SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J1837

ISSUED JUN91

Issued 1991-06-14

An American National Standard

ELECTROPLATE REQUIREMENTS FOR DECORATIVE CHROMIUM DEPOSITS ON ZINC BASE MATERIALS USED FOR EXTERIOR ORNAMENTATION

***Foreword*—**This Document has not changed other than to put it into the new SAE Technical standards board Format.

1. Scope

***Scope*—**This SAE Standard covers the physical and performance requirements for electrodeposited copper, nickel, and chromium deposits on exterior ornamentation fabricated from die cast zinc alloys (SAE J468 alloys 903 and 925), and wrought zinc strip (ASTM B 69). This type of coating is designed to provide a high degree of corrosion resistance for automotive, truck, marine, and farm usage where a bright, decorative finish is desired.

1.1 Purpose—This document details the physical and chemical properties that are necessary to optimize coating appearance and durability of decoratively plated parts. When properly applied, the electroplate described in this document has a bright, highly reflective, and specular finish with an inherently high degree of corrosion resistance. The coating's resistance to a corrosive environment is highly dependent on the proper maintenance of the processes used to produce the coating. Since the treatment of processing variables is outside the scope of this document, it is important for applicators of this coating to develop an intimate knowledge of their process, and control all parameters that affect the quality of the end product. The use of techniques such as statistical process control (SPC), capability studies, design of experiments, process optimization, etc., are critical to produce a material of consistently high quality.

The subjects included in this document are: substrate preparation, metal finishing, plate thickness, electrochemical potential difference, ductility, chromium microdiscontinuity, accelerated corrosion, adhesion, bend testing, and sampling. The appropriate specification limits and test methods are described in each section. Where possible, the test methods specified are well established and accepted within the plating industry. In a few instances, several test methods are specified. In these cases, it is up to the purchaser and supplier to agree on the test method to be used.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J468—Zinc Alloy Ingot and Die Casting Compositions

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-8512 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER; (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS http://www.sae.org

Printed in U.S.A.

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 69—Specification for Rolled Zinc
ASTM B 252—Preparation of Zinc Alloy Die Castings for Electroplating and Conversion Coatings
ASTM B 368—Copper-Accelerated Acetic Acid-Salt Spray (Fog) Testing (CASS Test)
ASTM B 374—Standard Definitions of Terms Relating to Electroplating
ASTM B 456—Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
ASTM B 487—Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section
ASTM B 490—Micrometer Bend Test for Ductility of Electrodeposits
ASTM B 504—Measurement of Thickness of Metallic Coatings by the Coulometric Method
ASTM B 507—Design of Articles to be Electroplated on Racks
ASTM B 537—Rating of Electroplated Panels Subjected to Atmospheric Exposure
ASTM B 556—Measurement of Thin Chromium Coatings by the Spot Test
ASTM B 571—Adhesion of Metallic Coatings
ASTM B 602—Attribute Sampling of Electrodeposited Metallic Coatings and Related Finishes
ASTM B 697—Selection of Sampling Plans for Inspection of Electrodeposited Metallic Coatings and Related Finishes on Products
ASTM B 762—Variables Sampling of Metallic and Inorganic Coatings
ASTM B 764—Simultaneous Thickness and Electrochemical Potential Determination of Individual Layers in Multilayer Nickel Deposit (STEP Test)

3. Definitions

3.1 Significant Surfaces—These are defined as surfaces that are visible when the finished component is assembled onto the vehicle and is observed in normal viewing position. Nonsignificant surfaces that may cause corrosion products to run onto significant surfaces are significant. Also, nonvisible surfaces, when designated by the customer, are significant.

3.2 Microdiscontinuous—A chromium deposit in which microscopic voids exist in the chromium, exposing the underlying nickel layer. The production of suitable microscopic voids or sites in the chromium layer causes a dispersion of the corrosion potential over a relatively large surface area. The resulting corrosion potential dispersion reduces the effects of localized high corrosion potentials and the associated large corrosion pits.

3.2.1 ASTM B 374 provides definitions of the more common terms related to plating.

4. Appearance—All parts manufactured to this document shall meet the visual requirements for color, luster, and other specific finish standards agreed on between the customer and supplier, on all significant surfaces.

Standard panels or typical production parts should be used to define the various appearance levels for major surfaces and parting line finishes.

Various classes or types of finish may be specified by the purchaser. The production drawing should indicate, via symbols or notes, the specifics of these requirements. Visual standards, including textured surface standards, may be used to supplement the drawing notes showing minimum acceptable appearance conditions.

5. Substrate Preparation—The substrate surface finish can affect the plated appearance. Suitable precautions in casting, forming, finishing, and cleaning must be taken to assure a satisfactorily finished plated part.

Evidence of surface porosity, stress cracks, blisters, or other surface defects may indicate improper substrate preparation or inferior castings that may not have adequate durability after plating. The proper practices for preparing the zinc die casting for plating are discussed in ASTM B 252.

6. ***Design Guidelines***—An entire document could be written on "design guidelines" and the reader is urged to consult a document such as ASTM B 507.

7. ***Metal Finishing***—Buffing or other mechanical treatments of the substrate, copper or nickel deposits are permitted provided that minimum plating thickness, chromium microdiscontinuity, and other applicable requirements are met following these treatments. Buffing of the final chromium plate is not permitted as it will adversely affect corrosion resistance.

8. *Plate Thickness*

8.1 The plate thicknesses listed in Table 1 shall be met on all areas of the significant surfaces. These thicknesses also apply to nonsignificant surfaces which, on corroding, may drip onto or otherwise affect a significant surface.

TABLE 1—PLATE THICKNESS

	Thickness, µm (minimum)	in (minimum)
Copper Strike	5 (a)	0.0002
Copper	15 (b)	0.0006
Semibright Nickel	20	0.0008
Bright Nickel	10 (c)	0.0004
Total Semibright and Bright Nickel	30	0.0012
Microdiscontinuous Chromium	0.25 (d)	0.00001

a. Generally consists of a cyanide copper layer. It is up to the customer and supplier to agree on what type of copper or other plating process is utilized as the initial layer on zinc base parts.
b. The copper layer may be plated from either a cyanide copper bath or an acid copper bath and it is up to the customer and supplier to agree on an acceptable plating bath.
c. The use of a "high potential" nickel layer (generally 2.5 µm or 0.0001 in thick) between the bright and semibright nickels can improve corrosion performance of the composite plate. The semibright nickel thickness may, therefore, be reduced by the thickness of the "high potential" nickel layer if approved by the customer.
d. If trivalent chromium is employed, the minimum thickness shall be 0.50 µm (0.00002 in).

8.2 If, due to part geometry, the specified plating thickness on significant surfaces cannot be met, the customer and supplier shall agree on a minimum plate thickness or the use of an alternate coating method, e.g., auxiliary anodes.

8.3 **Thickness Measurements**—The thickness of the individual copper and nickel layers may be determined using the microscopic method, ASTM B 487, or the coulometric method, ASTM B 504. The nickel layers may also be measured using the "STEP" test, ASTM B 764. Chromium thickness may be measured using ASTM B 504 or the spot test, ASTM B 556. In case of disputes, the microscopic method for measuring thickness shall be the referee method.

9. "Step" Test Requirements

9.1 Procedure—The "STEP" test shall be carried out in accordance with ASTM B 764. To obtain reliable and reproducible results, the following precautions should be adhered to:

a. Prevent the reference electrode from drying out when not in use by keeping it immersed in either water, "STEP" test electrolyte or dilute (5 to 10%) hydrochloric acid solution.
b. Run sufficient verification tests on a primary or secondary standard to insure that the instrument is working properly, before carrying out a test on an unknown sample. If the STEP value of the primary standard or secondary standard cannot be reproduced to within at least ±5% of the reported value of the standard after three attempts, the instrument should be thoroughly checked for possible problems, e.g., plate buildup on inside of cell, faulty reference electrode, miscalibrated chart recorder, etc. Primary standard test panels are available from the National Institute of Standards and Technology,[1] while some instrument suppliers provide secondary standards. Tertiary standards may be actual parts or prepared plated panels that have been calibrated against a primary or secondary standard.
c. Keep plate buildup on the inside surfaces of the metal test cell to a minimum by frequent cleaning.
d. Make sure the pH of the test electrolyte is 3.0 ± 0.1 when preparing new solution or checking old solution.

9.2 Interpretation of Results

a. The "STEP" test may be used to measure the thickness of individual nickel layers when the instrument is properly calibrated. The thickness of the individual nickel layers shall meet the requirements of this document (See 8.1).
b. Measurements should normally be made in low to medium current density areas on significant surfaces whenever part geometry permits. The customer specified plating thickness check points are usually suitable locations for making "STEP" test measurements. High current density areas of a part can be expected to exhibit values at least 15 to 20 mV greater than the low current density areas of the same part.
c. At least two measurements should be made at any given test site and the average value reported. Test spots must not touch or overlap each other. The individual readings at any one site should not vary from each other by more than 10%. Large variations suggest poor technique, faulty equipment, or defective deposits (e.g., cracks, pits, dirt inclusion, etc.).
d. The millivolt "STEP" potential difference between the various nickel layers shall be measured at the mid or low current density areas (See 9.2 [b]) and shall exhibit the relative values and activities listed as follows:

    1. 100 mV: Minimum difference between bright and semibright nickel layers with the bright nickel more active than the semibright. A difference of at least 125 mV is recommended as the statistical mean with values of 100 mV as the absolute minimum. Maximum values have yet to be determined, but generally should not exceed 200 mV.
    2. 20 mV: Minimum difference between the bright nickel and the high activity nickel strike (between the semibright and bright nickel) when one is present. The high activity nickel strike shall be more active than the bright nickel layer.
    3. 20 mV: Maximum difference between the bright nickel and any subsequent nickel strike or microdiscontinuous nickel layer when one is present. This layer shall be less active than, or equal to, the activity of the bright nickel layer.

---

[1] National Institute of Standards and Technology Office of Standard Reference Materials, Room B-311 Chemistry Building, Gaithersburg, MD 20899.

e. It is stressed that successfully meeting the "STEP" requirements of this document without conforming to other deposit requirements, such as thickness, ductility, chromium microdiscontinuity, CASS test, etc., may result in premature failure of the plated part in service. All the requirements of this document must be complied with to achieve maximum corrosion protection.

10. Ductility—Test Method: ASTM B 490

The ductility of the composite electrodeposit on the finished part is considered acceptable when foils plated out of the individual nickel baths meet or exceed the following values:

Semibright Nickel	67%
Bright Nickel	11%

NOTE—A fully ductile individual nickel layer will have a foil test value 100% when computed using the formula D = 100 T/(2R-T).

11. Specifications for Microdiscontinuity

11.1 Determination of Microdiscontinuity and Active Sites—Determination of microdiscontinuity after chromium plate, and active sites after corrosion testing, shall be conducted as per ASTM B 456, Appendix X4. However, to determine active sites, the chromium layer in the area to be examined shall be stripped using hydrochloric acid (concentrated), so that the corrosion sites in the nickel layer are more easily seen and counted.

11.2 Microdiscontinuity After Chromium Plate—There shall be a minimum of 10 000 pores/cm^2 (64 000/in^2).

A maximum quantity of pores has not been established, but is dictated by visual acceptance, both before and after environmental testing, as agreed on between the customer and supplier. (The minimum number of cracks required when a trivalent chromium deposit is used, has not been established.)

11.3 Active Sites After Corrosion Testing (CASS)—There shall be a minimum of 10 000 pores/cm^2 (64 000/in^2) after 22 h CASS test. The chromium deposit must be stripped off after the CASS test, but prior to counting and measuring the active sites. The active sites shall be limited in depth to the bright nickel layer and the average diameter shall not exceed 31 µm (0.0025 in) in diameter after 44 h CASS test. No individual site shall exceed 63 µm (0.0025 in). Active sites with a diameter less than 10% of the diameter of the largest site present shall not be counted toward meeting the minimum number of active sites.

12. Accelerated Corrosion—The CASS test shall be carried out in strict accordance with ASTM B 368. Nickel weight loss panels[2], collection rates, pH and specific gravity should preferably be run with every CASS test cycle (22 h) or at least once a week. Nickel panel weight loss measurements shall be made whenever a new test solution is used or when the cabinet is restarted after any shutdown.

The copper accelerated acetic acid salt spray or CASS test is presently the most widely used accelerated corrosion test in the automotive industry and is the only test considered in this document. The CASS test is not used to predict the number of years a part may last in service, but rather to evaluate the integrity of the entire casting, metal finishing, and plating operation. The CASS test does not have an exact correlation to years of corrosion protection in service. Failure to pass the test may be regarded as a probable indication of early failure in service. The results of other plating test requirements such as deposit thickness, ductility, STEP values, chromium porosity, etc., must also be considered when attempting to predict the performance of plated parts under actual service conditions.

---

[2] Suitable nickel panels are obtainable from Metal Samples, Route 1, Box 152, Munford, AL 36268.