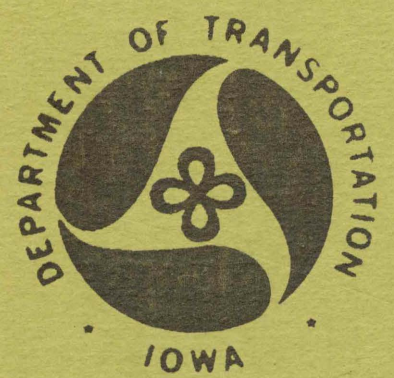
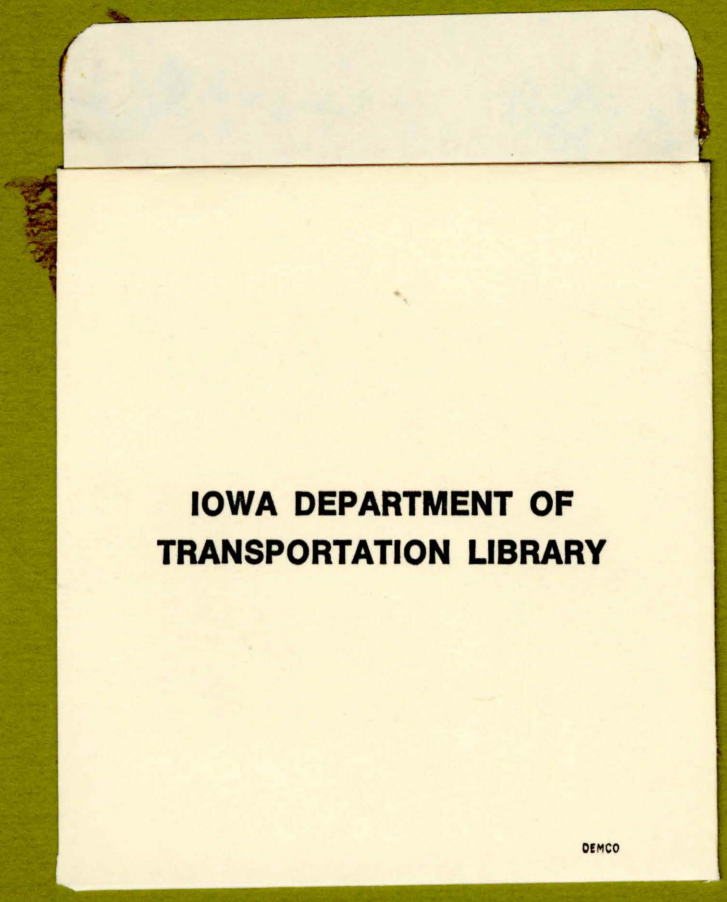
STRUCTURAL STEEL PAINTING INSPECTION MANUAL FOR ZINC-SILICATE SYSTEMS



HIGHWAY DIVISION

OFFICE OF MATERIALS

1979



INTRODUCTION

The purpose of this manual is to provide information to assist painting inspectors with their inspection of the painting of structural steel bridges using a zinc-silicate primer and vinyl topcoat. It is intended to provide an insight to the complexities of these modern coatings and the difficulties that can arise with their use.

The manual includes information about the paints, surface preparations required, application of the paints, and inspection duties. Some of the material presented is of a technical nature and may appear to be of little practical value to the inspector on the job. Experience has shown, however, that a basic knowledge of all aspects concerning the paints and painting operations will prove valuable to the competent inspector.

The information contained herein should not be considered as specification requirements but is intended to assist the inspector in their interpretation.

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ZINC-SILICATE PAINTING INSPECTION

PART I PAINTS

A. ZINC-SILICATE PRIMER

1. General. Zinc-silicate is the name used by the Iowa D.O.T. for paints known in the industry as self-cured, solvent based, inorganic zinc rich primers. These coatings are noted for their excellent corrosion protection of steel and abrasion resistance and are considered to be as close to a permanent primer as is now available. They are also currently considered to be environmentally acceptable.

2. Composition. Zinc rich coatings can be divided into organic or inorganic classes according to the resin or binder used. The organic coatings have organic binders (carbon based compounds) such as linseed oil, epoxy resins, vinyl resins, etc. The inorganic coatings have binders consisting of compounds based on substances other than carbon such as silica. The pigment used in both classes is metallic zinc and the solvents used in zinc-silicate paints are alcohols or similar liquids. Petroleum solvents or water are not compatible.

3. Specified Types. Specifications allow the use of either two-component or single component types. The two-component type is supplied with the pigment packaged separately to be mixed at the time of application. The pot life varies with temperature and is usually about 8 hours at 77 degrees F., but can be as low as 1 or 2 hours on a hot summer day. The single component type is packaged ready-to-use.

4. Characteristics:

(a) A zinc-silicate film does not dry in the usual sense but cures to a hardened state by reacting with moisture in the surrounding air. When the film is applied the solvents evaporate rapidly and the film appears to be dry. At this stage the binder has not cured and the film can be easily removed. The time required for thorough curing depends on the ambient temperature and relative humidity. The paint film must be thoroughly cured before it is topcoated (see Section B under Paint Applications for test to check curing).

(b) The cured zinc-silicate film is not continuous but is an open lattice network which allows electrical contact between zinc particles and between zinc and steel. The zinc can thus sacrifice itself for the steel without disturbing the integrity of the coating. This porous film will not

blister or peel because it allows free transfer of air and vapors. However, bubbling of a topcoat can occur if air or vapors are entrapped in the film.

(c) A zinc-silicate film without topcoat will form deposits of white zinc salts on the surface when the film is allowed to weather for an extended period of time. These salt deposits slow down further sacrifice of zinc but must be removed, if excessive, to obtain adhesion of the topcoat.

(d) Intercoat adhesion between two coats of zinc-silicate paint is marginal unless the first coat is not fully cured. A cured film will absorb the binder of the second coat so that adhesion cannot occur. When building film thickness of a deficient prime coat, thinning of the paint used for build-up and sweep-blasting of the cured initial coat are recommended.

B. VINYL FINISH COATING

1. General. The vinyl topcoat is quick-drying paint characterized by the flexible and tough film it forms that has outstanding resistance to water, chemicals, and weather. This coating reduces the need for sacrificial action of the zinc in the primer and thus increases the life of the painting system.

2. Composition. The vinyl paint is made by dissolving solid vinyl resin in strong solvents, adding a plasticizing agent, and dispersing the pigment in the resin solution. There is a wide variety of vinyl resins available from which vinyl paints can be made and the proper type must be used to obtain adhesion to zinc-silicate primer. For this reason, the specifications require the vinyl paint to be made by the same manufacturer that makes the primer over which it is applied. However, vinyl paint from approved suppliers may generally be considered compatible in this respect.

3. Characteristics.
(a) The vinyl paint film dries solely by solvent evaporation. It dries to touch in about 20 minutes but will retain a small amount of solvent which dissipates slowly over an extended period of time.

(b) The vinyl film, regardless of age, remains soluble in the original solvents. This allows easy repair because the solvents in a second application redissolve some of the initial coat and excellent intercoat adhesion results. Future maintenance touch-up is thus possible without adhesion problems.

(c) Vinyl paints have poor wetting properties and must therefore be applied to a surface free from dust and other foreign matter.

(d) Vinyl paints contain a low volume of film-forming solids. A so-called high build type is specified which allows application of the proper film thickness in one coat. A 9 to 10 mil wet film is required to obtain 3 mils dry.

C. ACCEPTANCE PROCEDURES

1. General. Both paints are accepted for project use on the basis of a certification from an approved supplier. Materials Office I.M. 482.09 covers the acceptance procedures and includes a list of approved suppliers which is updated periodically. A copy of this I.M. appears in the appendix.

2. Information Required for Acceptance. Project numbers and the name to whom the paint was shipped, as given on certifications, may not correspond to the project being inspected because of paint stock transfers, etc. Therefore, paint may be accepted for project use if the batch numbers to be used are covered by any shipment certification from an approved supplier.

3. Obtaining Certification Copies. A master file of all paint certifications is maintained at the Central Laboratory in Ames. Copies are available on request, if needed, by providing the name of the paint manufacturer and batch numbers.

4. Using Paint Without Certification. Batch certifications are not always immediately available at the time the contractor wishes to begin painting. Painting can be allowed in this situation, if the paint is from an approved supplier and the contractor understands that applied paint found not acceptable must be removed. The Central Materials Office should be notified so that certifications covering the paint can be obtained as soon as possible.

D. SAMPLING

1. Required Samples. Sampling in the field is unnecessary unless a paint appears questionable in some respect. Monitor sampling and testing is scheduled and handled by Central Laboratory personnel.

2. Procedure. Representative samples of these paints are difficult to obtain because of fast evaporating solvents and pigment settlement. The best sample is an unopened original container.

E. MIXING AND THINNING

1. Mixing During Application. It is usually difficult to keep zinc-silicate paints homogeneous during application because the heavy zinc pigment may settle rapidly. Agitated paint pots are recommended. If an agitated pot is not used, the zinc-silicate paint should be manually mixed, occasionally, while it is being applied. Vinyl paint only requires initial mixing.

2. Thinning for Proper Application. Thinning of both paints is often required to obtain proper application. Conventional thinners such as mineral spirits are not compatible with either paint and special solvents must be used. During hot or windy conditions a slow-evaporating solvent may be used to obtain a sprayable consistency. Thinning will lower the dry film build-up that can be obtained for an applied volume of paint.

PART II SURFACE PREPARATION

A. PURPOSE

Steel surfaces are cleaned prior to application of paints to obtain the best performance of the coatings consistent with the economics of expected exposure and preparation costs. Complete removal of all foreign matter is expensive and is not normally required for good performance of coatings on highway bridges. Zinc-silicate and vinyl paints, unlike conventional coatings, do require a good grade of cleaning and special surface preparation considerations.

B. CLEANING METHODS

1. Solvent Cleaning.
   (a) This method includes wiping surfaces with a solvent-soaked rag and the use of high pressure water. It is used to remove dirt, salt deposits, grease and other similar contaminants. Solvent cleaning should precede blast cleaning to remove heavy grease deposits or if the abrasive is recirculated.

   (b) Petroleum solvents or chlorinated hydrocarbons are commonly used to remove grease and oil. The rags and solvents should be clean to avoid spreading these contaminants on the surface.

   (c) High pressure water may be used to remove dirt and salt deposits. If detergent or soap is used, any residual soap film must be removed.

2. Hand and Power-Tool Cleaning.
   (a) This method includes the use of wire brushes, scrapers, grinders, etc. It's use is limited to small areas for touch-up cleaning or repair work. Abrasive blasting is preferred, even for small areas, but practicality may dictate hand tool use.

   (b) Wire brushes and scrapers are used to remove loose rust, zinc salt deposits, or poorly bonded paint.

   (c) Grinders are used to remove mill scale from small areas protected by holding devices during blast cleaning or to remove small defects on the steel surface that are exposed by the blasting process. The ground surface should be rough to allow adhesion of the primer.

3. Abrasive Blast Cleaning.
   (a) This method involves propelling abrasives at the surface with a centrifugal wheel or by air blast. It is used for the over-all cleaning of the steel in preparation for the prime coat and may also be used for touch-up cleaning and repair work. The abrasive used includes sand, grit, and steel or iron shot.

   (b) Sand is the only abrasive used to clean existing structures. River sand and white silica sand are the types commonly used. Silica sand is the most efficient and cleanest sand to use but river sand is the least expensive.

   (c) Grit and shot are used only in the fabricating shops where recovery is possible. Grit provides a rough, sharp, angular profile on the steel surface to which the primer can best adhere.

   (d) Shot has more impact power than grit and is often added to grit to aid in mill scale removal. New shot must not be used alone because the spherical shape tends to produce a peened surface to which the primer will not adhere.

C. CLEANING FOR PRIMER APPLICATION

1. General. Zinc silicate paint requires an abrasive blast cleaned surface to obtain good adhesion and effective corrosion control. Adhesion depends not only on removing non-adherent or imcompatible contaminants, but on providing a surface to which the film can mechanically bond. To provide cathodic protection, the zinc must be in intimate contact with the steel, so most of the contaminants should be removed.

Cleaning of new steel in the fabricating shops is usually excellent because of the surfaces of new steel are more uniform and most shops use the centrifugal wheel equipment. The surfaces on existing structures, however, vary considerably in the amount of corrosion that may be present and also involve removal of old paint. Uniform inspection on different structures that is carried out to the letter of the specification is, therefore, difficult to attain. Each situation must be judged separately with the primary considerations of obtaining a surface to which the primer can adhere and provide protection.

2. Specified Cleaning. Specifications call for steel cleaning in accordance with the Steel Structures Painting Council Specification, SSPC-SP10, entitled "Near-White Blast Cleaning". The following is the definition of this grade of blast cleaning as quoted from that specification:

> "A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface 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 that remain. At least 95 percent 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. Photographic or other visual standards of surface preparation may be used as provided in the Appendix to modify or further define the surface if specified in the contract".

3. Applying the Cleaning Definition. Describing a degree of blast cleaning that calls for less than complete removal of foreign matter is difficult because the descriptive terms are necessarily relative. The judgement decisions required to apply such a definition can therefore lead to misunderstandings. The following comments concern application of the cleaning definition:

   (a) The foreign matter remaining on the cleaned surface should be slight. The shadows, streaks, and discolorations referred to are all very thin residues of contaminants that remain after removal of rust, mill scale, or old paint.

   (b) All old paint must be removed except for the slight residues allowed in the definition. These residues should be limited to those remaining in the bottom of the surface profile pits. Zinc-silicate paint will not adhere to any smooth surface such as an old paint film.

(c) An objective method of measuring the amount of surface that complies with the 95 percent requirements is not available. The percentage must be determined by a visual estimate made from an overall view of the surface. This judgement cannot be made with exactness, but it is intended that the slight amounts of foreign matter remaining should be distributed uniformly over the surface and not concentrated in any area.

(d) The color and sheen of a prepared surface will not normally be uniform. The natural color of the blasted steel may vary, may be changed by the abrasives used, and a bright blasted surface may dull rapidly. Discolorations due to rust stains or old paint residues can usually be distinguished by their specific colors, while mill scale oxides appear as dark or black spots.

(e) Photographic standards are helpful when the standard photo is carefully compared with photos showing bracketing grades of cleaning. Their practicle use is somewhat limited, however, because they cannot show all situations that may occur.

(f) Old paint on existing structures should be allowed to remain in the cracks between steel members such as a rivet head and a plate or between a splice plate and web. This may not always be possible but any old paint remaining in the crack will help maintain a seal.

4. Surface Profile Height.

(a) Profile height is the distance between the high and low points (peaks and valleys) of a blast cleaned surface. If this dimension is too small, the primer may not bond. If it is too large, the possibility of a thin film over the peaks is increased.

(b) A nominal profile height of 1.0 to 2.5 mils is specified to indicate the minimum height for good primer adhesion and that a low profile is desirable. In practice, however, a profile height less than 1.0 mil is difficult to attain and a reasonable height over 2.5 mils is of little concern if the film thickness is as specified. Profile height measurements are therefore not recommended except in unusual circumstances.

(c) The dry film thickness measured by magnetic gage is indicative of the thickness of the film over the profile peaks of average height. The possibility of a film thin enough to allow rusting, even on the highest peaks, is minimal if proper thickness measurements show compliance.

(d) A high profile will require the painter to apply more paint to obtain the specified film thickness. Paint quantities figured on the basis of a smooth surface will not be adequate.

5. Cleaning After Blasting. Dust, abrasives, and other loose blast products should be removed from the surface with brushes, compressed air, or by vacuum before primer is applied.

D. CLEANING THE PRIMER FILM

1. Primer Film Build-Up. When it is considered necessary to apply additional primer to build film thickness, some preparation of the initial cost may be necessary because of the marginal adhesion problem. The cleaning required depends on the curing status of the initial cost as follows:

(a) If the initial coat has not fully cured, no cleaning is necessary unless contamination has occurred.

(b) For a cured initial coat, sweep-blasting is recommended before applying additional primer. This cleaning method consists of a single, light pass of the blasting nozzle which is intended to slightly etch the existing film with a minimum of film removal. contaminants will also be removed by this method. Wire brushes can be used for small areas.

2. Primer Touch-Up.

(a) Unprimed field connection parts on new construction, including rivet heads, bolt heads, etc., are cleaned after erection by sand blasting before applying the prime coat.

(b) To repair damaged areas of the prime coat, the area should be sweep-blasted before touch-up with primer. Small areas may be cleaned with a wire brush, etc.

(c) Pinpoint rusting, also called "salt and pepper rusting" occurs if the primer film thickness is not sufficient to cover the highest peaks of the blast profile. All rust should be removed by sweep-blasting before applying additional primer.

3. Preparation for Vinyl Topcoat.

(a) On new construction, this cleaning involves removal of white zinc salts, dirt, dust, grease, etc. High pressure water is the preferred cleaning method except cleaning with petroleum solvents is necessary for oily deposits. Hand cleaning may be used for small areas.

(b) On existing structures, this cleaning normally consists of removing dirt and dust. It may also involve removing loose zinc particles resulting from dry sprayed or over-sprayed primer. Cleaning methods include hand cleaning, high pressure air, and high pressure water.

E. CLEANING THE VINYL TOPCOAT FILM

1. Topcoat Film Build-Up or Touch-Up.
   (a) Removal of contaminants by solvent washing is normally the only cleaning necessary. Small damage areas, not seriously involving the underlying prime coat, do not require any special cleaning.

   (b) If the vinyl topcoat has lost adhesion to the primer, the area should be sweep-blasted (silica sand preferred) to remove any remaining loose vinyl paint leaving feathered edges. Small areas may be hand cleaned. Removal of primer during this operation should be kept to a minimum.

2. Repairing Both Topcoat and Primer Film. If it is necessary to repair a prime coat that has been topcoated, the repair area should be sweep-blasted before applying the approved organic zinc-rich primer. This repair primer does not require special cleaning before application of the vinyl topcoat.

PART III PAINT APPLICATION

A. WEATHER CONDITIONS

1. Temperature.
   (a) A minimum surface temperature of 40 degrees F. is specified for painting. This limit helps assure a moisture and frost free painting surface and is intended to allow the primer an opportunity to cure in a reasonable time.

   (b) If the temperature falls below the minimum during the curing or drying period, damage to either paint is unlikely. However, the curing rateof the zinc-silicate paint will be slow and should be checked carefully.

   (c) A maximum temperature is not specified but high temperatures can cause application problems such as dry spray or pinholes. These problems can be avoided by thinning and proper application technique.

   (d) Any corrective action deemed necessary because of temperature related failure, should be based on indicated damage and not on temperature measurements.

2. Moisture.

(a) Both paints must be applied to a dry surface. This can be determined by the following test: Lightly moisten a small area with a damp cloth and observe evaporation and drying. The surface may be considered dry if the applied dampness evaporates and decreases in area within 15 minutes.

(b) Damage to either paint is not likely to occur from moisture, once the paint has been applied. Zinc-silicate paint can be moistened in a short time after application without affect, except for a faster curing rate. Vinyl paint is usually sufficiently dry within 20 minutes to avoid moisture damage.

(c) A wet paint film exposed to moisture should be permitted to dry. Damage such as erosion or premanent discoloration may require repainting.

(d) To avoid expensive recleaning of steel, application of primer over cleaned steel should be allowed, at the contractor's option, if the weather becomes threatening. Damage to the prime coating is extremely unlikely in such situations, but this should not preclude discontinuing painting for safety, traffic protection, or other reasons.

B. CURING TIME OF PRIMER

1. General. The zinc-silicate film must be thoroughly cured before the topcoat is applied. The extent of curing is determined by the coin hardness test given below. A curing time chart based on ambient temperature and relative humidity is included in the appendix for information only. Acceleration of the curing can be achieved by spraying the film with a water mist.

2. Coin Hardness Test. A zinc-silicate film cures from inside to outside and any uncured film can be easily scraped away from the top of the film. This is the basis for the coin hardness test with the following procedure:

Scrape the film with the edge of a coin and observe the amount of film removed (appears as powdered zinc). If the amount removed is practically nil and the area scraped has a shiny, polished appearance, the film is considered thoroughly cured. NOTE: A small amount of zinc can sometimes be removed from a cured film depending on the pressure applied to the coin. Also, a partially cured film will leave a polished appearance on the area scraped.

C. FILM THICKNESS

1. General. Film Thickness is a critical measurement for determining the adequacy of a paint film to protect steel. A thicker film will generally provide a longer protective life. The specified film thickness for each coat of paint is obviously important, but in practical situations the relative importance of these measurements varies as follows:

   (a) The total combined thickness of the primer and topcoat is the most critical measurement because it essentially decides the life of the paint system.

   (b) On new construction, the thickness of the prime coat applied in the fabricating shop is critical because this film will be required to withstand weathering for an indefinite period of time before it is topcoated. The proper film thickness will avoid pinpoint rusting and minimize field repairs.

   (c) On existing structures, the prime coat will normally be topcoated within a short period of time. Therefore, prime coat measurements in this case are not as critical as those on new construction.

2. Specifications.

   (a) The specifications require a 3 mil average dry film thickness for each coat and a minimum of 2.5 mils at any point. The thickness measurement at a point consists of the average of at least 5 instrument readings taken in a small area (4 inch diameter or less). Individual gage readings are not valid by themselves. The 3 mil requirement refers to the average thickness found on a large test area: one side of a beam web, for example. This overall average thickness is obtained by averaging several point results taken at selected small areas representative of the larger test area.

   (b) It is not intended that the thickness of the vinyl topcoat be determined separately, but rather the total thickness of both primer and topcoat. The overall average thickness of the two coats must then be a minimum of 6 mils and the minimum at any point must be 5 mils. Deficient total thickness is corrected by adding more vinyl paint.

3. Gage Operation.
   (a) The procedure for using the magnetic film thickness gage is given in Materials Office I.M. 332, included in the appendix. Valid measurements with this gage depend on use with close attention to procedure details.

   (b) The gage must be calibrated with a paint film standard obtained at the Central Laboratory. These standard films are painted over a sandblasted surface and the stated film thickness related to actual readings taken with a gage calibrated against certified thickness standards obtained from the National Bureau of Standards.

   (c) Central Laboratory studies indicate that proper measurements made with a gage calibrated with the paint film standard will give film thickness results that includes the paint about 0.5 mil below the average peak height of the blast profile.

4. When to Make Measurements. The ideal time to make film thickness measurements is when the coating has thoroughly cured or dried. The vinyl paint dries reasonably hard in about 4 hours, so the time delay before measurements are taken is normally not a problem. The primer appears to dry rapidly, but curing is much slower and the film will shrink slightly during the curing period. Preliminary thickness measurements can usually be made about 2 hours after application to determine any need for film-build. Final measurements should be made after the film has cured at least overnight.

5. Measurement Test Areas.
   (a) Test areas should be selected to represent the various components of the structure, with consideration of the exposure to which they will be subjected. Surfaces directly exposed to weathering such as outside web surfaces should always be checked. The bottom surface of the bottom flange is a difficult area to paint and should also be checked. Any steel above the bridge deck should be checked to at least a height of six feet.

   (b) A test area may be any designated size of continuous flat surface such as a web on one side of a beam or one side of a small beam stiffener. Large areas can be divided into smaller areas at the discretion of the inspector. For example, if an initial check on a web indicated a thin coat at one end, this end could be redesignated as a separate test area and be rechecked. If found deficient, it would only be necessary to repaint that end of the web.

(c) The number of test areas selected will depend on the size and complexity of the structure, but should always be sufficient to reasonably assure the inspector that the proper amount of paint is being applied. If a deficient area is found, this warrants increasing the number of test areas.

6. Point Measurements.

(a) Point measurements should be randomly distributed over the test area. The exact locations are decided solely by the inspector.

(b) The number of point measurements made within a test area depends on the dimensions of the area. Usually, 3 to 5 points are sufficient.

D. APPLICATION PROBLEMS

1. Dry Spray.

(a) Dry spraying occurs when semi-dry particles of paint hit and stick to the surface. The contributing factors are fast evaporating solvents, hot ambinet temperatures, and the distance the paint gun is held from the surface being painted. On hot days it is advisable for the painter to thin the paint for application. Dry spray, however, usually occurs on the web where the painter fans the gun as he paints along the beam. The dry spray appears at the ends of the swing of the gun where it is farthest from the beam. Dry sprayed areas can usually be recognized by a shadowy appearance of glossy and dull areas or light and dark areas.

(b) Dry sprayed zinc-silicate paint produces a lumpy texture on the surface caused by semi-adherent zinc particles which can usually be removed by rubbing with the hand. To assure topcoat adhesion the loose zinc particles must be removed by wiping, brushing, or high pressure water. In severe cases, it may be necessary to clean the surface by sweep-blasting followed by repainting.

(c) A dry sprayed vinyl film is more porous than a sound film and provides a bad appearance. It should be corrected by applying a new coat of highly thinned vinyl paint.

2. Overspray. Overspray occurs when sprayed paint misses the target and lands semi-dry on other steel or painted surfaces in close proximity. When this occurs with the primer, the resulting loose particles of zinc must be removed before paint is applied to the affected surfaces. A stiff bristle brush can be used for removal or, in extreme cases, a wire screen. Loose particles should be removed with compressed air.

3. Mud-Cracking. Mud-cracking of a zinc-silicate film occurs when it is too thick This is most likely to occur in areas where paint is applied from several directions such as inside corners. The condition appears as a network of cracks in the film. To repair, the film must be scraped back to soundly bonded paint and the area recoated, if necessary, to obtain minimum film thickness.

4. Topcoat Bubbling.
   (a) There is a tendency for the vinyl topcoat to trap air or absorbed solvent in the porous zinc silicate film. When the trapped air or solvent escapes, bubbles are formed in the coating. This phenomenon is most likely to occur when the topcoat is applied too thick or when the painted surfaces are exposed to the heat of the sun. Dry sprayed zinc silicate paint also enhances the problem.

   (b) The bubbles formed usually break and reseal, but they may remain as blisters after the topcoat dries leaving a poor appearance. Poor adhesion of the topcoat or pinholes can also result.

   (c) The need for repair of a bubbled or blistered topcoat depends on the initial adhesive properties of the topcoat or on the presence of pinholes. If the topcoat, while still curing, is easily peeled from the primer, the coating should be completely removed and the area repainted. If pinholes are present or if a broken blister reveals the underlying prime coat, the blisters should be removed using a scraper and the area repainted with highly thinned vinyl paint. If appearance is the only problem, it is usually better not to attempt repairs.

   (d) Bubbling of the topcoat can almost always be traced to improper application of the coating or to application under poor ambient conditions. The problem can be avoided or at least minimized by one or more of the following application procedures: (1) remove

all loose zinc particles from the primed surface, (2) apply a very thin mist coat of vinyl paint 10 to 20 minutes prior to application of the full coat or (3) thin the vinyl paint up to 50% and apply a full wet coat about 1/2 to 1 hour prior to application of the full coat. Weathering of the prime coat prior to topcoating, as occurs on new construction, usually allows zinc salts to seal the porous surface of the primer which eliminates the bubbling problem.

5. Topcoat Adhesion. Basically, good adhesion of the topcoat to the primer is achieved if the vinyl paint wets and penetrates the primer film. The viscosity (or amount of thinning) of the vinyl paint is therefore important in this regard. It must be thin enough to provide penetration and allow air and solvent to escape. If it is too thin, the coating may run and sag or film-build may be required. The amount of thinning necessary is primarily related to the ambient and surface temperatures.

The adhesion of the topcoat to the primer will increase with time as the last traces of solvent evaporate. In the early stages it may be easily scraped off but if it cannot be peeled, good adhesion will eventually result.

The following list summarizes the cause of topcoat adhesion failure:

(a) Use of an improper type of vinyl paint.

(b) Application to an improperly cleaned primer film.

(c) Application over frost or moisture.

(d) Application to an uncured primer film.

(e) Application over dry sprayed primer or overspray.

(f) Application on a hot surface causing premature evaporation of solvent before penetration.

PART IV INSPECTION

A. GENERAL

Painting cannot be adequately inspected by visual observation of the final product because a poor paint job often looks the same as a good one. Early failures due to poor workmanship often occur after the work has been completed and has been paid for. It is necessary, therefore, to inspect the work as it progresses if there is to be any reasonably assurance that a paint job was completed as specified.

The paints used with this sophisticated system are subject to some unique application problems not found when using conventional paints. To provide competent inspection of the operations, the inspector must receive special training regarding the use of these paints and the inspection procedures.

B. RECORDS

The inspector should keep a daily log containing pertinent information concerning the painting and related operations. A complete record will be valuable to the inspector and the engineer if disputes arise as the work progresses and is also essential for any future evaluations of the painting.

In addition to the standard project information (project number, location, contractor, etc.) the record should include the following where applicable:

1. General Information.
   (a) Notes on safety, traffic protection, etc.
   (b) Cleaning equipment used (wheelabrator, sand blast, etc.).
   (c) Abrasive used (river sand, silica sand, shot, grit, etc.).
   (d) Notes on cleaning procedures (removal of dust, grease, etc.).
   (e) Paints to be used (manufacturer, batch numbers, etc.).
   (f) Paint mixing and thinning procedures used (Agitated pot, hand mixing, amountof thinning, etc.).
   (g) Application equipment used (airless spray, conventional spray).

2. Daily Details.
   (a) Weather conditions (ambient temperature and humidity, sky conditions, wind, etc.).
   (b) Notes on surface preparation (area cleaned, general surface condition, any unusual phenomenon).
   (c) Surface temperature at time paint was applied.
   (d) Location on structure of area painted.
   (e) Paints applied (batch numbers, thinning, etc.).

(f) Dry film thickness measurements (test area description, point thickness values, average thickness).

(g) Primer curing time allowed before topcoating.

(h) Application problems encountered (dry spray, bubbling, etc.).

(i) Corrective actions taken to avoid application problems or to make repairs.

C. INSPECTOR DUTIES

1. General. The inspectors primary job is to recognize and report sub-specification work. Unfortunately it cannot always be assumed that the painter is completely knowledgeable about the paints to be applied and the specifications governing their application. Discussion with the contractor, before the work begins, to clarify such things as degree of surface preparation, curing times, film thickness requirements and corrective actions to be taken if problems arise will help avoid inspection difficulties.

Experience and good judgement are of particular importance for inspection of this painting system. Technical assistance from the Central Materials Office should be sought if unusual problems arise.

2. Summary of Responsibilities. The major responsibilities of the painting inspector may be summarized as follows:

(a) Record keeping.

(b) Approval of traffic control procedures.

(c) Acceptance of paints.

(d) Approval of surface preparation before paint is applied.

(e) Checking cure of primer before topcoating or shipment from fabricating shop.

(f) Visual inspection of each coat of paint for defects.

(g) Determining film thicknesses.

3. Inspection Equipment. The inspector will need the following equipment:
   (a) Field notebook.

   (b) Surface temperature thermometer.

   (c) Dry-film gage and paint thickness standard.

   (d) Pocket knife.

4. Scheduling Inspection. It is not always possible for the inspector to be on the job at all times because of other commitments and duties. Obviously it is important for the inspector to be familiar with the painter's operational schedule and for the painter to have a clear understanding of what the inspector wishes to check. An agreement between the inspector and painter can then be established so that the inspector can at least be present at the critical times and any hold-up of painting operations can be avoided.

Highway Division

OFFICE OF MATERIALS — INSTRUCTIONAL MEMORANDUM

INSPECTION AND ACCEPTANCE OF PAINTS FOR THE ZINC-SILICATE PAINTING SYSTEM (4182.02 AND 4182.03)*

GENERAL

Acceptance of paints for painting structural steel with the zinc-silicate painting system will be on the basis of certification from an approved paint producer, subject to satisfactory results obtained from testing monitor samples.

Producer and product approval shall be obtained before paints can be furnished to projects.

PRODUCER AND PRODUCT APPROVAL

Producer and product approval will be based on information supplied by the producer and the results of tests made by the Central Materials Laboratory. Both zinc-silicate paint and foliage green vinyl finish coating must be accepted before approval is given.

The paint producer shall submit to the Materials Office, product data for both types of paint showing compliance with all specification requirements. The information provided shall also include the producer's name, brand name of each paint, identification number of each paint, and mixing instructions for any two-component paint involved.

In addition, the producer shall submit to the Central Materials Laboratory, a sample (at least one quart) of both types of paint. Standard color chips for foliage green are available from the Materials Office on request.

When the producer and products have been accepted by the Materials Office, the approval will remain in effect indefinitely, unless withdrawn because of deficient test results on monitor samples, unsatisfactory field results traceable to the paint, or failure to comply with paint acceptance procedures. If a change is made in the manufacturing process or formulation of either paint originally approved, the change must be reported to the Materials Office for decision on continuance of the approval. This decision shall be made before such paints are furnished for projects.

*General rewrite. Read in detail.

PAINT ACCEPTANCE PROCEDURES

The paint producer shall furnish three copies of a certification document for each shipment intended for use on Iowa projects. The document shall include the following information concerning the shipment:

1. Date of shipment
2. Name of painting contractor or company to which shipment was made
3. Brand names of product identification numbers
4. Batch or lot numbers
5. Quantity of paints

In addition, the document shall bear the following certification statement and the signature of a responsible company representative:

CERTIFICATION STATEMENT

We hereby certify that the products herein described have been previously approved in accordance with the procedures established by the Iowa Department of Transportation and that they comply with the applicable specifications.

Signed _____

The three copies of the document prescribed above shall be mailed, at the time of shipment, to the Materials Office in Ames, who will forward one copy to each District Office and Project Engineer who have work scheduled by the contractor or company involved.

Paint shipments from an approved producer, which are documented as outlined above and appear otherwise satisfactory may be incorporated in the work.

MONITOR SAMPLING AND TESTING

Producers which actively supply paints for projects shall be required to submit samples of paint to the Central Materials Laboratory on request. These samples shall be randomly selected at a minimum rate of one (1) per fifteen (15) batches shipped.

In addition, monitor samples may be requested from the project destination or fabricating shop. Such samples may be taken by District Highway Division personnel, the painting contractor,

or the fabricator. Paint which the project engineer believes to be questionable may be sampled at any time.

All monitor samples shall consist of unopened containers. Maximum sample size shall be 5 gallons or a 5-gallon kit for two-component paint. Samples taken within the state may be returned after testing.

Test results not in reasonable close conformity with the specifications will be considered sufficient cause to discontinue use of the batch represented and to require sampling of additional batches for evaluating the continuance of producer and product approval. Article 1105.05 of the Standard Specifications applies in case paint not in reasonably close conformity has been used.

APPROVED PRODUCERS AND PRODUCTS FOR ZINC-SILICATE PAINTING SYSTEMS

Carboline Company
328 Hanley Industrial Ct.
St. Louis, MO 63144

Carbo Zinc SP76, single pack.
Carbo Zinc 12, two-comp.
Polyclad 936, vinyl

Mobil Chemical Company
901 N. Greenwood Ave.
Kankakee, IL 60901

Mobilzinc Uni-Pak, single pack.
Mobilzinc 7(13-F-12), two-comp.
Mobilzinc 11(13-F-11K0, two-comp.
Mobil Hi-Build Vinyl

Ameron
Corrosion Control Division
Brea, CA 92621

Dimetcote EZ, single pack.
Dimetcote 6, two-comp.
Amercoat 99R, vinyl

Diamond-Vogel Paint Co.
217 Front St.
Burlington, IA 52601

Zinc Silicate Paint, WLX-5R, two-comp.
Hi-Build Vinyl, WLX-35-F

Perfection Paint & Color Co., Inc.
715 E. Maryland St.
Indianapolis, IN 46202

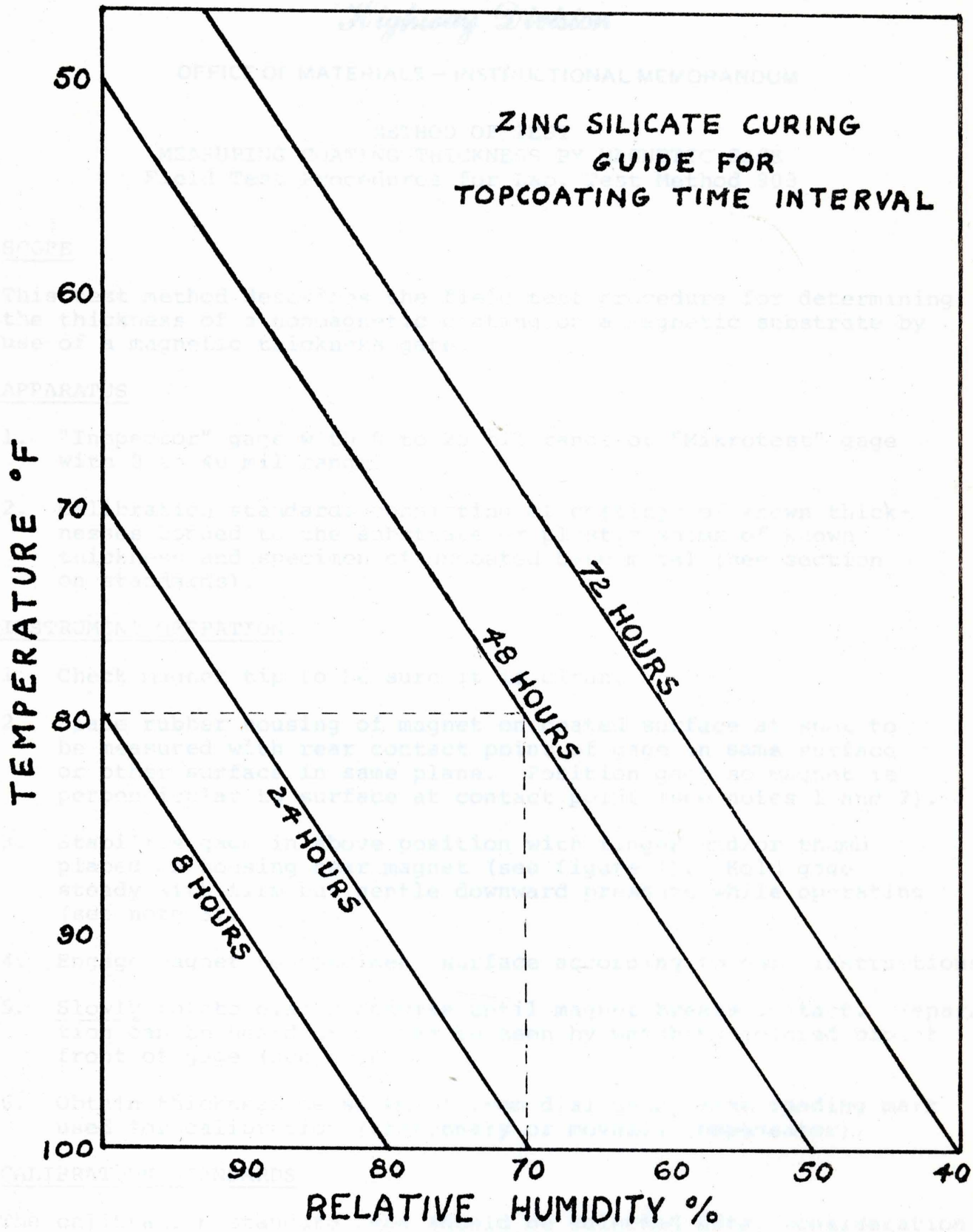
Zinc Silicate Paint, No. 22076
Vinyl Finish Coat, No. 22109

Stewart Paint Mfg. Co.
1729 N. Second St.
Minneapolis, MN 55411

Inorg. Zinc-Rich Primer, S-2304
Vinyl Finish Coat, S-2305

Morris Paint & Varnish Co.
15th and Brady
East St. Louis, IL 62207

Morzinc-1 (EA-9237A), single pk.
Vinyl Top Coat


ZINC SILICATE CURING
GUIDE FOR
TOPCOATING TIME INTERVAL
72 HOURS
48 HOURS
24 HOURS
8 HOURS
TEMPERATURE °F
50
60
70
80
90
100
90
80
70
60
50
40
RELATIVE HUMIDITY %

Highway Division

OFFICE OF MATERIALS — INSTRUCTIONAL MEMORANDUM

METHOD OF TEST
MEASURING COATING THICKNESS BY MAGNETIC GAGE
Field Test Procedures for Lab. Test Method 803

SCOPE

This test method describes the field test procedure for determining the thickness of a nonmagnetic coating on a magnetic substrate by use of a magnetic thickness gate.

APPARATUS

1. "Inspector" gage with 0 to 25 mil range or "Mikrotest" gage with 0 to 40 mil range.

2. Calibration standards consisting of coatings of known thicknesses bonded to the substrate or plastic shims of known thickness and specimen of uncoated base metal (see section on standards).

INSTRUMENT OPERATION

1. Check magnet tip to be sure it is clean.

2. Place rubber housing of magnet on coated surface at spot to be measured with rear contact point of gage on same surface or other surface in same plane. Position gage so magnet is perpendicular to surface at contact point (see notes 1 and 2).

3. Stabilize gage in above position with finger and/or thumb placed on housing near magnet (see figure 1). Hold gage steady with firm but gentle downward pressure while operating (see note 3).

4. Engage magnet to specimen surface according to gage instructions.

5. Slowly rotate dial clockwise until magnet breaks contact. Separation can be heard or it can be seen by watching colored pip at front of gage (see note 3).

6. Obtain thickness measurement from dial using same reading mark used for calibration (stationary or movable compensator).

CALIBRATION STANDARDS

The calibration standard used should be selected after consideration of the following factors:

1. Film Composition. Standard film composition should be about the same as the coating being tested: i.e. zinc films for gal-

vanizing and paint films for painting. Plastic shims should only be used for curved surfaces coated with a paint type material (not galvanizing).

2. Film Thickness. Standard Film Thicknesses should be as close as possible to thickness being measured. The approximate recommended thicknesses are:

Range of Sample Thickness, mils	Approx. Standard Thickness, mils
0.3 - 1.5	1
1.5 - 3.5	2
2.5 - 5.5	4
4 - 8	6
8 - 12	10

3. Substrate. Substrate of standards should have the same magnetic properties, surface texture (sandblasted, smooth, etc.), curvature, and effective thickness as material being tested (see notes 4 and 5).

INSTRUMENT CALIBRATION

1. Select standard film of proper composition, thickness, and substrate.

2. Determine the average of 5 readings taken at different spots on the standard film, using stationary reading mark on gage.

3. If gage has movable compensating reading mark, set dial to indicate step 2 average on stationary mark and without moving dial, set compensator to indicate film thickness of standard. Subsequent test measurements are read using compensating mark (see note 6).

4. If gage doesn't have compensating mark, determine difference between standard film thickness and step 2 average. Use this difference to correct subsequent test results (see note 6).

TEST PROCEDURE

1. Calibrate gage as outlined above (see note 7).

2. Select a small area (about 4 inch diameter or less) on smoothest portion of test surface and remove all foreign material. Avoid areas difficult to clean.

3. Make at least 3 individual thickness measurements within the small area. These readings should be taken at different spots (see note 8).

4. Average all individual readings obtained within the small area and apply any calibration correction. This average is the test result for that point on the surface (see note 9).

5. To obtain an overall coating thickness for a large area, average several step 4 point results taken at selected small areas representative of test area (see note 10).

REPORTING RESULTS

Report test results to the nearest 0.1 mil. A zinc coating thickness in mils may be converted to ounces per square foot by dividing by (1.7).

NOTES AND PRECAUTIONS

1. Instrument Position. Gage position during measurements, i.e. upright, horizontal, or upside down, may affect results. Calibration for different positions should be verified. Gage should be positioned parallel to longitudinal axis of cylindrical specimens.

2. Edge Effect. Measurements should not be taken closer than 1/4 inch from edges or inside corners.

3. Instrument Operation. Different finger pressures applied to hold gage and different rates of rotating the gage dial may affect results. Separation of magnet from surface should occur only while dial is moving slowly and smoothly. Operation technique and measurement consistency can be checked by repeated readings taken without changing gage position. Calibration by same operator who makes test measurements will reduce or eliminate these variations.

4. Effective Substrate Thickness. Substrate thicknesses of 0.030 inch or more are equivalent. This effective thickness for flat specimens may be increased by placing the specimen on a flat layer of material with similar magnetic properties. Gage must be calibrated on a substrate of same thickness if sample measurements are taken on specimens less than 0.030 inch thick.

5. Curvature Effect. For measurements on curved surfaces the gage should be calibrated on a standard with similar curvature or with a shim placed on similarly curved base metal. Measurements may be made on cylindrical specimens of 1 inch diameter or more, using calibration with flat standard and subtracting 0.3 mil from result.

6. Measurement Corrections. Best results are obtained when compensation or applied corrections are small. Gages can be adjusted at the Central Laboratory.

7. Calibration Frequency. To assure proper performance, calibrate gage before each use and at frequent intervals during use.

8. Number of Measurements. The number of readings that should be taken depends on the uniformity of the coating thickness. For example, ten readings are recommended for galvanizing on culvert metal and five readings are taken on paint over a sandblasted surface.

9. Valid Measurements. Only averages of several individual measurements taken in the point area are valid results. Individual measurements that are obviously too high may result from gage vibration and should be discarded and rerun.

10. Test Areas. A test area on which an overall average coating thickness is determined may be of any designated size of continuous flat surface or curved surface of the same radius. To avoid unnecessary coating repairs it may be desirable to divide a large test area into smaller inspection units.

11. Instrument Care. Magnetic gages are delicate instruments and should be handled as such. Store in the case provided when not in use.

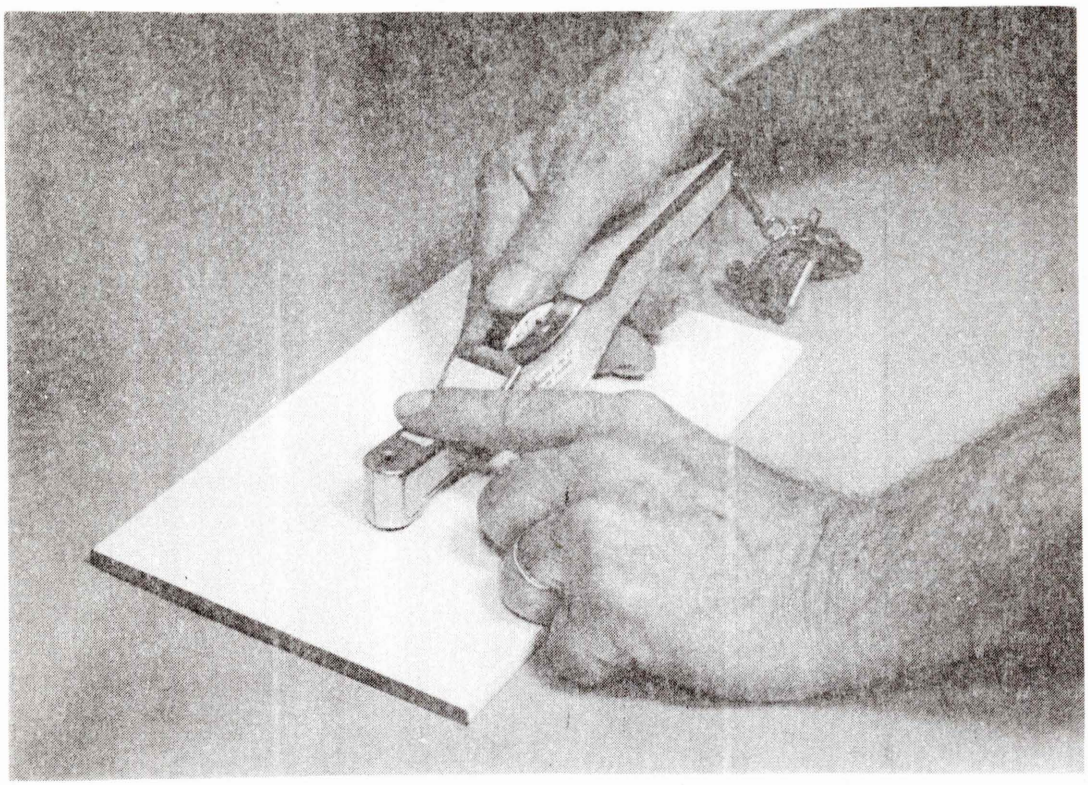


Figure 1. Operation of Film Thickness Gage

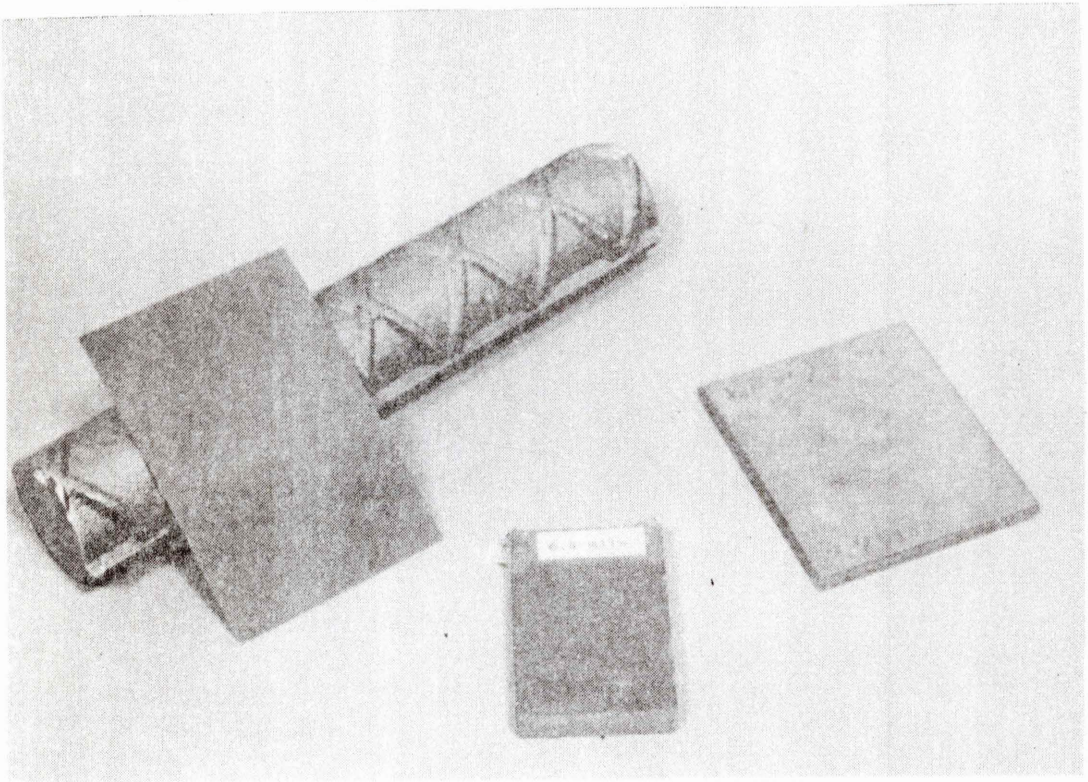


Figure 2. Various Calibration Standards