Designation: E 937 – 93 (Reapproved 2000)

An American National Standard

Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members[1]

This standard is issued under the fixed designation E 937; 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 test method covers a procedure for measuring the corrosion to steel induced by sprayed fire-resistive material.

1.2 These SFRMs include sprayed fibrous and cementitious materials applied directly in contact with the structural members.

1.3 This test method is applicable only to laboratory procedures.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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:*

E 119 Test Methods for Fire Tests of Building Construction and Materials[2]

E 605 Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members[3]

E 631 Terminology of Building Constructions[3]

3. Terminology

3.1 *Definitions*—Definitions in this test method are in accordance with Terminology E 631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *corrosion*—chemical reaction between a metal and its environment that produces a deterioration of the metal and its properties.

3.2.2 *sprayed fire-resistive materials*—materials that are sprayed onto substrates to provide fire-resistive protection of the substrates.

4. Summary of Test Method

4.1 In this test method replicate panels of bare, shop-coated, and galvanized steel are sprayed with SFRM and subjected to room temperature and humidity conditions and to 240 h of conditioning in a temperature- and humidity-controlled chamber. Corrosion induced under these conditions is determined by weight loss[4] of the sheets as related to sheets not so conditioned.

5. Significance and Use

5.1 It is the intent of this test method to determine relative corrosive properties of direct applied SFRM that provides an indication of serviceability. Satisfactory performance of SFRM applied to structural members and assemblies depends upon its ability to withstand the various influences that occur during the life of the structure, as well as upon its satisfactory performance under fire conditions.

5.2 This test method evaluates the relative corrosion of steel induced by SFRM and determines whether the presence of SFRM increases, decreases, or has no effect on the corrosion characteristics of steel.

6. Apparatus

6.1 *Standard Temperature Humidity Cabinet*, equipped to maintain the temperature at 35 ± 1.7°C (95 ± 3°F) and a relative humidity of 95 ± 3 %. The cabinet and all accessories shall be of a material that does not affect the corrosiveness of the atmosphere in the cabinet. Additionally, all parts that come into contact with the test specimens shall be made of material that will not cause electrolytic corrosion. Adequate circulation of the atmosphere over the specimens shall be provided.

6.2 *Scale*, having a capacity of 5 kg and a sensitivity of ±0.1 g.

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[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.21 on Serviceability.

Current edition approved March 15, 1993. Published May 1993. Originally published as E 937 – 83. Last previous edition E 937 – 83.

[2] *Annual Book of ASTM Standards*, Vol 04.07.

[3] *Annual Book of ASTM Standards*, Vol 04.11.

[4] Although "mass" is being determined, the term weight is used in this test method as an accepted substitute.

6.3 *Wire Brush*, described as "cement mold brush" with brass wire bristles 25 mm (1 in.) long mounted in a handle. The bristle section shall be 127 mm (5 in.) long by 19 mm (¾ in.) wide.

7. Materials

7.1 This test method requires the application of SFRM in accordance with manufacturer's published instructions. The apparatus, materials, and procedures used to apply the SFRM shall be representative of application in the field.

7.2 The density of the prepared sample shall be the same as the density tested and reported during the Test Methods E 119 fire exposures or as required by the sponsor of the test.

7.3 Determine the density and thickness of each laboratory-prepared specimen. Report in accordance with Test Methods E 605.

7.4 Steel sheets shall be 200 mm by 200 mm (8 in. by 8 in.) by minimum 12 gage and shall be: bare steel—A36 grade, galvanized steel—G60 grade, and shop-coated—A36 grade steel coated with iron oxide alkyd shop coat primer.

8. Laboratory Test Specimens

8.1 The three sets of specimens shall consist of four sheets each, in the following categories: bare, shop-coated, and galvanized steel.

8.2 The steel sheets shall be free of all surface rust. Wash the metal specimens with analytical grade trichlorethylene to remove any oil or grease. Dry at room temperature. For test purposes of this test method, the duplicate sets of steel sheets are referred to as follows:

Bare	I, II, III, IV
Shop-coated	I, II, III, IV
Galvanized	I, II, III, IV

9. Procedure

9.1 Weigh each sheet to the nearest 0.1 g and record the weighed samples as Ia, IIa, IIIa, and IVa for the bare, shop-coated, and galvanized sets, respectively. See Table 1.

9.2 Protect the opposite sides and edges of the sheets with a suitable coating. This coating shall be stable under the conditions of this test method and shall not promote corrosion; ceresin wax is suggested.

TABLE 1 Sample Weights

	Bare	Shot-Coated	Galvanized
I =	Ia = g/mm^2	Ia = g/mm^2	Ia = g/mm^2
Specimens having SFRM, conditioned at room temperature (9.4).	Ib = g/mm^2	Ib = g/mm^2	Ib = g/mm^2
II =	IIa = g/mm^2	IIa = g/mm^2	IIa = g/mm^2
Specimens having SFRM, conditioned for 240 h at 35 ± 1.7°C (9.5).	IIb = g/mm^2	IIb = g/mm^2	IIb = g/mm^2
III =	IIIa = g/mm^2	IIIa = g/mm^2	IIIa = g/mm^2
Specimens having SFRM, conditioned at room temperature (9.4).	IIIb = g/mm^2	IIIb = g/mm^2	IIIb = g/mm^2
IV =	IVa = g/mm^2	IVa = g/mm^2	IVa = g/mm^2
Specimens having SFRM, conditioned for 240 h at 35 ± 1.7°C (9.5).	IVb = g/mm^2	IVb = g/mm^2	IVb = g/mm^2

9.3 Apply the SFRM at a minimum thickness of 19 ± 3 mm (¾ ± ⅛ in.) to all sheets.

9.4 *Specimens I and III of Respective Sets*:

9.4.1 Condition the specimens for 240 h at room temperature (20 ± 5°C (68 ± 9°F)) and relative humidity not greater than 60 %. Record if a constant weight[3] was reached.

9.4.2 Remove the SFRM, as well as the protective wax coating, from the steel sheet identified as I and III, from each of the respective sets.

9.4.3 Remove all surface rust from I and III of the respective sets with the wire brush described in Section 6 and clean with solvent as described in 8.2.

9.4.4 Weigh sheets I and III of the respective sets to the nearest 0.1 g, and record as Ib and IIIb.

9.5 *Specimens II and IV of Respective Sets*:

9.5.1 Place the remaining sprayed sheets, specimens II and IV of the respective sets, into the temperature humidity cabinet and keep at 35 ± 1.7°C (95 ± 3°F) and a 95 ± 3 % relative humidity for a duration of 240 h.

9.5.2 At the completion of the 240-h period, remove the specimens from the cabinet.

9.5.3 Remove the SFRM and the protective wax coating, along with all rust, from the sheets as described in 9.4.3.

9.5.4 Weigh the cleaned sheets to the nearest 0.1 g, and record as IIb and IVb.

10. Calculation

10.1 Calculate the average weight [3] loss at the end of the initial aging period (see 9.3) and the weight loss at the end of the 240-h humidity test (see 9.4) as follows:

$$L_{\mathrm{I}} = \frac{\mathrm{Ia} - \mathrm{Ib}}{A_{\mathrm{I}}} \qquad L_{\mathrm{II}} = \frac{\mathrm{IIa} - \mathrm{IIb}}{A_{\mathrm{II}}} \qquad (1)$$

$$L_{\mathrm{III}} = \frac{\mathrm{IIIa} - \mathrm{IIIb}}{A_{III}} \qquad L_{\mathrm{IV}} = \frac{\mathrm{IVa} - \mathrm{IVb}}{A_{\mathrm{IV}}}$$

where:

A_{I} = area of steel sheet I, mm^2,
A_{II} = area of steel sheet II, mm^2,
A_{III} = area of steel sheet III, mm^2 and
A_{IV} = area of steel sheet IV, mm^2.

I, III Sheet to be sprayed with SFRM and to be conditioned, during initial aging period, at room temperature (see 9.4).
II, IV Sheet to be sprayed with SFRM and to be placed in temperature humidity cabinet for 240 h (see 9.5).

10.1.1 *For Bare, Shop-Coated, and Galvanized—*

Ia, IIa, IIIa, IVa	=	Original weight of steel (9.1).
Ib, IIIb	=	Weight of steel after cleaning off SFRM and any rust (9.4.4).
IIb, IVb	=	Weight of steel after cleaning off any rust (9.5.4).
L_{I}, L_{III}	=	Loss (g/mm^2) at end of initial aging period (specimens sprayed with SFRM).
L_{II}, L_{IV}	=	Loss (g/mm^2) at end of the 240 h humidity test (specimens sprayed with SFRM).

10.2 Calculate the average weight[3] loss at the end of the initial aging period (see 9.3), and the average weight loss at the end of the 240 h humidity test (see 9.4) as follows:

$$L_{I,III} = \frac{L_I + L_{III}}{2} \qquad L_{II,IV} = \frac{L_{II} + L_{IV}}{2} \qquad (2)$$

11. Report

11.1 Report the name of the SFRM and manufacturer.

11.2 Report the thickness in millimetres (or inches), the density of the SFRM in kilograms per cubic metre (or pounds per cubic foot), and the individual and average loss in weight[3] in g/mm ^{2} of each specimen or set, respectively.

11.3 Report information on the steel including the grade; the nature of the shop coating, including the product name and manufacturer; the measured dry film thickness; and the elapsed time (number of days or hours) between application of shop coating and application of SFRM.

12. Precision and Bias

12.1 Precision and bias of this test method have not been determined. A statement is being developed and will be added when completed.

13. Keywords

13.1 corrosion; sprayed fire-resistive materials