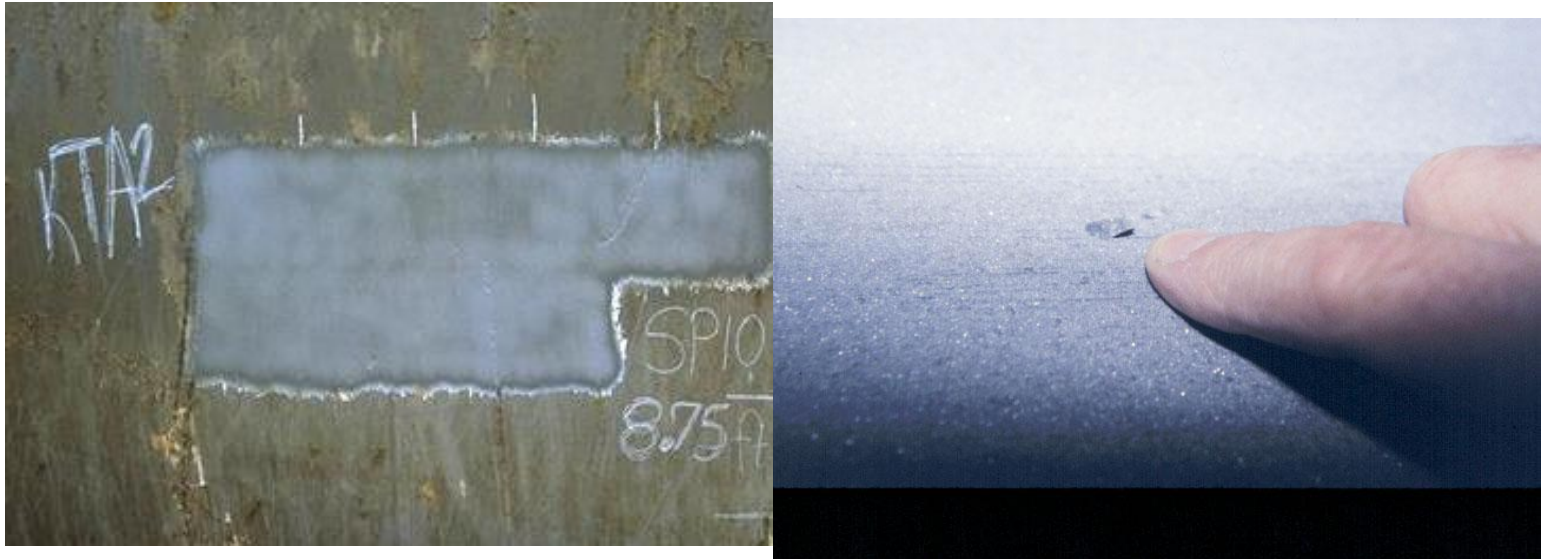
- Have contractor blowdown the compressor downstream of the water and oil traps for 15 minutes minimum; to blow out condensed moisture. (ASTM-D 4285 Blotter Test)



- Check for oil or moisture by having contractor place clean white rag over the end of the hose and look for the presence of contamination.

Surface Preparation Inspection

- Have the Contractor blast a Test Section. This is to set the level of expectation so all can see what is required. (6" x 6" area)



Verify SSPC/NACE Blast Profile. (SSPC 5/NACE 1 or SSPC 10/NACE 2 etc. that was specified is what you have in the test area)

Verify Surface Profile depth. (Anchor Pattern or Tooth in Mils 1/1000th inch; usually 2-4 mils in the test area)

Inspect for exposed surface defects: laminations, slivers, burrs, hackles etc. these may require grinding and reblasting

Surface Preparation Standards

▣ ABRASIVE BLAST STANDARDS

1. White Metal: NACE No. 1 / SSPC-SP-5
2. Near White Metal: NACE No. 2 / SSPC-SP-10
3. Commercial: NACE No. 3 / SSPC-SP-6
4. Brush-Off: NACE No. 4 / SSPC-SP-7

Surface Preparation Standards

▣ NON-ABRASIVE BLAST STANDARDS

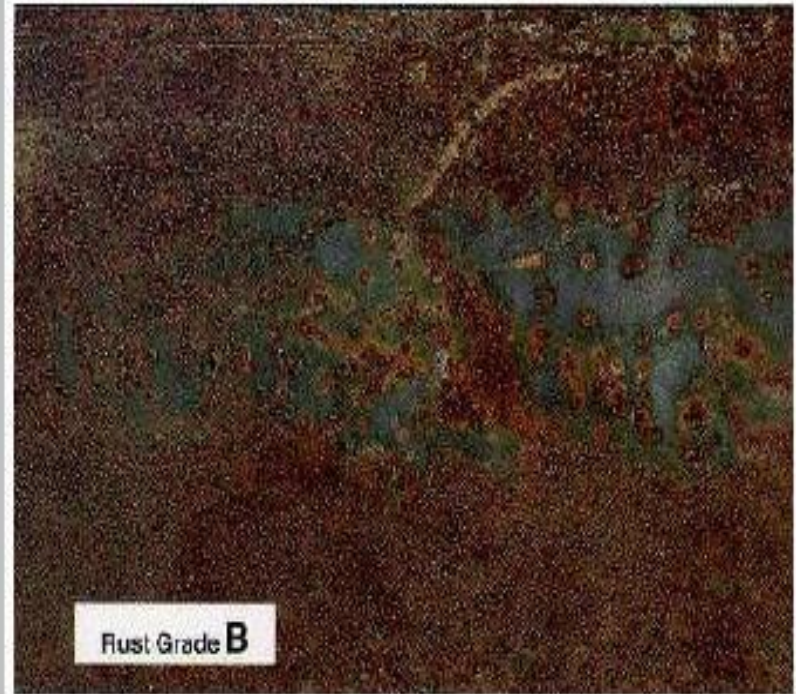
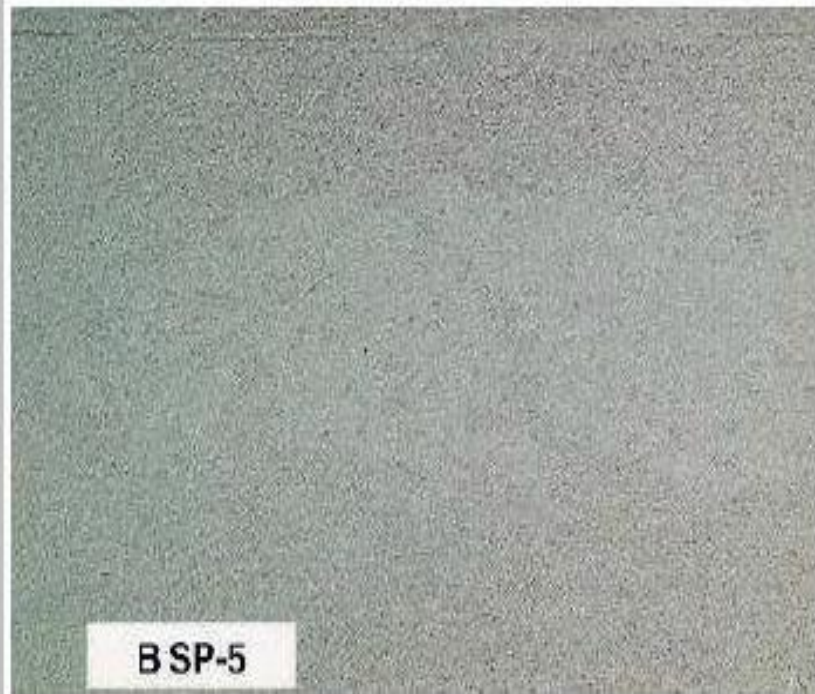
1. Solvent Cleaning: SSPC-SP-1
2. Hand Tool Cleaning: SSPC-SP-10
3. Power Tool Cleaning: SSPC-SP-6
4. Power Tool Cleaning to Bare Metal: SSPC-SP-11

NACE No. 1 / SSPC-SP-5

- ❑ 2.1 A White Metal Blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter.
- ❑ 2.2 No staining
- ❑ 2.3 Immediately prior to coating application, the surface shall be roughened to a degree suitable for the specified coating system.
- ❑ 2.5 In any dispute, the written standards shall take precedence over visual standards and comparators.

NACE 1/SSPC 5 VS RUST GRADE B

[SP5 Picture](#)



SURFACE PREPARATION

Near White Metal Blast SSPC-SP10 or NACE

#2 Definition:

- In this method, all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface by abrasive blasting, except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides or slight, tight residues of paint or coating
- At least 95% of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discolorations mentioned above. From a practical standpoint, this is probably the best quality surface preparation that can be expected to today for existing plant facility maintenance work

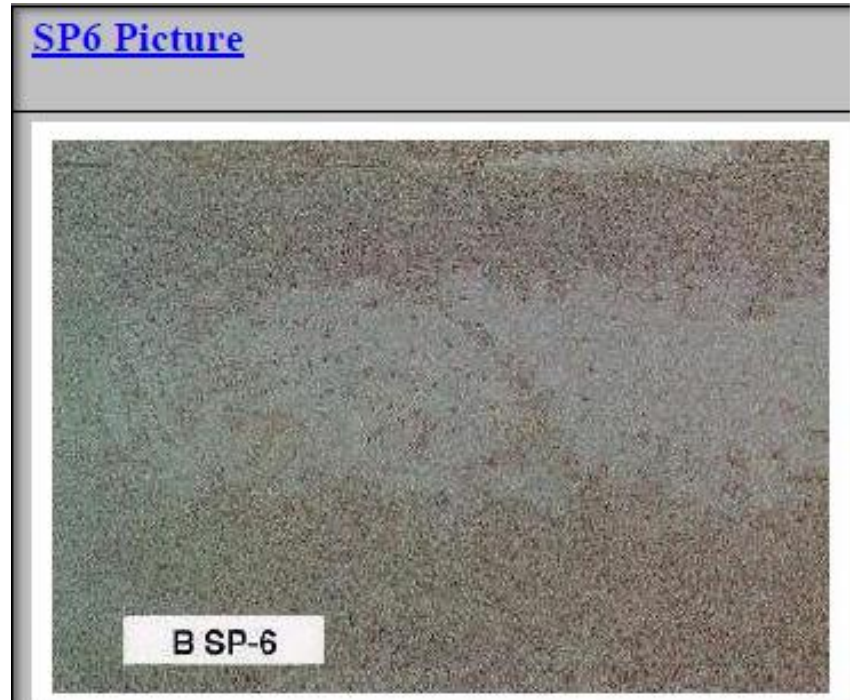


SURFACE PREPARATION

Commercial Blast SSPC-SP6 or NACE #3

Definition:

- All oil, grease, dirt, rust scale and foreign matter are completely removed from the surface and all rust, mill scale and old paint are completely removed by abrasive blasting except for slight shadows, streaks or discolorations caused by rust stain, mill scale oxides or slight, tight **residues** of paint or coating that remain
- If the surface is pitted, slight residue of rust or paint may be found in the bottom of pits; at least two-thirds of each square inch of surface area shall be free of all visible residues and the remainder shall be limited to the light residues mentioned above



SURFACE PREPARATION

Brush Off Blast SSPC-SP7 or NACE #4

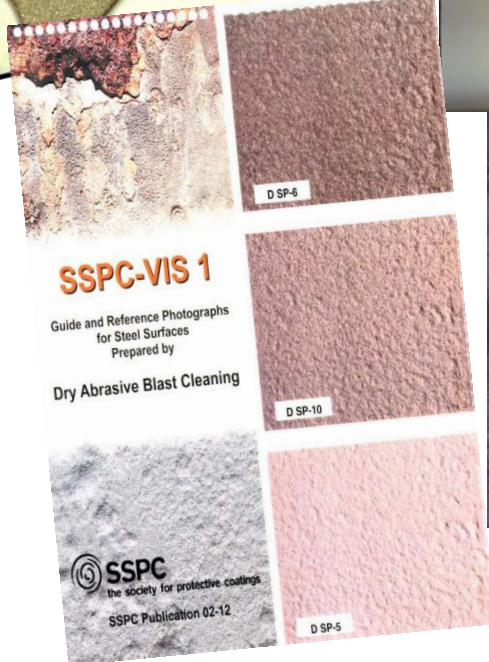
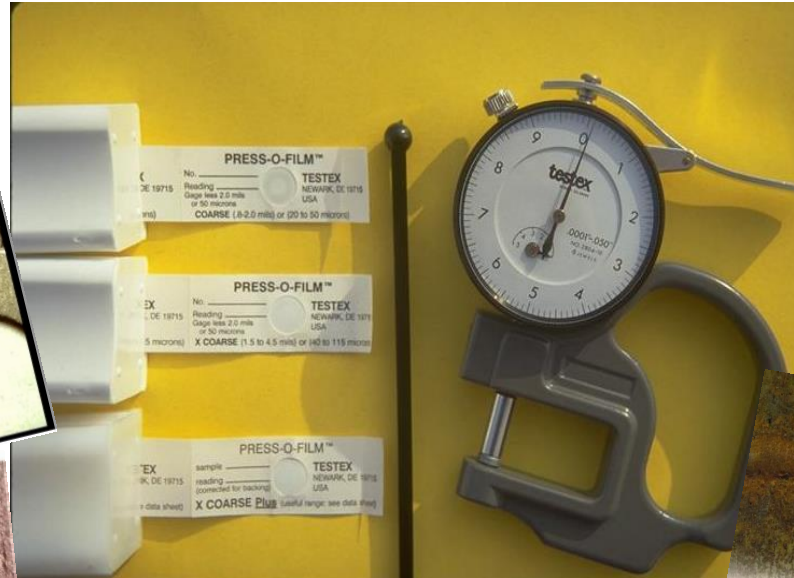
Definition:

- A method in which all oil, grease, dirt, rust scale, loose mill scale, loose rust and loose paint or coatings are removed completely. Tight mill scale and tightly-adhered rust, paint and coatings are permitted to remain
- However all mill scale and rust must have been exposed to the abrasive blast pattern sufficiently to expose numerous flecks of the underlying metal fairly uniformly distributed over the entire surface
- Use 30-65 Fine Mesh U.S. Sieve Series abrasive to produce 1.0-1.5 mil

[SP7 Picture](#)



COATING INSPECTION AND TOOLS



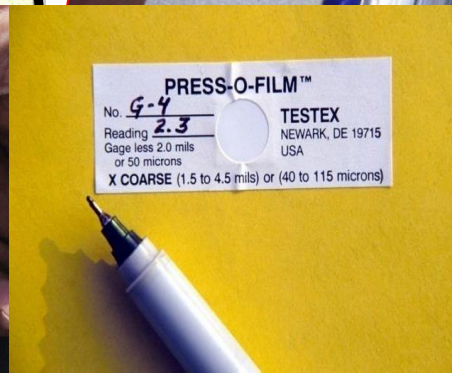
Surface Preparation Inspection

- Verifying Surface Profile Depth ASTM 4417

Method A (visual comparator)

Method B (depth micrometer)

Method C (replica tape)



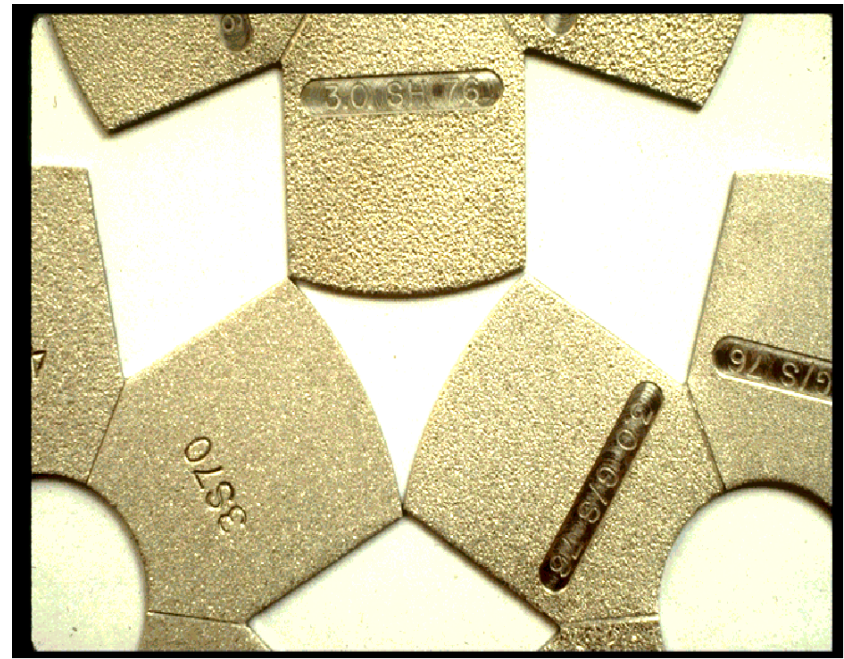
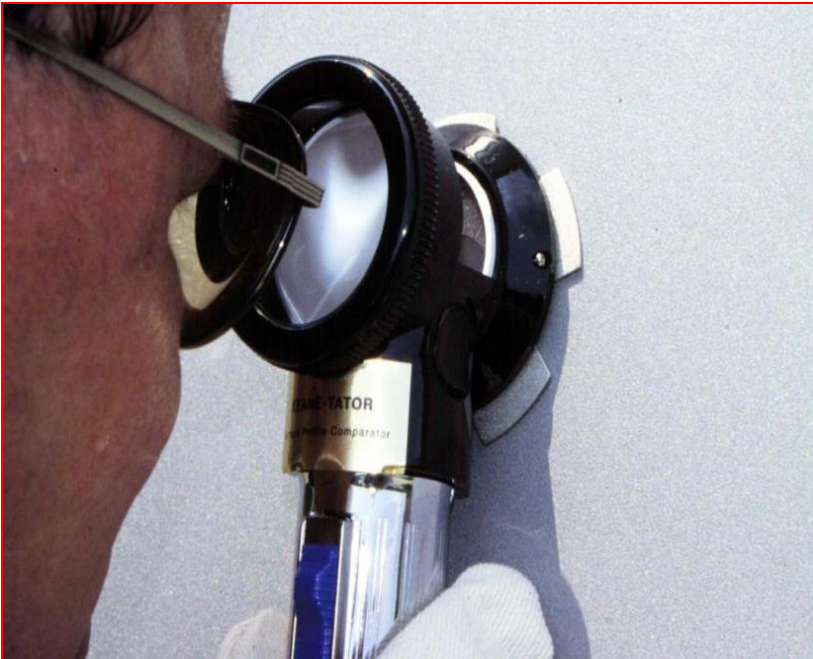
Surface Preparation Inspection

Method A – Visual Comparator

Place the star shaped replica on the surface

Place the illuminated lensed comparator over the center of the star

Compare the prepared surface to the replicas and choose the one that most closely matches or average the measurement between the two specimens for a final measurement (2 to 3 = 2.5mils)



Surface Preparation Inspection

- Method B – Depth Micrometer
Place the instrument on the surface

Turn the instrument on for the digital model or read the dial for the analog model

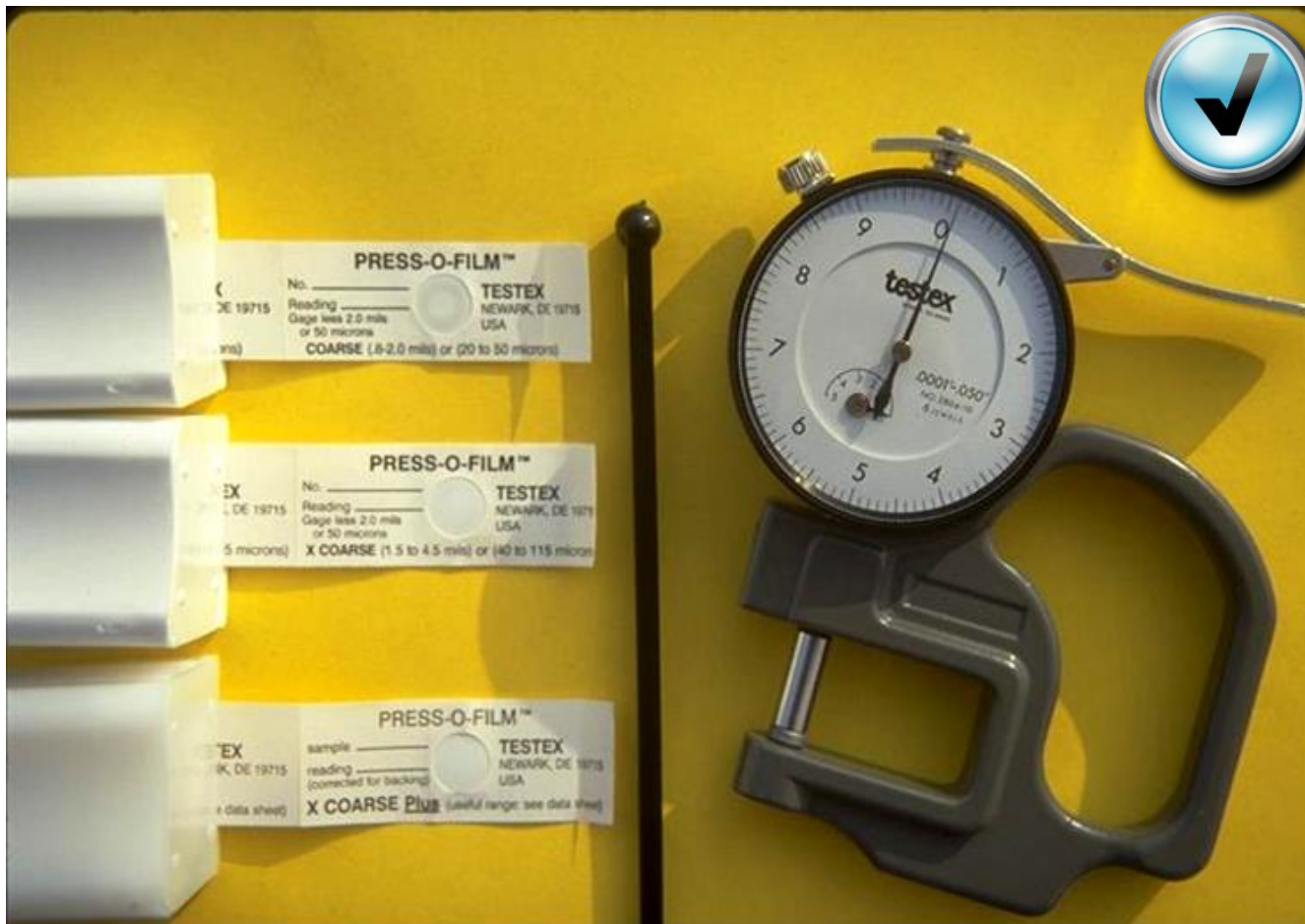
Not analog not recommended for field use.



Surface Preparation Inspection

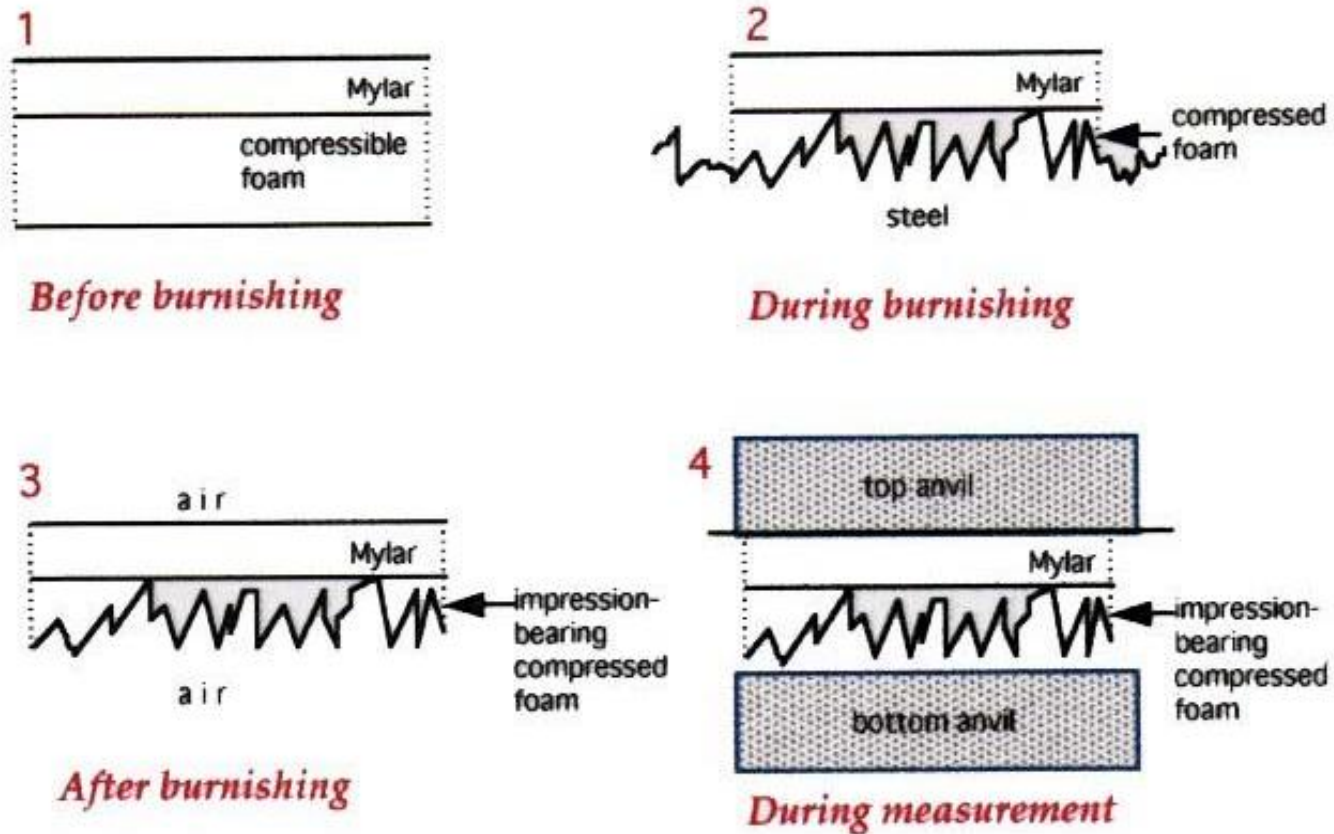
Method C: Replica Tape

Measuring Anchor Profile with Replica Tape:



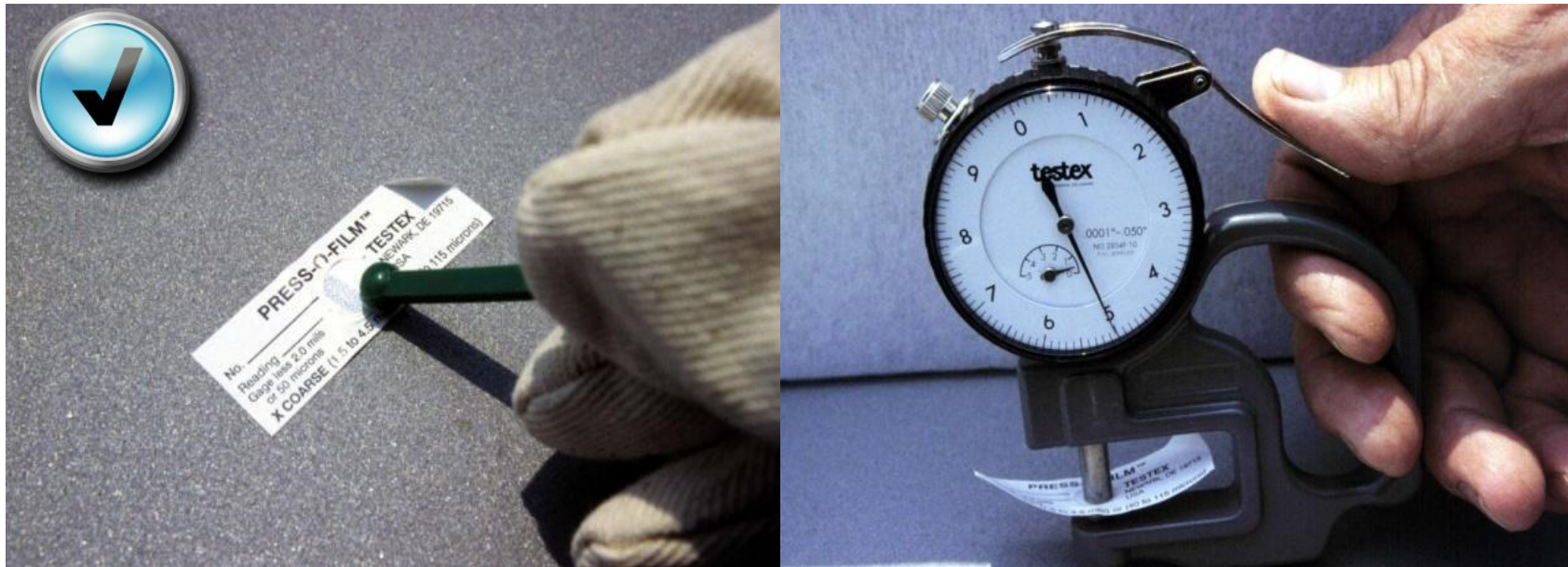
Surface Preparation Inspection

- How Replica Tape Works:



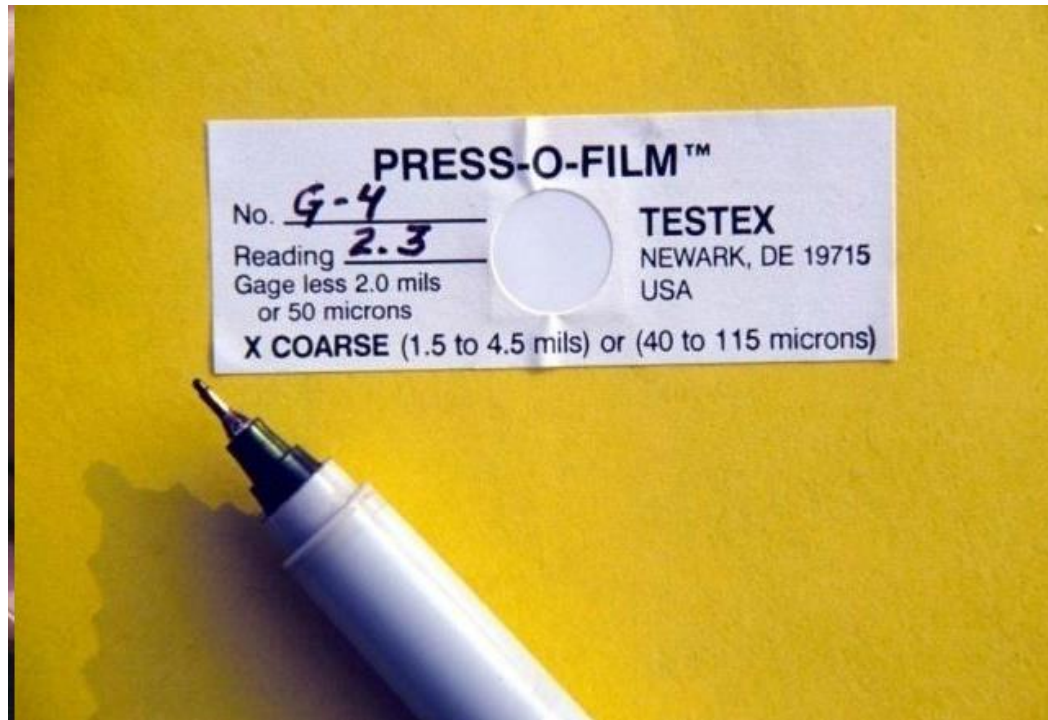
Surface Preparation Inspection

- Apply the adhesive (sticky) side of the mylar on the prepared surface
- Gently rub the clear Mylar with the burnishing tool. Rub in all direction with the goal of getting a uniform darkened (grayish) area within the window.
- Measure the tape impression with the spring micrometer



Surface Preparation Inspection

- Record the measurement on the Press-O-Film tape itself. Joint # and Date should be added in the margin with the Inspectors Initials. The film shall be attached to the daily log sheet.
- All other job data should be recorded on the Daily Inspection Log and maintained by the Applicator and Coating Inspector
- This daily log shall be part of the final data book.

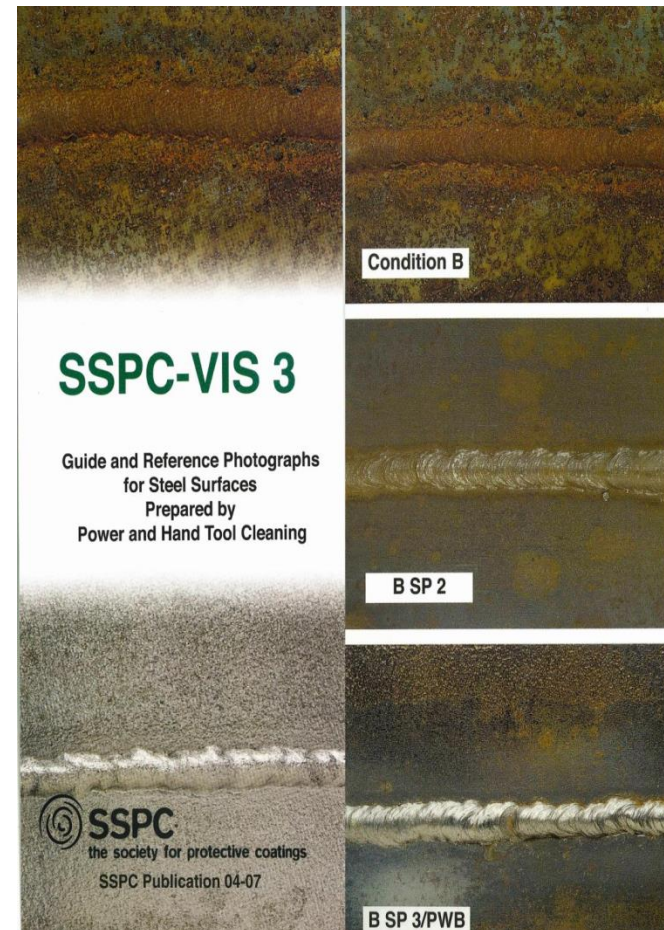
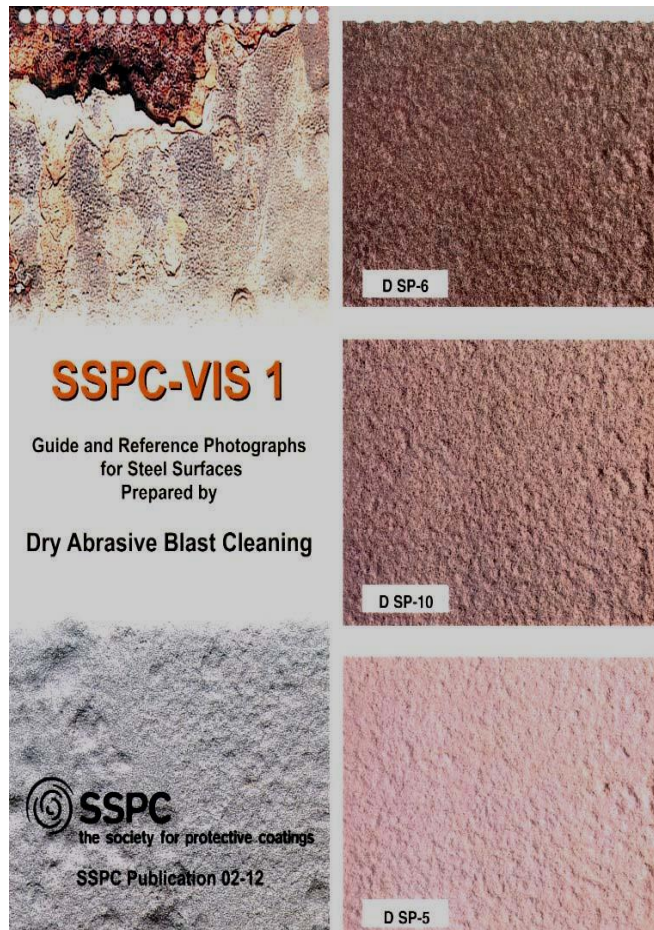


Surface Preparation Inspection

Verifying Surface Cleanliness:

Dry Abrasive Blast Cleaning by use of SSPC VIS 1 Visual Guide

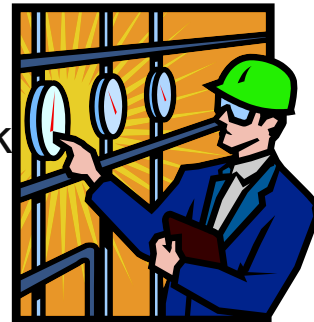
Power & Hand Tool Cleaning by use of SSPC VIS 3 Visual Guide



Coatings: Inspection

Coating Inspector and Applicator - Verify Ambient Conditions:

- Measure & record the Surface Temperature of the substrate (object painted)
- Measure and record the Air Temperature within 2 ft of the part
- Measure and record the Relative Humidity within 2 ft of the part
- Measure and record the Dew Point Temperature within 2 ft of the part
- The Surface Temperature of the part must be $5^{\circ}\text{F} \geq$ greater than the Dew point Temperature or no painting can be performed.
- Shelf life Expiration Date: One year for most Epoxies (Check with Mfg.)
- Record the date, time, joint number, location, Etc. for the data book to protect all parties,



Environmental Testing

□ Environmental Conditions Affect the Coating:

1. Surface (substrate) temperature

2. Ambient conditions:

Temperature

Relative Humidity

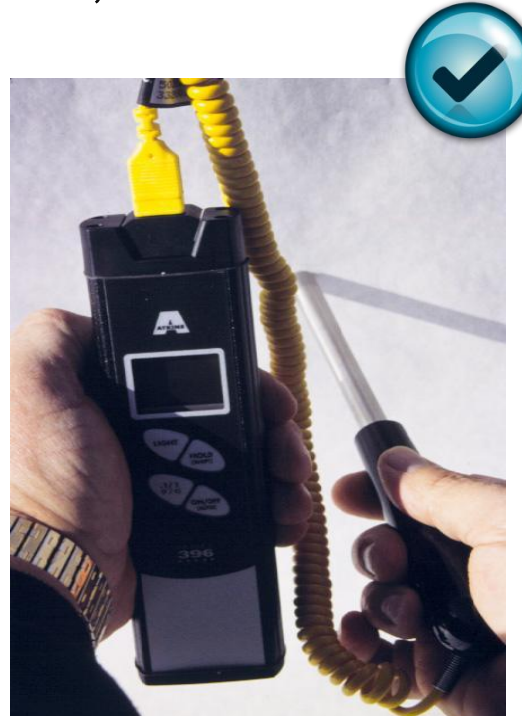
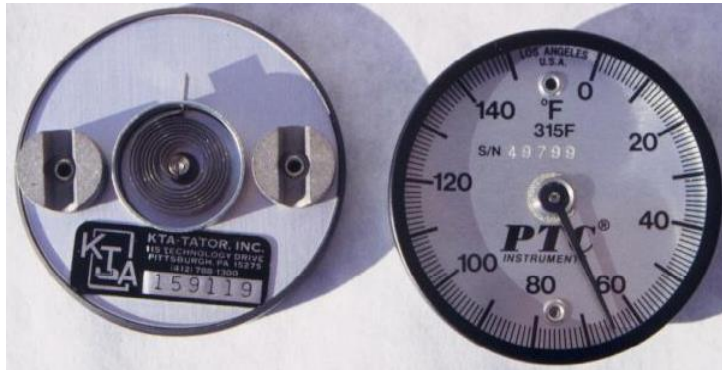
Dew point

Wind Velocity

Airborne Contaminants (chemical fumes, welding fumes, exhaust fumes, salt spray, etc.)

Coatings: Inspection

Skin or Surface Temperature Devices: Analog Contact Thermometers, Digital Contact Thermometers, Infrared Instruments.



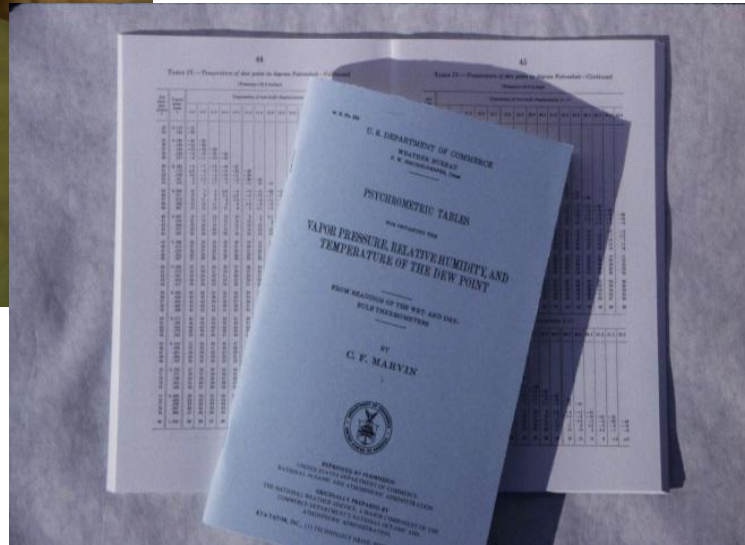
Some Disadvantages:

Analog Dial Gages use a calibrated spring to determine temperature. Dirt, rust and other contaminants can foul the spring and provide erroneous measurements.

The Digital units run on batteries which can and do fail at the most inopportune times.

Coatings: Inspection

Dew point measurements, Multi-Measurement Devices



Analog Sling Psychrometers are fragile, require several steps to set up and require the use of charts and graphs. These only measure dew point

Multipurpose Digital Instruments combine temperature, humidity, and dew point together. They display and record all data in one device

Sling Psychrometer

- Whirling Hygrometer: is most often used in coating inspection.
- It is used to measure the ambient air temperature (dry bulb temp.) and wet bulb temperature as close to the work site (piece) as practical. This information is then used to calculate the dew point and relative humidity
- The wet bulb measures the latent heat loss of water evaporation from the wetted sock
- The faster the rate of evaporation the lower the humidity and dew point
- Dew point is the temperature at which water vapor will condense onto a surface

Dew Point

- Dew point is very important, a film of moisture on the substrate or between coats can cause a lack of adhesion and premature coating failure.
- Final blast cleaning and coating application should not take place unless the surface temperature is at least 5°F higher than the dew point.

Airborne Contaminants

- DEBRIS:
- Dust, dirt oil, mud, sand and insects are debris

- CHEMICALLY ACTIVE CONTAMINANTS:
- Equipment Exhaust Fumes, Welding Fumes etc, if not removed prior to coating can affect the coating by reacting with the steel surface , or by forming deposits that cause a lack of intercoat adhesion

*Coatings: Mixing, Thinning, Application

Coating Inspector and Applicator - Verify Coating Material Inventory:

- Condition of containers/storage: Damage?
- Storage: Are the coatings materials protected from the environment, are temps within Mfg. guidelines
- Number of components: 2 Part / 2 to 1 Ratio
- *Record Manufacturer, product no., color
- *Record Batch/Lot No.
- Shelf life Expiration Date: One year for most Epoxies
- Record this information for the data book to protect all parties

Coatings: Mixing, Thinning, Application

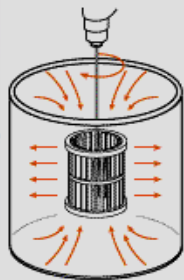
Verify Proper Mixing Procedures

- Component agitation (shear mixing blade)
 - Is the mixing blade the one recommended by the Mfg?
 - Is it clean? Excessive buildup can hinder proper mixing action.
- Blending components together
 - Is the mixing blade deep in the container?
 - Are mixing speeds on slow to prevent formation of air bubbles
 - Have the sides of the container been scraped to insure all of the contents are blended.
 - What is the recommended mixing time per Mfg. & are the contents uniform in color with no streaks?



Vortex Mixing Action

Guaranteed to mix faster than any other mixer. Attach to any variable speed drill. The cage takes liquid from the bottom and draws it up to mix.



*STRIPING OF HARD TO COAT AREAS

Striping Purpose: The hardest areas to coat completely to provide corrosion resistance and prevent rust are on bolt threads, nuts, and in between flange facings on pipe and on valves. This pretreatment is mandatory to effectively coat these areas to prevent corrosion and rust staining. This pretreatment step will be conducted after the initial surface preparation (abrasive blasting) is completed and **prior** to applying selected coating system. Inside of flange facings should be completely dry prior to pre-treatment application. *The dry film thickness of the stripe coat will range from .05 mils to 1.5 mils. The primary purpose of the stripe coat (coating thinned 40%) is to assure that all of the hard to reach areas are adequately exposed to the rust inhibiting properties of the primer to eliminate corrosion. The primary consideration of this stripe coat is coating coverage of these hard to reach surfaces, and not milage (film build)! It is mandatory to allow the solvents in this stripe coat to adequately evaporate (completely flash off) prior to topcoating with prime coat!*

Coatings: Inspection

Wet Film Gages



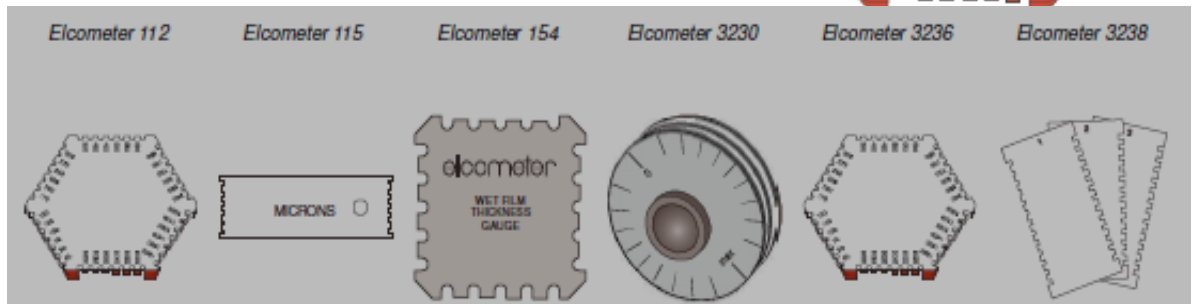
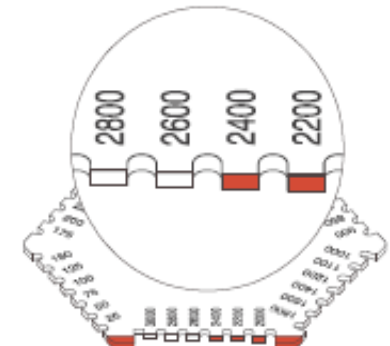
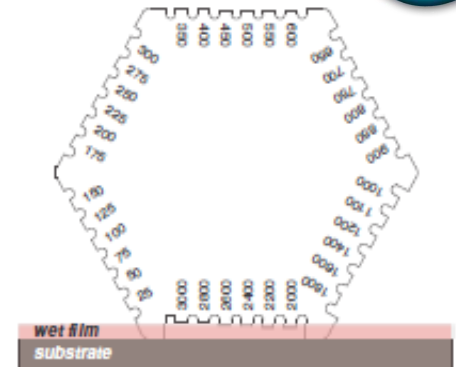
2 USING A WET FILM COMB

Before you start, ensure your Elcometer Wet Film Comb is clean and undamaged.

1. Hold the comb perpendicular to the wet film and press the edge of the comb into the film until it is stable on the substrate.
2. Remove the comb from the wet film.
3. Examine the teeth of the comb and locate the last tooth which is fully wetted. Read the thickness value of this tooth. The wet film thickness is situated between this value and the thickness value of the next dry tooth.

In the example shown, the wet film thickness lies between 2400 μm and 2600 μm .

4. Calculate the dry film thickness using the wet-to-dry ratio or the % volume solids stated in the film material data sheet.



Coatings: Inspection

Dry Film Thickness Gages:



Type 1-Magnetic Pull off Gage

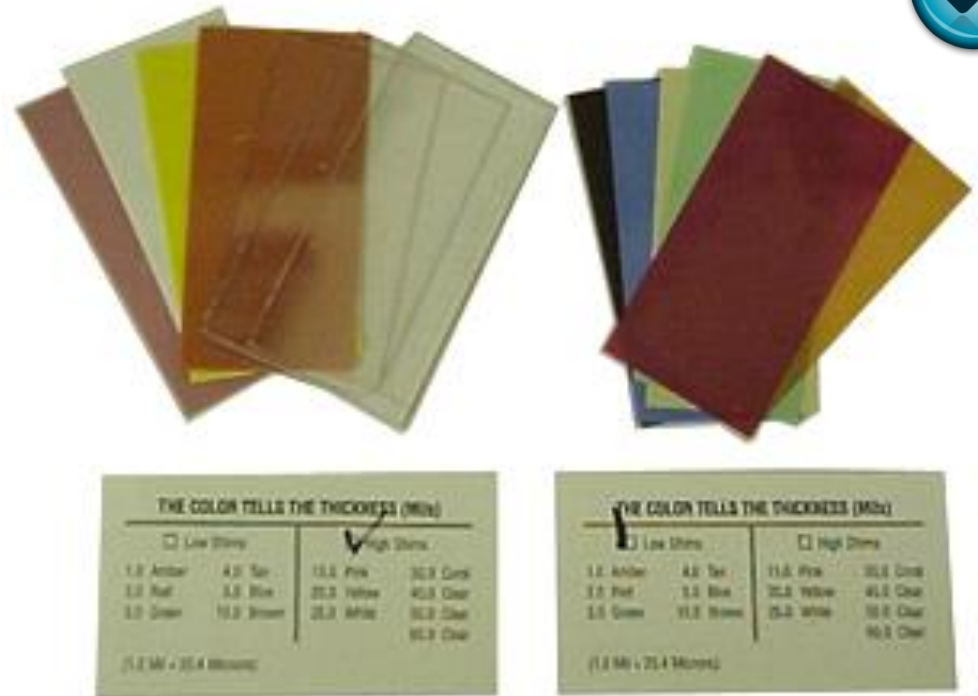
Analog “Banana” Gages are simple to use in the field.

Type 2 –Digital Eddy Current Instruments

Simple to use. Battery operated. Most store data in the device

Coatings: Inspection

Dry Film Thickness Calibration Stds.



The NIST Stds. are certified to $\pm 5\%$ of the true thickness (Left)

Proprietary Plastic Shims can be used in accordance with

Coatings: Inspection

Holiday / Pinhole Detection

- High Voltage (spark testing)
- Non-conductive coatings (> 20 mils) applied to conductive substrates, 100-125 volts/mil
- Obtain coating manufacturers recommended voltage
- Reference :
 - NACE Standard RP0188-99 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
 - NACE SP0490-07 Holiday Detection of FBE External Pipeline Coatings
 - NACE RP0274 High Voltage Electrical Inspection

Coatings: Inspection

Final Visual Inspection

Critical last steps

- Perform visual and holiday inspection simultaneously if possible with applicator.
- Make all repairs in accordance with Specification
- No paint stick repairs.
- Two part epoxies or inner tape wrap followed by a water activated fiberglass wrap or two part epoxy followed by an H₂O activated outerwrap are acceptable alternatives.
- Re-Inspected the all repaired areas.
- Fill in ditch after inspecting for handling damage.