LEAD INDUSTRIES ASSOCIATION
420 LEXINGTON AVENUE
NEW YORK 17, N. Y.

Pigments and Chemicals Division

April 27, 1956

SUBJECT: RED LEAD TECHNICAL LETTER NO. 11

To Members of the Red Lead Technical Committee:

Attached is a second draft of proposed Red Lead Technical Letter No. 11, "Surface Preparation of Steel for Red Lead Paints." Please review this and make whatever suggestions, corrections or revisions you see fit.

Receipt of your comments before the end of May will be very much appreciated.

Yours very truly,

Kempton H. Roll

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Secretary to the Committee

N2776

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APRIL, 1958

SURFACE PREPARATION OF STEEL FOR RED LEAD PAINTS

Red Lead Technical Committee
LEAD INDUSTRIES ASSOCIATION
420 Lexington Avenue
New York 17, N. Y.

RED LEAD
TECHNICAL LETTER
No. 11

N2776.01

PURPOSE

In past Red Lead Technical Letters, the Red Lead Technical Committee of the Lead Industries Association has confined itself to the recommendation of red lead paints and has left other considerations involved in painting to be discovered by the user from other sources. The extreme importance, however, of surface preparation for the proper performance of any metal protective paints, has now led the Committee to prepare the recommendations contained in this Technical Letter to aid the industrial user in getting the most out of his paint. The success or failure of a paint system, after all, very often depends upon the adequacy of the surface conditions. An excellent paint will fail quickly over a dirty, ill-prepared surface while a lesser paint may do well over a scrupulously clean surface. The stringency of preparation requirements, then, varies with the type of paint used.

The recommendations contained in this Technical Letter are intended to aid in the proper determination of need and selection of the proper method of surface preparation. Simply, they are a listing of surface preparation requirements in reference to a number of painting conditions for which red lead primers are suggested. Formulas for all the paints listed are contained in previous Red Lead Technical Letters (these are available, at no charge, upon request to the offices of the Association).

This Technical Letter also includes a short discussion of surface preparation to emphasize the differences and completeness of surface contaminant removal by the most widely used methods of surface preparation.

Inquiries on the contents of this letter or on specific painting problems are welcome and should be addressed to the Lead Industries Association or to the designated individuals in the cooperating companies listed below.

Cooperating Companies

RECOMMENDED SURFACE PREPARATION OF STEEL FOR RED LEAD PAINTS

WHY SURFACE PREPARATION?

The reason for surface preparation may be stated simply and wholly in terms of adherence of the paint film. This phenomenon consists of molecular attraction of paint and surface, properly called adhesion, and mechanical anchoring to relatively rough surface, called bonding. Paint will fail in direct proportion to the lack of adhesion and bonding. Any dirt, oil, grease, salts, rust and other foreign matter will hinder adhesion up to the point of making good painting impossible. Except for rust, the contaminants prevent wetting of the metal which is the essential of adhesion. Rust, while it can be painted over, forms scale which eventually lifts off the surface taking the paint with it. Likewise a completely smooth surface is extremely difficult to paint. Surfaces to be painted, therefore, must be free of adhesion retarding substances and the surfaces themselves must provide at least some degree of mechanical anchor.

WHAT TO CONSIDER IN SELECTING A METHOD OF SURFACE PREPARATION

Presuming a decision has been made on the matter of economy, which, in relation to surface preparation must be considered in terms of the total extension of paint film life, the question of selecting a method depends on three factors:

1. Condition of the surface before preparation.
2. Practicality, because of physical condition, of using a particular method.
3. The type of paint which is to be applied.

The first two considerations are easily understood. The third may perhaps be amplified.

Most essentially the adherence of a paint, as indicated above, is a matter of its wetting ability. The requirements for surface preparation, therefore, are more severe as the wetting ability of paints decreases. One reason why the straight red lead in linseed oil paint, L.I.A. Formula 6-1 (the same as Fed. Spec. TT-P-86a,

Type I, or SSPC Paint 1-55T) or its near equivalent, has achieved an eminent position in the painting of steel is that its superior wetting characteristics make it possible to be used over steel where small amounts of rust and tightly adherent mill scale are present. Such a surface condition is often the best that can practically be obtained in the field. The corrosion inhibitive red lead pigment, of course, contributes to this advantageous characteristic.

The linseed-oil vehicle, however, is slow drying and it is often necessary to use a faster drying oil-resin vehicle primer, such as L.I.A. Formula 6-7 (TT-P-86a, Type II). Such a paint is limited in its wetting ability by the presence of synthetic resins. Therefore, surfaces receiving paints of this type must be carefully cleared of all corrosion products and contaminants.

Going still further, painting requirements may necessitate the use of the very rapid drying synthetic vehicle type paints, such as L.I.A. Formulas 3-7, or 6-13 (TT-P-86a, Type III) or 6-16, MIL-P-17545 (Ex Ships Paint Formula No. 116). These paints are useful and excellent but only on the most carefully prepared surfaces so that they may only be used where a high degree of cleaning is practical or on factory-fabricated equipment.

With these considerations in mind, the surface preparation of steel recommended for red lead paint follows.

SURFACE PREPARATION OF STEEL RECOMMENDED FOR RED LEAD PAINTS

IF YOU HAVE TO PAINT:	FOR THIS TYPE OF EXPOSURE:	AND THE DRYING TIME REQUIREMENT IS:	THEN THE INDICATED RED LEAD PRIMER IS:	AND THE FOLLOWING SURFACE PREPARATION IS RECOMMENDED:	BUT THESE STEPS MAY ALSO BE REQUIRED:	SPECIFICATIONS RECOMMENDED AND WHERE SECURED:
Structural Steel	Atmospheric	36 Hrs.	L.I.A. 6-1*	Hand Cleaning or Power Tool Cleaning	Solvent Cleaning to precede other cleaning. SSPC-SP 1-52T	SSPC-SP 2-52T** or SSPC-SP 3-52T
Structural Steel, Oil Storage Tanks	Chemically Contaminated Atmospheres and Marine Environments	24 Hrs.	L.I.A. 3-7	Blast Cleaning Or Pickling		SSPC-SP 5-52T SSPC-SP 8-52T
Structural Steel	Atmospheric	16 Hrs.	L.I.A. 6-7		Solvent Cleaning Or Steam Cleaning	SSPC-SP 1-52T
Structural Steel	Atmospheric	24 Hrs.	L.I.A. 6-3	Hand Cleaning Or Power Tool Cleaning	Solvent Cleaning to precede other cleaning	SSPC-SP 2-52T SSPC-SP 3-52T
Structural Steel	Atmospheric	4 Hrs.	L.I.A. 6-13	Blast Cleaning Or Pickling	In some cases, commercial blast cleaning may be used. SSPC-SP 6-52T	SSPC-SP 5-52T SSPC-SP 8-52T

* Lead Industries Association, Red Lead Technical Letter: The (6) refers to bulletin number; the (1) refers to paint formula.

** All SSPC specifications referred to herein may be found in Volume II of Steel Structures Painting Manual, 4400 Fifth Avenue, Pittsburgh 13, Pa.

IF YOU HAVE TO PAINT:	FOR THIS TYPE OF EXPOSURE:	AND THE DRYING TIME REQUIREMENT IS:	THEN THE INDICATED RED LEAD PRIMER IS:	AND THE FOLLOWING SURFACE PREPARATION IS RECOMMENDED:	BUT THESE STEPS MAY ALSO BE REQUIRED:	SPECIFICATION RECOMMENDED AND WHERE SECURED:
Structural Steel, Especially Building Frames	Atmospheric, Temporary (6 Mos.)	8 Hrs.	L.I.-M. 11-1 (SSPC 13-55T)	Solvent Cleaning And Wire Brushing		SSPC-SP 1-52T SSPC-SP 2-52T
Railroad Rolling Stock	Atmospheric	18 Hrs.	L.I.-M. 8-8 Or 8-9	Hand Cleaning Or Power Tool Cleaning	Solvent Cleaning To Precede Other Cleaning	SSPC-SP 2-52T SSPC-SP 3-52T
Hydraulic Structures, e.g. crest gates, sluice gates, tainter gates, exposed structural steel at pumping stations	Partial or Continuous Immersion in Fresh Water	6 Hrs.	L.I.-M. 7-4	Blast Cleaning Plus Chemical Conditioner (e.g. MIL-P-15328)***		SSPC-SP 5-52T SSPC-PT 4-53T
Hydraulic Structures, e.g. crest gates, sluice gates, tainter gates, exposed structural steel at pumping stations	Partial or Continuous Immersion in Fresh Water	1 Hr.	L.I.-M. 7-5	Blast Cleaning Plus Chemical Conditioner		SSPC-SP 5-52T SSPC-PT 4-53T
Ships (Topsides, Interiors, Boottoppings), Bridges Over Tidewater, Docks	Marine Intermittent Immersion In Sea Water	6 Hrs.	L.I.-M. 6-16	Blast Cleaning Or Pickling		SSPC-SP 5-52T SSPC-SP 8-52T

*** May be obtained from the nearest General Services Administration Regional Office at a nominal cost.

SURFACE PREPARATION METHODS

Foremost of the major factors to be considered in maintenance of any metal protective paints are surface preparation and the condition of the surface at the time of application. Other factors which contribute to the service of such paints are the character of the base metal, the environmental exposure and the extent and kind of mechanical injury.

Because of the primary importance of surface preparation in its relation to a paint system's protection and service, it has claimed the attention of paint manufacturers, contractors, construction and maintenance engineers and all industrial, public and private users of metal protective paint.

The life of red lead paint, therefore, is governed by the condition of the surface at the time of application despite its inherent strength, its impermeability to water and gases, its anticorrosive character and high resistance to weather disintegration.

Only those surface preparation methods which are pertinent to structural steel cleaning and which are most generally used are considered in this technical letter. The major methods of surface preparation of steel may be classed under two categories:

1. Mechanical or physical surface preparation
   a. Hand cleaning
   b. Power tool cleaning
   c. Blasting, sand- or shot-blasting
   d. Flame cleaning
2. Chemical surface preparation
   a. Degreasing
   b. Weathering
   c. Chemical cleaning
      1. Alkali cleaning
      2. Acid cleaning
      3. Pickling
      4. Phosphate cleaning

Each paint job presents factors which require a more or less specific type of surface preparation. The most common surface contaminants are grease-like organic substances, oxidation products such as mill scale, water, and previous paint coats. The performance afforded by an applied paint is primarily dependent upon the degree to which the surface contaminants have been removed and the physical condition of the metal surface at the time of painting.

For the greatest service the importance of intimate contact, (wetting), between the base metal and the prime coat cannot be overemphasized. Hence, in the preparation of structural steel completeness of the removal of surface contaminants is synonymous to long service life. Grease-like organic substances prevent direct contact between the metal surface and the primer paint and thus prevent maximum adhesion. Water not only reduces the adhesion between the metal surface and the paint, but also promotes the formation of corrosion products under the film. The rust, being hydroscopic, entraps moisture which acts as an electrolyte in promoting rapid electrochemical corrosion through cathodic rust in contact with the anodic metal surface.

MILL SCALE

Most structural steel is hot worked. It is covered with a mixture of iron oxides called mill scale which is of variable thickness, continuity, and adhesion. The variations in the mill scale are dependent primarily upon the shape, cross section, rolling temperatures, and subsequent number of rollings and annealings.

Mill scale is brittle and is mainly magnetic iron oxide, Fe_3O_4. Due to the difference in coefficient of expansion between the mill scale and the base metal, it cracks. When first formed on structural steel it is bright and almost silvery in appearance, but on exposure to the atmosphere it acquires a blue-gray color.

If moisture enters a mill scale crack, rusting of the base metal commences. As the rust creeps under the mill scale, adhesion is destroyed, partially due to increased volume of the rust over that of the base metal. The rust is a product of electrochemical action between the cathodic mill scale areas and the adjacent