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Designation: B537 – 22

Standard Practice for Rating of Electroplated Panels Subjected to Atmospheric Exposure[1]

This standard is issued under the fixed designation B537; 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 covers a preferred method for evaluating the condition of electroplated test panels that have been exposed to corrosive environments for test purposes. It is based on experience in use of the method with standard 10- by 15-cm (4- by 6-in.) panels exposed on standard ASTM racks at outdoor test sites in natural atmospheres. It has been used also for rating similar panels that have been subjected to accelerated tests such as those covered by Practice B117, Method B287, Test Method B368, and Test Method B380. Any modifications needed to adapt the method to rating actual production parts are not considered in this practice.

1.2 This practice refers only to decorative-protective coatings that are cathodic to the substrate, typified by nickel/chromium or copper/nickel/chromium on steel or zinc die castings. It is not intended for use with anodic sacrificial coatings such as zinc and cadmium on steel.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B117 Practice for Operating Salt Spray (Fog) Apparatus

B287 Method of Acetic Acid-Salt Spray (Fog) Testing (Withdrawn 1987)[3]

B368 Test Method for Copper-Accelerated Acetic Acid-Salt Spray (Fog) Testing (CASS Test)

B380 Test Method for Corrosion Testing of Decorative Electrodeposited Coatings by the Corrodkote Procedure

3. Basis of Procedure

3.1 The rating method described in this recommended practice is based on the recognition that typical decorative-protective deposits such as nickel/chromium, with or without a copper undercoat, have two functions: (*1*) to protect the substrate from corrosion and thus prevent degradation of appearance caused by basis metal corrosion products (for example, rust and rust stain); and (*2*) to itself maintain a satisfactory appearance. Although these functions overlap, they can be evaluated separately, and it is frequently desirable to do so. Accordingly, this practice assigns separate ratings to (*1*) appearance as affected by corrosion of the substrate and (*2*) appearance as affected by deterioration of the coating itself.

3.2 The rating number assigned to the ability of the coating to protect the substrate from corrosion is called the "protection" number or rating.

3.3 The rating number assigned to the inspector's judgment of the overall appearance of the panel, including all defects caused by the exposure (Note 1), is called the "appearance" number or rating.

NOTE 1—Panels that are not "perfect" even before being exposed should normally be rejected (see Note 4).

3.4 The result of inspecting a panel is recorded as two numbers separated by a slash (/), the protection number being given first.

3.5 In addition to recording the numerical rating of a panel, the inspector should note the type(s) and severity of defect(s) contributing to the rating. This may be done by the use of agreed symbols for the most common defects (Appendix X1) and abbreviations for degree or severity of these defects.

[1] This practice is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.05 on Decorative Coatings.

Current edition approved Oct. 1, 2022. Published November 2022. Originally approved in 1970. Last previous edition approved in 2019 as B537 – 70(2019). DOI: 10.1520/B0537-22.

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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4. Types of Defects

4.1 "Protection" defects include crater rusting (Note 2), pinhole rusting, rust stain, blisters (Note 3), and any other defects that involve basis metal corrosion.

NOTE 2—"Rusting" or "rust," as used in this practice, includes corrosion products of the substrate and is not confined to iron or steel: the white corrosion products of zinc die castings and aluminum, for example, are included in this term.

NOTE 3—Blisters on plated zinc die casting usually connote basis metal corrosion, but the inspector's judgment may be required to decide whether a blister does or does not arise at the substrate-coating interface.

4.2 "Appearance" defects include, in addition to those caused by basis metal corrosion, all defects that detract from the appearance (that is, the commercial acceptability) of the panel. Typical are: surface pits, "crow's feet," crack patterns, surface stain, and tarnish.

4.3 Defects developing on exposure that reflect improper preparation or plating should be noted but no attempt should be made to rate panels showing major amounts of such defects. Peeling of the coating from the substrate, or of one coat from another, is the principal such defect.

5. Preparation for and Manner of Inspection

NOTE 4—It may be desirable to expose panels for test even though they are defective in certain respects before exposure. In that case, an inspection should be made and recorded before the panels are exposed.

5.1 Panels may be inspected on the exposure racks or may be removed to a more suitable location if necessary. Lighting during inspection should be as nearly uniform as possible; direct reflection from sun or clouds should be avoided, and various angles of inspection should be tried to ensure that defects show up.

5.2 If the condition of the panels allows, inspection should be made in the "as-is" condition. If dirt, salt deposits, and so forth, make it impractical to inspect them, panels may be sponged with a mild soap solution followed by water rinse; but no pressure should be exerted in this procedure such as would tend to upgrade the rating by, for example, cleaning off rust or rust stain. Panels should be allowed to dry before inspecting them.

5.3 Defects to be noted and taken into account in rating panels include only those that can be seen with the unaided eye (Note 5) at normal reading distance.

NOTE 5—"Unaided eye" includes wearing of correctional glasses if the inspector normally wears them.

5.3.1 Optical aids may be used to identify or study defects once they are found by unaided eye inspection.

5.4 Edge defects, occurring within 6.5 mm (¼ in.) of the edges of a panel, may be noted in the description but are not counted in arriving at the numerical rating. Similarly, contact and rack marks, mounting holes, and so forth, should be disregarded.

5.5 Rubbing, polishing, and so forth, of the surface of the panel may be desirable to study one or another aspect of its condition. Such procedure shall be confined to the minimum area absolutely necessary for the purpose, preferably not more than 1 cm^2 of a 10- by 15-cm panel.

6. Assignment of Protection Rating

6.1 The numerical rating system is based on the area covered by protection defects, by the following equation:

$$R = 3\,(2 - \log A) \tag{1}$$

where R = rating and A = percentage of the total area covered by defects. R is rounded off to the nearest whole number, leading to the tabulation given in Table 1.

6.1.1 Strict application of the equation given in 6.1 would lead to ratings greater than 10 for panels with extremely small defective areas. Rating 10, accordingly, is arbitrarily assigned to a panel with no defects, and the equation operates at ratings 9 and below.

6.1.2 If desired, fractional ratings between 9 and 10 may be assigned to panels judged better than 9 but not perfect. Fractional ratings below 9, although normally not especially useful, may be assigned if desired.

6.2 As an aid in judging the defective area, standards of comparison, consisting of photographs of panels or of dot charts are made part of this practice. See Appendix X2. These photographs and charts are 10 by 15 cm (4 by 6 in.) to facilitate comparison with the panel being inspected. The standards represent, as nearly as possible, the maximum amount of corrosion permissible for a given rating; there is a standard for each rating 1 through 9. A panel worse than the standard for rating 1 would rate 0.

6.2.1 The types of corrosion defects normally encountered differ according to the type of atmospheric exposure. Typical decorative deposits exposed to marine atmospheres often tend to fail by crater rusting, whereas in industrial atmospheres, they are more likely to exhibit pinpoint rusting; and the latter atmosphere also tends to be more severe with regard to degradation of the coating system but somewhat less severe with regard to basis metal corrosion. For this reason, the same standard comparison photographs or charts are not suitable for use at both types of locations; photographs are more helpful in assessing panels exposed to marine atmospheres, whereas dot charts can be used for industrial locations (Appendix X2).

6.3 In rating any given panel, it is recommended that the appropriate series of standards be placed beside it and the basis metal corrosion defects in the panel be matched as nearly as possible with one of the standards. If the panel is somewhat better than standard (X), but not as good as standard ($X + 1$), it is rated (X); if somewhat worse than standard (X), but not as

TABLE 1 Protection Rating Versus Area of Defect

Area of Defect (in percent)	Rating
0	10
To 0.1	9
0.1 to 0.25	8
0.25 to 0.5	7
0.5 to 1.0	6
1.0 to 2.5	5
2.5 to 5	4
5 to 10	3
10 to 25	2
25 to 50	1
>50	0

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bad as standard ($X - 1$), it is rated ($X - 1$). At the inspector's option, decimal fractional ratings may be assigned.

6.3.1 If a large group of panels is being inspected at one time, it is recommended that the panels be assessed individually as in 6.3; but when the entire group has been rated, the ratings should be reviewed to make sure that ratings assigned actually reflect the relative merits of the panels. This acts as a check on individual ratings and aids in ensuring that the inspector's judgment or frame of reference has not changed during the course of the inspection, owing to fatigue, change in lighting conditions, haste to finish the job, or other causes. One method of facilitating this comparison is to remove individual panels from their racks and place them beside other panels. It may be advisable to physically arrange all of the panels in order to merit.

7. Assignment of Appearance Rating

7.1 This recommended practice recognizes that whereas the degree of protection afforded the substrate can be assessed fairly objectively in accordance with Section 6, the assessment of appearance depends on many subjective factors. Therefore, the appearance rating cannot be assigned with the same degree of precision as can the protection rating.

7.1.1 There are many modes of deterioration in appearance mentioned in 4.2 but this list is not exhaustive, and as new plating systems are developed and introduced to industry, they may well exhibit new types and modes of deterioration.

7.1.2 Unlike the protection rating, the appearance rating is based not only on the area of the defects but also on their severity: the degree to which they would detract from the commercial acceptability of an article of appearance similar to that of the panel.

7.2 The appearance rating is based, in the first instance, on the protection rating. Since corrosion of the substrate also detracts from appearance, the appearance rating can be no higher than the protection rating.

7.2.1 If basis metal corrosion is the only defect, there being no additional defects affecting only the coating, the appearance rating is the same as the protection rating. If there are surface defects not accounted for in the protection rating, the appearance rating will be one or more units lower than the protection rating. This lowering of the appearance rating is referred to in what follows as the "penalty."

7.3 The inspector must decide, on the basis of best current practice and opinion, whether a surface coating defect is (*1*) very slightly, (*2*) slightly, (*3*) moderately, or (*4*) severely damaging to the acceptability of the appearance. Guidelines are given below, but judgment factors inevitably enter into the decision.

7.3.1 Defects only slightly damaging may include very light surface pitting that detracts little from the reflectivity, light tarnish or stain easily removed by mild cleaning (such as would be given, for instance, in normal car-washing practice), superficial crack patterns typical of some kinds of chromium plate, and so forth. Such defects, to be categorized as "slight," must not render the finish commercially unacceptable.

7.3.1.1 A penalty of 1 or 2 points (rating numbers) is assessed for appearance defects classified as slight. One point is assessed if the defects can be classified as very slight, two if slight.

NOTE 6—If fractional rating was used for the protection number, this would result in a fractional appearance rating; in that case, the fractional appearance rating may be retained, or rounded off to the nearest whole number, provided, however, that the appearance rating may not be higher than the protection rating.

7.3.2 Defects moderately damaging include the same types as in 7.3.1 but more severe, so as to render the appearance questionably acceptable from a commercial standpoint. For example, surface pits that begin to detract from reflectivity; tarnish or stain that, although removable, requires more drastic treatment than routine washing.

7.3.2.1 A penalty of 3 or 4 points (rating numbers) is assessed for appearance defects classified as moderate.

7.3.3 Surface defects that render the panel definitely unacceptable in appearance are classified as severe.

7.3.3.1 A penalty of 5 or more points, up to the maximum available, is assessed for severe surface defects.

7.4 The procedure for checking the ratings described in 6.3.1 is of particular importance in assigning appearance ratings, and is strongly recommended.

8. Low-Rated Panels

8.1 The system described in the foregoing should be satisfactory for assessing relatively good panels. Difficulties may be encountered in attempting to rate severely corroded panels. For example, if a panel rates as low as 4 for protection, it may be difficult to assess any additional appearance defects. At the option of the inspector, this difficulty may be handled as follows:

8.1.1 A cutoff point may be chosen below which appearance ratings are deemed to be of no significance. For example, it may be agreed that any panel with a protection rating of 5 is so unacceptable that an appearance rating has no meaning. Such panels may arbitrarily be assigned one of two appearance ratings: (*1*) if there are no obvious additional surface defects, appearance rating is set equal to protection rating; (*2*) if there are any surface defects at all, no attempt is made to assess their severity and the appearance rating is 0.

8.1.2 Alternatively, after setting the cutoff point as in 8.1.1, the appearance rating may be disregarded and only a protection rating assigned.

9. Keywords

9.1 atmospheric exposure; corrosion rating; electroplated deposits

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