

# Concrete and Steel Preservation

Brent Snowden, P.E.

Maine DOT

# Introduction

- This Module of Bridge College will discuss current methods we use to preserve concrete and steel on our bridges
- We will discuss why preservation is important and the role it plays in a strategic approach to taking care of bridges in Maine

# Agenda

- Concrete Preservation (approx. 30 min.)
- Steel Preservation (approx. 30 min.)
- Module Test (approx. 15 min.)

# Overview

- FHWA established a Bridge Preservation Expert Task Group comprised of representatives from state highway agencies, FHWA, Academia and Industry and this is their definition of “Bridge Preservation”
- **“Actions or strategies that prevent, delay or reduce deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in good condition and extend their useful life. Preservation actions may be preventative or condition driven.”**

# Bridge Cleaning and Washing

- Done annually in the Spring during high water flow to minimize environmental impacts as agreed to with the Department of Environmental Protection
- The primary goal of cleaning and washing is to remove residual chlorides (deicing salts) that if left would result in the corrosion and deterioration of the bridge



## BRIDGE DECK CORE TEST REPORT

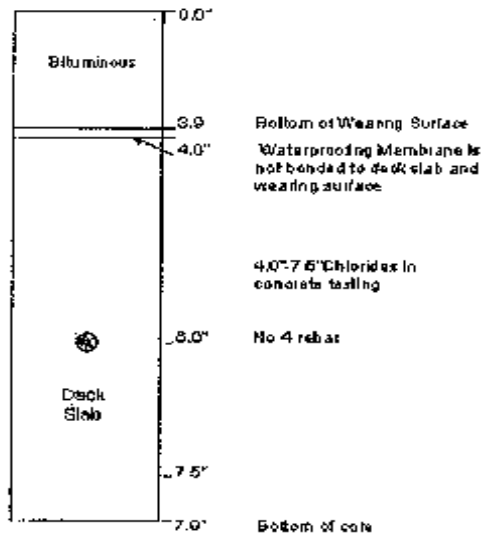
### Central Laboratory

#### SAMPLE INFORMATION

|                                |   |                        |                       |
|--------------------------------|---|------------------------|-----------------------|
| Reference No.<br><b>175577</b> | Sample Description<br><b>BRIDGE DECK CORE</b> | Saturated<br>11/6/2003 | Received<br>11/7/2003 |
| Sample Type: OTHER             | Sampler: THOMPSON, CRAIG                      | Sample Location:       |                       |
| PIN: 006068.06                 | Town: Statewide                               | Station: 1+812         | Offset: ft: 1, RT     |
| Contractor:                    |   | Resident:              |                       |

#### TEST RESULTS

#### Physical Description (175577)



| Shear Bond (MeDOT) |               |  |
|--------------------|---------------|--|
| Location, Inch     | Strength, psi |  |
| Specimen 1         |               |  |
| Specimen 2         |               |  |

| Chloride Content (T 260) |                                    |  |
|--------------------------|------------------------------------|--|
| Location, Inch           | Chloride Level, lb/yd <sup>3</sup> |  |
| 4.0 - 4.5                | 3.97                               |  |
| 4.5 - 5.5                | 2.56                               |  |
| 5.5 - 6.5                | 2.4                                |  |
| 6.5 - 7.6                | 1.25                               |  |

| Compressive Strength (T 22) |               |  |
|-----------------------------|---------------|--|
| Location, Inch              | Strength, psi |  |
| Specimen 1                  |               |  |
| Specimen 2                  |               |  |

| Rebar Corrosion (MeDOT) |                 |      |
|-------------------------|-----------------|------|
| Location, Inch          | Corrosion Level |      |
| Specimen 1              | 8.0             | NONE |
| Specimen 2              |                 |      |
| Specimen 3              |                 |      |
| Specimen 4              |                 |      |

Comments:

Core 2

Sample Meets All Requirements? N/A

#### AUTHORIZATION AND DISTRIBUTION

Reported by: COLSON, STEPHEN W

Date Reported: 5/19/2004

Paper Copy: Structure File    Electronic: Customer —



















# Bridge Cleaning

- Review the bridge cleaning and washing JSA and set up traffic control and signage as outlined in the MaineDOT “Work Zone Traffic Control” handbook which is based on the Manual on Uniform Traffic Control Devices (MUTCD)
- Clean material, sand and debris from the bridge roadway and curb surfaces through manual or mechanical methods
- Functionality of the bridge also improves when accumulated material is removed from the drainage and expansion/contraction devices (bridge joints)

# Bridge Cleaning

- Approximately 25 feet of the bridge approaches shall be included for cleaning
- Sand and debris lying underneath and behind approach guardrail should be “cut” to the shoulder cross slope grade and uniformly deposited/broadcast out beyond the shoulder break onto a grassy or shrubby side slope



# Bridge Cleaning

- If sand & debris is used to fill embankment erosion holes or gullies immediately adjacent to bridge, then one or more of the following erosion control methods shall be used with a grass seed application
  - Mulch
  - Erosion control blanket
  - Silt fence

# Bridge Cleaning

- Sand and debris that cannot be disposed of on site will have to be disposed of in accordance with the Bureau of Maintenance & Operation Policy “Placement of Inert Fill on Private Property”









# Bridge Washing/Flushing

- After removing all sand and debris the bridge steel and concrete surfaces shall be thoroughly flushed with water.
- If there are birds on the structure that are building nests, laying eggs or tending young, avoid washing area or obtain appropriate environmental permits to address issue

# Bridge Washing/Flushing

- Use clean fresh water without any soaps or detergents, do not use salt water
- Ensure water-blast spray and back splash is directed away from or otherwise shielded from vehicular traffic, pedestrians and coworkers
- After getting most of the wash water off the deck, then flush out the bridge drains

























# Concrete Sealant Application

- Concrete Sealants are applied to concrete that is exposed to the weather and deicing chemicals that we utilize to treat the roads during the winter
- Almost all damage to concrete is attributable to moisture intrusion resulting in: alkali-silica reactivity (ASR), chemical intrusion, repeated freeze/thaw cycles and corrosion of reinforcing steel

# Concrete Sealant Application

- MaineDOT currently utilizes two different sealants
- A 50/50 mixture of raw or boiled linseed oil and mineral spirits is the standard sealant that we apply
- We also on occasion apply a silane sealant, but only in special research situations to evaluate the effectiveness of silane

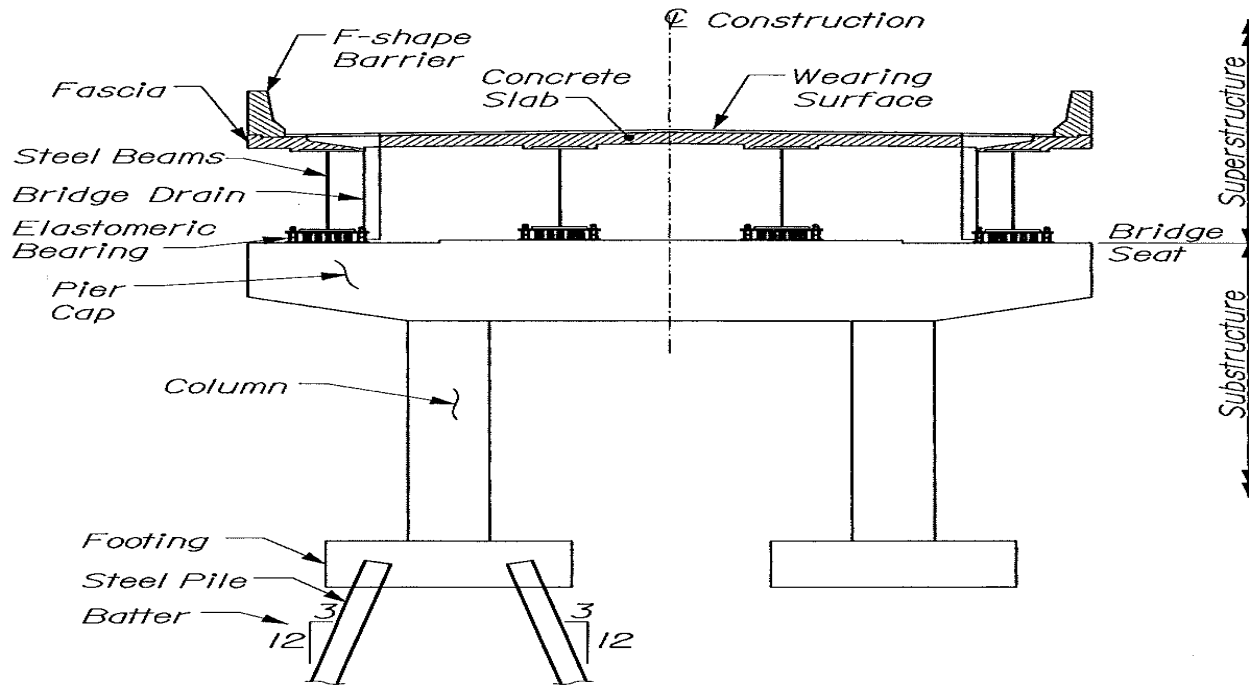
# Concrete Sealant Application

## Linseed Oil

- Linseed oil, also known as flaxseed oil, is a clear to yellowish oil obtained from the dried ripe seeds of the flax plant.
- Linseed oil can also be used as:
  - Paint binder in oil paint
  - In putty due to its drying properties
  - Wood finish
  - In linoleum
  - A nutritional supplement and food

# Concrete Sealant Application Linseed Oil

- Concrete surfaces that we treat are:
  - Wearing surfaces and other horizontal surfaces such as curbs and sidewalks
  - Concrete curb faces
  - Silica fume wearing surfaces, curbs and sidewalks
  - Bridge Rail and Barrier Rail
  - Pier Columns and shafts



TRANSVERSE SECTION  
Figure A-2 Superstructure and Substructure

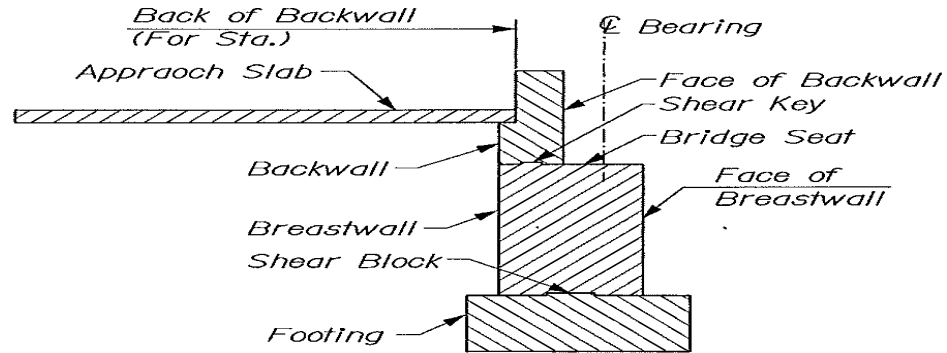
# Concrete Sealant Application Linseed Oil

- Concrete surfaces that we treat are:
  - All pier surfaces when heavy applications of winter salt are applied to travel ways
  - Abutment bridge seats, backwalls and exposed portions of breastwalls under open joints
  - Entire surfaces of piers under open joints
  - Other surfaces subjected to a severe salt environment and/or showing signs of deterioration
  - New concrete repairs

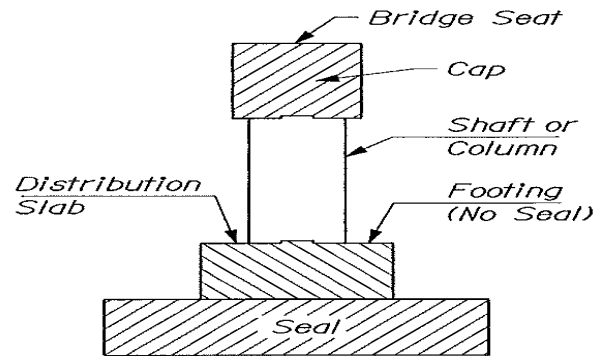


APPENDICES

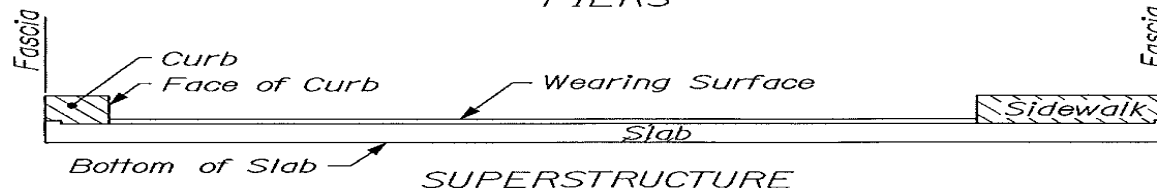
A.2 Drawings



ABUTMENTS



PIERS



SUPERSTRUCTURE

# Concrete Sealant Application Linseed Oil

- Application of linseed oil is an annual activity performed during warmer weather and is considered a continuation of the cleaning and washing program
- All safety precautions should be followed similar to the cleaning and washing program including traffic control

# Concrete Sealant Application Linseed Oil

- Provide an initial protective coat of linseed oil on new concrete surfaces and again yearly for the next two years
- After two years of treatment a schedule for “re-treatment” should be established depending on the severity of the environment and the **ability of the surface to accept treatment**

# Concrete Sealant Application Linseed Oil

- After completing concrete repairs and/or replacements a protective coating shall be applied before the project is closed and signs removed
- New concrete shall receive a minimum of 7 days wet curing followed by a minimum of 7 days drying exposure prior to treatment
- Air drying exposure on the last placement of concrete may be reduced in order to not unnecessarily delay project closure

# Concrete Sealant Application

## Linseed Oil

- Precautions when using and applying Linseed Oil
  - If applying to a wearing surface it must be inspected prior to opening to traffic to ensure that the surface will not be slippery. The crew needs to keep a supply of sand available to apply to surfaces that do not dry sufficiently after treatment
  - Spraying is an efficient way to apply the oil, but care must be taken not to get the materials onto vehicular traffic or into a water body



# Concrete Sealant Application Silane

- Silane is another concrete sealer that has been used a few times in this state and is being considered for increased use in the future
- Application of Silane has been done to test its effectiveness in dealing with alkali-silica reactivity (ASR) in some of our existing bridges

# Concrete Sealant Application

## Silane

- Alkali-silica reactivity is the process in which certain minerals (mostly glass type silica) in the presence of moisture are broken down by the highly alkaline environment of concrete producing a gel that expands creating tensile forces in the concrete which cause cracking of the concrete



# Concrete Sealant Application

## Silane

- The cracking then allows more water to infiltrate into the concrete creating more gel, more expansion and ultimately the concrete fails or disintegrates
- The application of silane onto the existing concrete will soak into the concrete and do a fairly good job of sealing the concrete













# Concrete Sealant Application Silane

- The concrete needs to be saturated heavily with a high solid silane to achieve longer life
- If heavy spread rates are used (50 to 80 square feet per gallon) and then secondary and tertiary applications at (75 to 150 square feet per gallon) a significant seal can be achieved resulting in 5 to 8 years before retreatment



# Concrete Sealant Application Silane

- Disadvantages of using silane
  - High cost – silane is an expensive material and the required heavy saturation rates exacerbates the cost
  - Staining – If the application is too light or the silane dissipates it leaves an active chemical chain that can result in a permanent stain if other hydrocarbons such as oil, transmission fluid, gasoline or diesel fuel gets on the concrete, only removal of the concrete will eliminate the stain

# Concrete Sealant Application Silane

- Disadvantages of using silane
  - The silane itself will permanently darken or discolor the concrete if the concrete is properly saturated as required for the silane to be effective

# Summary

- Concrete preservation methods currently used
  - **Cleaning Bridges** – Removes the sand and debris from the bridge roadway that can interfere with the functionality of bridge drains and joints and can hold moisture and chloride ions close to the concrete

# Summary

- Concrete preservation methods currently used
  - **Washing/Flushing Bridges** – Flushes residual chlorides from the superstructure and substructure of bridges to prevent intrusion into concrete and subsequent rusting of reinforcing steel as well as protecting steel beam ends

# Summary

- Concrete preservation methods currently used
  - **Applying Linseed Oil** – Protects concrete from chemical intrusion, repeated freeze thaw cycles and corrosion of reinforcing steel
  - **Applying Silane Sealant** – Arrests alkali-silica reactivity as well as other chemical intrusion, repeated freeze thaw cycles and corrosion of reinforcing steel

# Where to Get More Information

- **M&O Bridge Maintenance Manual**
  - **BR 601 – Protective Coating for Concrete Surfaces**
  - **BR 602.1 – Removal Winter Maintenance Sand/Debris from Bridges**
  - **BR 602.2 – Water-Blast Cleaning/Flushing**
- **Best Management Practice – Bridge Cleaning and Washing**

# Concrete Preservation

- QUESTIONS?



The Best Bridge Joint  
Is  
No Bridge Joint  
The Best Bridge  
Paint  
Is  
No Bridge Paint

(Unless You Have To)



# Overview

- **What We Paint and Treat**
- **Surface Preparation**
- **Tools**
- **Materials**
- **Access & Enclosures**
- **Safety and Training**

# What We Paint & Treat

- **Bearings and Beam Ends**
- **Steel Bridge Rail**
- **Zone Painting - Steel Arches & Trusses**
- **Full Paint – Small Pony Trusses & Steel Stringers**

# Surface Preparation Specification No. 2

## SSPC-SP2

### Hand Tool Cleaning

Removes all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter.

### Surface Prep & Methods

- Remove visible deposits of oil, grease or other materials.
- Use impact hand tools to remove stratified rust (scale) & weld slag.
- Use hand wire brushing, abrading, scraping & similar.
- May feather the edges of remaining old paint so repainted surface can have reasonably smooth appearance.



# Surface Preparation Specification No. 3

## SSPC-SP3

### Power Tool Cleaning

Also removes all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter.

### Surface Prep & Methods

- Remove visible deposits of oil, grease or other materials.
- Use rotary or impact power tools to remove stratified rust (scale) & all weld slag.
- Use power brushing, abrading impact or other power rotary tools.
- Do not burnish surface or form burrs, sharp ridges or cuts.



# Other acceptable surface preps :

- SP7 is Brush Off Blast-Cleaning.
- SP12 is using Waterjetting.
- SP10 is Near-White Blast-Cleaning.
- SP6 is Commercial Blast-Cleaning.



# Tools

- Wire Brush
- Scraper
- Slag Hammer
- Pneumatic Chisel
- Needle Gun
- Roto-Peen
- Needle Grinder







# Needle Grinder



# Type of Paint

- Lead Paint can legally be used, but only on existing lead paint
- Moisture Curing Urethane
- Carboline

# Paint

Sherwin Williams

3 Coat Moisture Curing Urethane

1. COROTHANE I GALVAPAC 1K ZINC PRIMER \$60/gal
2. COROTHANE I IRONOX B \$38.50/gal
3. COROTHANE I HS ALIPHATIC FINISH COAT \$57/gal

# Carboline

## Carbomastic 15 Aluminum Paint

*This modified aluminum epoxy mastic was the pioneer mastic coating in a number of industrial markets.*

- Excellent performance over minimal surface preparation.
- Suitable for topcoat for most tightly adhered existing coatings.

### Primers

Self-priming. May be applied over most tightly adhered coatings as well as inorganic zinc primers.

### Substrate & Surface Prep

- SSPC-SP2 & SP3 are acceptable methods.
- SSPC-SP6 is for maximum protection.
- SSPC-SP7 & SP12 are also acceptable preparation methods.

### Topcoats

**Maybe be used underneath:**

- Acrylics
- Alkyds
- Epoxies
- Polyurethane
- Or leave as is.

# Additional Features

- May be applied at 35° F  
(when CM 15 FC part B utilized.)
- VOC compliant
- Excellent choice for field touch-up of zinc-rich primers & galvanized steel.
- Cleanup uses Thinner #2 or Acetone.
- Application: Brush & Roller or Airless Spray.
- 2 Gallon Kits available, A + B, 1:1 Ratio, 25 lbs.
- Reasonable cost @ \$60/gallon.
- Recoat time: 5 to 32 Hours.
- Pot Life is 1 to 2 Hours  
(unless thinned with Thinner #76)
- Application Conditions are reasonable: 50 - 100° F & 0 – 95% Humidity.

Reasonable amount of effort for good protection – Cost = \$30,000



# Access & Enclosures

- Swing-Lo Staging used extensively
- Ladders
- Aerial Lifts
- Standard platforms and enclosures are designed within the Bridge Maintenance Division.
- Bed Ladders & Dimensional Lumber



2001. 4. 10 08:47





# Custom Designs are Not Unusual







# Zone Painting



# Zone Painting



# Hand Tool & Lead Overcoat





# Work Areas

- Designated and distinguishable areas required to eliminate or minimize public and worker exposure.
- Each work zone has distinct exposure level and activity restriction.

# Zone 0: Public Zone

- This area is uncontrolled and is occupied by the public.



# Zone 1: Support Zone

- Lead removal equipment and waste are not handled or stored.
- General industry standards apply, generally respirators not required



# Zone 2: Contamination Reduction Zone

- Areas that include storage and handling of lead paint removal equipment and waste.
- Respirators and protective clothing are required.





# Hygiene

- HEPA vacuum clothing
- Remove protective clothing and shoe covers
- **Remove respirator last!**
- Wash face and hands
- New coveralls daily
- Wet wipe respirator daily



# No Transport Manifest Req'd

**SPECIAL WASTE**

|             |                                 |
|-------------|---------------------------------|
| START DATE: | 7/21/05                         |
| DATE FULL:  |                                 |
| CONTENTS:   | Gray water                      |
| GENERATOR:  | NY Department of Transportation |
| LOCATION:   | I-95 BANGOR                     |



# Zone 3: Paint Removal Zone

- Paint removed by blasting or power tools with engineering controls
- Respirators required
- Zone 3 will revert to Zone 2 following paint removal and clean-up









# Zone 3



# Set up-Tear Down-Set Up Most time Consuming Effort



# Full Paint – Dust Collector



# Classifier





# Classifier

- Classifier separates the lead flakes from the steel shot
- Steel shot reused up to 3 times
- Paint chips transferred from classifier to hazardous waste barrels

# Hazardous Waste

- Lead paint chips and filters from dust collector
- Barrel clearly marked when first used
- Barrel marked when full and transported with a manifest to one of three of our large quantity generator sites.
- Large quantity generator sites can only accumulate 3 barrels.

U.S. D.O.T. SHIPPING DESCRIPTION

HAZARD CLASS

# HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL  
 IF FOUND, CONTACT THE NEAREST POLICE, OR  
 PUBLIC SAFETY AUTHORITY, OR THE  
 U.S. ENVIRONMENTAL PROTECTION AGENCY

**CAUTION** **CAUTION**

|                               |   |  |
|-------------------------------|---|--|
| HAZARDOUS MATERIALS ID NUMBER | FV11-8-29-08                                  |  |
| UNSPILLABLE                   |   |  |
| DESCRIPTION                   | MBDT Bridge Maintenance                       |  |
| ADDRESS                       | <del>XXXXXXXXXX</del> Arcootook River Bridge  |  |
| CITY                          | <del>XXXXXXXXXX</del> Fort Fairfield ME 04769 |  |
| STATE                         | ME  |  |
| ZIP CODE                      | 04769   |  |
| HAZARDOUS MATERIALS NAME      | Lead  |  |
| HAZARDOUS CONSTITUENTS        | Sandblast Sand                                |  |

CONTAINS HAZARDOUS OR TOXIC WASTE

FV11-8-29-08

# Safety

- Annual physical
- Annual respirator fit test (**Clean Shaven**)
- Competent person for scaffolding
- Competent person for fall prevention/protection
- Blood monitoring when initially exposed and rechecked 2-6 months based on blood lead levels
- MaineDOT's blood lead level 60% of OSHA

# Full Paint Costs

Lincoln Spur/I-95 width=34' length=458'  
5-beam arrangement Total cost \$360,000

I-95/Birch Stream width=47' length=100'  
5-beam arrangement Total cost \$100,000

# Summary

- Steel preservation methods currently used
  - **Cleaning Bridges** – Removes the sand and debris from the bridge roadway that can wash down onto the steel
  - **Washing/Flushing Bridges** – Flushes residual chlorides from the superstructure and substructure of bridge to prevent corrosion of steel stringers and other steel components
  - **Painting Bridges**

# Summary

- **What we paint & treat**
  - Bearings and beam ends
  - Steel bridge rail
  - Zone painting on steel arches & trusses
  - Full paint on small pony trusses & steel stringers

# Summary

- **Surface Preparation**

- SP 2 – Hand tool cleaning
- SP 3 – Power tool cleaning
- SP 6 – Commercial blast cleaning
- SP 7 – Brush off blast cleaning
- SP 10 – Near-white blast cleaning
- SP 12 – cleaning using waterjetting



# Summary

- **Tools**

- Wire Brush
- Scraper
- Slag Hammer
- Pneumatic Chisel
- Needle Gun
- Roto-Peen
- Needle Grinder

# Summary

- **Materials**

- Lead Paint
- Carboline
- Moisture Curing Urethane

# Summary

- **Access & enclosures**
  - Swing-Lo staging
  - Ladders
  - Aerial lifts
  - Standard platforms & enclosures designed in Augusta
  - Bed ladders & dimensional lumber

# Summary

- **Access & Enclosures – Work Zones**
  - Zone 0 – Uncontrolled are open to public
  - Zone 1 – Support Zone – general industry std
  - Zone 2 – Contamination reduction zone – storage & handling of hazardous waste & equipment
  - Zone 3 – Paint removal zone – where paint is removed by blasting or power tool with engineering controls, returns to zone 2 following paint removal & clean up

# Summary

- **Safety & Training**

- Annual physical
- Annual respirator fit test (**must be clean shaven**)
- Competent persons for scaffolding and fall prevention/protection
- Blood monitoring
- Max level of lead is 60% of what OSHA allows

# Where to Get More Information

- **M&O Bridge Maintenance Manual**
  - **BR 202 Breathable Air**
  - **BR 204 Medical Surveillance Testing Requirements**
  - **BR 205 Respirator Protection Program**
  - **BR 208 Repair of Aluminum Platforms**
  - **BR 209 Fall Rescue Plan**
  - **BR 402 Waste Management**
  - **BR 405 Barrel Labeling**

# Where to Get More Information

- **M&O Bridge Maintenance Manual**
  - **BR 701 Platform Roll Staging**
  - **BR 703 Anchor Clamp Supported Falsework (Form-releasing Type)**
  - **BR 706 Flemming Bracket Supported Platform (1/4" thick angle fabrication)**
  - **BR 708 Tubular Welded Frame Scaffold (also known as "pipe staging")**
  - **BR 711 Wood Pole Scaffolds**

# Where to Get More Information

- **M&O Environmental Policies & Procedures Manual, Oct. 2006**
  - **EP 204 Hazardous Waste Management Procedure**
  - **EP 206 Drum/Container Management Procedure**



# Steel Preservation

- Questions?

