Standard Practice for Conducting Case Studies on Galvanized Structures[1]

This standard is issued under the fixed designation A896/A896M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice sets forth the procedures for conducting case studies of galvanized installations. It is intended for structural members and other permanent parts of the installation, such as railings and other such fabrications.

1.2 Included in this practice are recommendations for the visual inspection of the galvanized structure, measurement of coating thickness, and reporting of results.

1.3 This specification is applicable to orders in either inch-pound units (as A896) or in SI units (as A896M). Inch-pound units and SI units are not necessarily exact equivalents. Within the text of this specification and where appropriate, SI units are shown in brackets. Each system shall be used independently of the other without combining values in any way.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals

E376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods

3. Significance and Use

3.1 This practice is applicable to galvanized structures exposed to the atmosphere or to plant environments, including buildings, bridges, and industrial plant constructions.

3.2 It provides for the collection of data to document the protection afforded by the galvanized coating.

3.3 Method A for conducting a coating thickness survey aims essentially at an assessment of the general condition of the galvanized structure, at the time of the inspection, by taking thickness measurements on several members of the structure.

3.4 Method B provides for accurate monitoring of the coating thickness decrease as a function of time, at specific locations on the structure, in order to assess the corrosivity of the environment, the effect of orientation, elevation, or other factors.

3.5 Method B is not an alternate procedure to Method A, but is complementary and optional.

4. Apparatus

4.1 *Surface Preparation:*

4.1.1 *Water.*

4.1.2 *Cloths,* for washing and drying.

4.1.3 *Soft Fiber Bristle Brush.*

4.2 *Coating Thickness Measurement :*

4.2.1 *Thickness Gage.*

4.2.2 *Steel Calibration Plates and Foils.*

4.2.3 *Permanent Marker.*

4.2.4 *Tape Measure.*

4.2.5 *Center Punch.*

4.2.6 *Hammer.*

4.3 *Electronic Magnetic Flux Gage*— The use of an electronic magnetic-flux gage in accordance with Method B499 is recommended. Instruments with an accuracy of ±3 to ±5 % are commercially available.

4.3.1 Probes having a constant pressure feature will minimize operator error.

4.3.2 The probe assembly should have a probe support if measurements are to be made on rounded or curved surfaces.

4.4 *Hand-Held Magnetic Gage*—A hand-held magnetic gage using the magnetic attraction principle in accordance with Practice E376 may be used for Method A.

5. General Procedure

5.1 *Background Information:*

5.1.1 Wherever possible, obtain information on the tonnage and cost of the steel work, the cost of galvanizing, and

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

estimates of alternative coating costs (initial and maintenance) if the steelwork had been coated by another method. Determine if there are areas of the installation which were painted rather than galvanized, or painted over galvanizing.

5.1.2 Determine if any problems were experienced during fabrication, galvanizing, construction, and operation.

5.2 *Corrosive Environment Identification :*

5.2.1 The galvanized installation should be divided according to the various corrosive environments to which it is exposed. For example, plant atmospheres could be categorized with respect to the processing step. Sheltered versus boldly exposed areas can be considered as two different environments.

5.2.2 Pertinent data relating to the corrosive environments should be obtained, such as types of chemical present, concentration of fumes, occurrence of spills, temperature fluctuations, amount of rainfall, or the use of de-icing salts.

5.3 *Visual Inspection:*

5.3.1 Observe the overall appearance of the galvanized structure, and the appearance of each type of plant environment, if applicable. Note such characteristics as color and spangle of the galvanized coating, the presence of rust or staining, and the condition of other coatings, such as paint. Take note of chemical spills or leaks, the presence of fumes or high humidity, and effects of orientation, elevation, design, or any other factors causing localized or nonuniform corrosion.

5.3.2 The condition of the galvanized coating may vary according to section thickness or geometry of the steel. For example, there may be differences with respect to light versus heavy sections or handrails versus beams.

5.3.3 The use of high silicon steels may be apparent, and should be noted.

5.3.4 Fasteners should be inspected. Look for rust, staining, or mechanical damage.

5.4 *Coating Thickness Survey:*

5.4.1 *Method A:*

5.4.1.1 The selection of structural members should be based mainly on the section thickness. A minimum of three representative members from each of the two categories of section thickness, light (bracing) and heavy (column, beam) should be surveyed for each corrosive environment. Selection of suitable locations for coating thickness measurements is at the discretion of the inspector and may be based on factors such as orientation or accessibility. Take measurements in areas where the coating is uniform.

5.4.1.2 Fasteners should be surveyed where their size permits. Measurements should be made on the center of bolt heads, or on the flat parts of bolt heads or nuts.

5.4.1.3 Calibrate the coating thickness gage against proper reference materials before making measurements.

5.4.1.4 Clean the surface, using a fine fiber brush or by washing with water and drying, or both. Avoid removing any of the coating material or the film of basic zinc salts.

5.4.1.5 At each location, make a minimum of five measurements and determine the mean coating thickness.

5.4.2 *Method B:*

5.4.2.1 A minimum of three locations should be surveyed for each corrosive condition or position of interest. The locations need not be on the same steel member. Selection of suitable locations is at the discretion of the inspector. Take measurements in areas where the coating is uniform.

5.4.2.2 Calibrate the coating thickness gage with proper reference materials before the survey is started. Calibrations should be checked periodically to ensure continued accuracy of measurements and again at the end of the survey.

5.4.2.3 Clean the surface, using a fine fiber bristle brush or by washing with water to remove dirt and dust, or both. (**Warning—**Do not abrade with emery paper or wire brush, or clean in any manner that would tend to remove the zinc coating or the film of basic zinc salts. By removing the basic zinc salts film, corrosion can be accelerated.)

5.4.2.4 Twenty-five measurements should be made at each location within an area 2 by 2 in. [50 by 50 mm] square, and the mean (X) and the 90 % confidence limit on the mean (S_m90) should be determined (see Appendix X1). A different test area should be surveyed if S_m90 is greater than 0.3 mil [6 µm]. If possible, use a template with 25 small holes (approximately 0.2 in. [4 mm] diameter) in a 5 by 5 grid, with outside corner measurements 2 by 2 in. [50 by 50 mm]. Holes should be 0.5 in. [12 mm] apart horizontally and vertically. The grid should be centered in a larger square measuring 3 by 3 in. [75 by 75 mm] with outside corners containing small holes (see Fig. 1). Put the template on the cleaned surface and mark the 29 holes with a felt tip marker. Measurements are to be taken starting with the top left and recorded on the report form in the same order as measured on the grid.

5.4.2.5 To make test areas easier to locate for future surveys, center punch the outside corners of the 3 by 3 in. [75 by 75 mm] square so identification marks do not interfere with coating measurements. If punching is not possible, use paint or other permanent marker (less desirable). If possible, take a

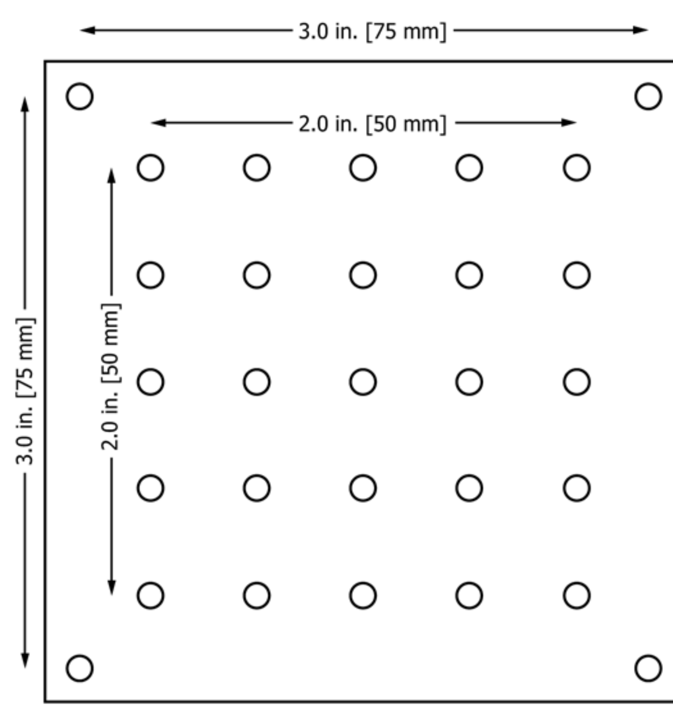

FIG. 1 Template (not to scale)

photographic record to properly document the position of each structural member on which measurements were made in relation to the plant layout.

5.4.2.6 Periodic surveys should be conducted. An initial two-year interval is recommended for the first several years. Depending on the nature of the data collected at the time of the second inspection, longer intervals may be considered.

5.4.2.7 The same thickness gage, or at least the same type of instrument as used in subsequent surveys. The steel calibration plate should be the same for each survey.

5.5 *Photographs:*

5.5.1 Obtain an overall photographic view of the installation, from several angles, if possible.

5.5.2 Photograph each corrosive environment where measurements are made, show the relation of the site to the general plant layout. If possible, show the fumes or chemicals that would normally be present.

5.5.3 Take close-up photographs where appropriate.

5.5.3.1 Include close-up photographs of areas where actual measurements were made.

5.5.3.2 Take close-up photographs of other areas pertinent to the study, such as those areas showing concentrated corrosion, coating damage, staining, etc., that is not typical of the galvanized structure as a whole.

5.5.3.3 Take close-ups of fasteners.

5.5.3.4 Take close-ups of painted or other coated areas.

6. Report

6.1 Report sheets are provided in Appendix X1.

6.2 State the name of the company of installation and its location. Describe the type of structure if an industrial plant.

6.3 The inspector should state his or her name, company contact, date of the inspection, and type of thickness measuring equipment used.

6.4 Present any data that is available regarding tonnage and cost of the steel, and comparison costs of galvanizing versus other coating systems.

6.5 *Visual Inspection:*

6.5.1 Report the general appearance of the galvanized structure or installation, and any noticeable changes since the last inspection. Report coating characteristics such as color, spangle, stains, rust, and condition of paint coatings, fasteners, and high silicon steels within each type of environment, if applicable.

6.5.2 Relate the photographs to the locations discussed in the report.

6.6 *Coating Thickness Measurement :*

6.6.1 *Method A*—State the range of average coating thicknesses measured on structural members, including high silicon steels, and on fasteners. Make mention of differences in coating thickness that may arise from such factors as section thickness, orientation, etc.

6.6.2 *Method B*—Provide details about each location at which thickness measurements were made and state the mean and the 90 % confidence interval, rounding to the least significant number of digits.

6.6.3 Relate photographs to the corresponding areas measured.

APPENDIXES

(Nonmandatory Information)

X1. CALCULATION OF 90 % CONFIDENCE INTERVAL

X1.1 The standard deviation, s, of a series of measurements can be calculated using the following equation:

$$s = \sqrt{\frac{\Sigma[(X_i - X)^2]}{n-1}}$$

where:

X_i = each individual reading,
X = mean of group of 25 readings, and
n = number of measurements.

X1.2 The 90 % confidence interval on the mean, S_m90, can be expressed as follows:

$$S_m 90 = \frac{ts}{\sqrt{n}}$$

where:

s = standard deviation, and
t = the t distribution value for $n - 1$ degrees of freedom.

X1.2.1 Tables containing values for t can be found in textbooks on statistics or in most engineering handbooks. For the number of measurements (n = 25) prescribed in 5.4.2.4, t = 1.711 for n-1 degrees of freedom and the value of

$$t/\sqrt{n} = 1.711/5 = 0.34$$

The 90 % confidence interval on the mean for 25 measurements can then be written as $S_m90 = 0.34\ s$.

X1.2.2 If some number other than 25 measurements is used, the value of t for n-1 degrees of freedom must be determined from statistical tables.

X1.2.2.1 Calculation of X, s, and S_m 90 values can be tedious, and the use of an electronic calculator is recommended.

X1.3 The significance of S_m90 is that there is a 90 % probability that the true value of the mean will lie within the range $X \pm S_m90$, the most probable value being X. A test program involving field measurements has shown that considering a corrosion rate of 0.1 mil/year [2.5 µm/year], it will be possible to see a significant difference between average coating thicknesses resulting from surveys carried out ten years apart in time and based on 25 readings.

X1.4 *Example of Calculations:*

X1.4.1 X_i = 5.6, 6.5, 6.7, 6.1, 6.6, 5.2, 6.4, 6.0, 7.0, 5.6, 6.2, 6.8, 6.0, 5.3, 6.7, 6.1, 6.5, 6.7, 6.5, 5.8, 6.0, 6.4, 6.0, 6.4, 6.3 mil [142, 165, 170, 155, 168, 132, 163, 152, 179, 142, 157, 173, 152, 135, 170, 155, 165, 170, 165, 147, 152, 163, 152, 163, 160 µm].

X1.4.2 Mean, X = 6.2 mil [157 µm].

X1.4.3 Standard deviation, s = 0.5 mil [12 µm].

X1.4.4 90 % confidence interval, $S_m 90$ = 0.2 mil [4 µm].

X2. CASE STUDY REPORT SHEET

X2.1 Fig. X2.1 shows a case study report sheet.

I. General Information

Project/Installation Name ________________________________

Type of Facility/General Description ________________________________

____

Location ________________________________

	name	address	contact	phone
Company/End User				
Engineer				
Architect				
General Contractor				
Steel Fabricator				
Galvanizer				

Date of Construction ________ /System		Tonnage	Cost
Galvanized			
Painted			
Paint over galvanized			

Steel specifications/typical sections ________________________________

II. List of Corrosive Environments/Corrosive Agents

1. ________________________________
2. ________________________________
3. ________________________________
4. ________________________________

III. Comments

What prompted use of corrosion system(s), engineering objects, cost comparisons with other systems, different or unusual applications, etc.?

____

____

____

____

IV. Visual Inspection (one report per corrosive environment)

Project/installation name ________________________________

Location ________________________________

Inspection Date ________ /

	name	firm	address	phone
Inspector				
Site Contact				

Corrosive Environment ________________________________

Steel Sections: heavy ________ light ________ fasteners ________

Overall Appearance ________________________________

Apparent Spangle/Heavily Weathered ________________________________

Discoloration/Rust Staining ________________________________

Silicon Steels ________________________________

FIG. X2.1 Case Study Report Sheet

Condition of Paints ______________________________

____

____

Effect of Orientation/Elevation ______________________________

____

Factors Causing Localized Corrosion: chemical spills ______________________________

fumes ______ high humidity ______ elevation ______

other ______________________________

List of Photographs and Identification Numbers

____

____

____

____

Remarks, Changes Since Previous Inspection

____

____

____

V. Coating Thickness Survey—Method A

Procedure

1. One report per corrosive environment or position.
2. Selection based on section thickness, a minimum of three representative members of each light (bracing) and heavy (column beam).
3. At each location, a minimum of five measurements to determine the mean.

Project/Installation Name ______________________________

Location ______________________________

Survey Date ______/

	name	firm	address	phone
Inspector				
Site Contact				

Corrosive Environment ______________________________

Gage type______ μm/mils (circle one) Calibration Plates__________

Heavy Member Section/Location	Thickness Readings					Mean
1. ______	______	______	______	______	______:	______
2. ______	______	______	______	______	______:	______
3. ______	______	______	______	______	______:	______
Light Member						
1. ______	______	______	______	______	______:	______
2. ______	______	______	______	______	______:	______
3. ______	______	______	______	______	______:	______

Fasteners ______________________________

____

List of Photographs and Identification Numbers

____

____

FIG. X2.1 Case Study Report Sheet *(continued)*

Remarks ____

____

____

____

VI. Coating Thickness Survey—Method B, Inspection Report (every inspection)

Procedure

1. One report per corrosive environment with three reading areas for each.
2. 25 measurements in 5 by 5 grid, outside corners 50 by 50 mm square.
3. Mark test area for future; center punch outer square 75 by 75 mm.
4. List remarks, photograph, in comments (for general and specific test locations).

Project/Installation ____

Date ______________ Inspection # ______________________________

	name	firm	address	phone
Inspector				
Site Contact				

Comments ____

____

____

____

____

____

VII. Coating Thickness Survey—Method B, Locations Description

Date ______________ Project ______________

Location # Project description, steel section, exact location and orientation, specific corrosive environment, draw site plan

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FIG. X2.1 Case Study Report Sheet *(continued)*

VIII. Coating Thickness Survey—Method B, Readings

Date ____________ Inspection # ____________

Project ____________

Inspector ____________

Gage Type ____________ µm/mils Calibration Plate Type ____________

Readings						Readings					
Location #	___	___	___	___	___	Location #	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
			S_m90	______	Mean				S_m90	______	Mean
Location #	___	___	___	___	___	Location #	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
			S_m90	______	Mean				S_m90	______	Mean
Location #	___	___	___	___	___	Location #	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
			S_m90	______	Mean				S_m90	______	Mean
Location #	___	___	___	___	___	Location #	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
______	___	___	___	___	___	______	___	___	___	___	___
			S_m90	______	Mean				S_m90	______	Mean

FIG. X2.1 Case Study Report Sheet *(continued)*