

ON SITE MEASUREMENT OF INTUMESCENT COATINGS

TECHNICAL GUIDANCE NOTE FOR THE MEASUREMENT OF DRY FILM THICKNESSES (DFT'S) FOR INTUMESCENT COATINGS:

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1. SCOPE

This document gives practical guidance in the selection of instrumentation, its calibration and use in measuring the applied thicknesses of an intumescent coating system used to impart fire resistance to elements of structure and the correct interpretation of such data. The document uses as an example a typical steel structured building although the principle used can be equally applied to other fire protection situations. The document is intended for the guidance of specifiers, applicators and site inspectors and offers a uniform approach to the site measurement of intumescent fire protection systems.

2. DEFINITIONS

- **Dry film thickness (DFT):** The thickness of the dried coating.
- **Wet film thickness:** The wet film thickness of a coat immediately after application.
- **Calibration:** The method used to systematically check and adjust the precision of a measuring instrument.
- **Calibration shims:** Slips of non-metallic material of pre-determined thickness used to calibrate electro-magnetic induction dry film thickness gauges.
- **Wet film thickness gauge:** A comb like gauge with indentations of pre-determined depths used to measure the wet film thickness of a coat during application.
- **Primer:** A protective coating, usually anti-corrosive, designed for application to suitably prepared metallic substrates.
- **Intumescent coating:** A fire protection material which functions by expansion on exposure to heat to form an insulating layer, thereby protecting the substrate.
- **Protective/Decorative Coating:** A coating which may be applied to protect the intumescent coat(s) from environmental conditions and/or to provide a decorative finish. It is often referred to as a sealer or top coat.
- **Tolerance:** The permissible deviation from the stated specified thickness of the coating(s).

3. INSTRUMENTATION

3.1 Choice of Instrument

An electro-magnetic induction dry film thickness gauge should be used to measure the coating thicknesses as specified. There are several suitable instruments available. Criteria for choice are that:

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- a. It must normally be capable of measurement on ferrous substrates.
- b. It must have a total range greater than that of the highest thickness to be measured.
- c. It should preferably be capable of storing measured values and calculating statistical parameters, eg. mean, standard deviation, minimum and maximum values.

Instruments should be manufactured to appropriate ISO or National standards. Some suitable instruments are included in the data sheet forming Appendix A to this document. Instruments are available for measurement of non-ferrous substrates. Specialist advice should be sought.

3.2 Calibration

Each instrument will require a slightly different procedure for calibration. In all cases the instrument manufacturer's instructions for smooth steel calibration should be followed. For guidance purposes only, basic principles are as follows:

- a. Calibration should always be carried out prior to any series of measurements. Some instruments will retain calibration even when switched off, but it is always good practice to recheck the instrument prior to use.
- b. For calibration purposes, a piece of smooth burnished steel, at least 1mm thick should be used. There should be no visible corrosion on the calibration plate. (Test substrates provided by the instrument manufacturer are acceptable.)
- c. Calibration shims (non-metallic), traceable to a national standard should be used. These can be obtained from the instrument supplier.
- d. Worn or damaged shims should be discarded.
- e. Shims should be selected above and below the expected coating thickness. (NB: Some instruments will require calibration of zero and a point above the expected thickness. Check with the instrument instruction manual.)
- f. Shims should preferably be no more than 50% above or below the target thickness, i.e. for a target thickness of 1mm, calibration shims between 500 microns (0.5mm) and 1500 microns (1.5mm) should be selected.
- g. An intermediate thickness value between the thicknesses chosen above, should be checked to ensure gauge accuracy.

The accuracy of modern digital gauges is high, typically $\pm 3\%$ of the actual thickness. If during calibration the instrument gives errors greater than its quoted tolerance, then the shims should be checked and/or the instrument should be checked by the manufacturer or his approved agent.

3.3 Use of Instrument

Each instrument must be operated in accordance with its own operating instruction manual. It is very important to follow the manufacturer's instructions to avoid errors in measurement.

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4. MEASUREMENT CRITERIA

4.1 Primer

Primer thicknesses should be measured as described in Section 3 to enable such thicknesses to be deducted from subsequent measurements. (NB: Where the surface is galvanised the thickness of the galvanised coating should be similarly deducted).

Once the primer thickness has been found to be within the specified tolerances, application of the intumescent coating can proceed.

If the primer thickness is found to be outside the specified tolerances the specifier and intumescent coating manufacturer should be informed in order to obtain guidance on acceptance.

4.2 Intumescent Coat(s)

The fire protective performance of an intumescent coating is defined by reference to the final applied dry film thickness.

The total intumescent dry film coating thickness should be measured using equipment as described in Section 3 prior to the application of any specified protective/decorative coat(s). Measurement at this stage will more easily facilitate any subsequent corrections which may prove necessary. If the total intumescent dry film coating thickness, allowing for the underlying primer, is found to be within specified tolerances, application of the next coat (usually a decorative and/or protective coat) can proceed.

If the total intumescent dry film coating thickness is found to be outside the specified tolerances, the procedure outlined in Section 5 should be followed. Indentation of the coating by the measuring instrument probe indicates insufficient hardness of the coating and measurements should be deferred. By agreement with the specifier, a shim of known thickness can be used to spread the load of the probe tip on the coated surface. The dry film thickness of coating and shim together can then be measured and the shim value deducted to give coating thickness.

(NB: It is recommended that a wet film thickness gauge be used in accordance with the intumescent coating manufacturer's instructions as a guide to achieving the required dry film thickness. In cases where multiple coats are used care should be taken when measuring the second or any subsequent coat to ensure that the teeth of the gauge are not pressed into the previous coat).

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4.4 Location

It is recommended that no readings are taken within 25mm of the edge of an I section or within 25mm of the join of flange to web of an I section. Taking the above into account, readings should be taken randomly over the remaining areas of the section with a frequency as described in 4.5 below.

4.5 Frequency

It is recommended that readings are taken as follows:

- I sections, Tee sections and Channels
- Webs: 2 readings per metre length on each face
- Outer flanges: 2 reading per metre length on each face
- Inner flanges: 1 reading per metre length on each face
- Square/rectangular hollow sections and angles: 2 readings per metre length on each face
- Circular hollow sections: 8 readings per metre length spread evenly around the section

Ideally, readings should be taken on every metre of every section in accordance with the above but it is recognised that this could result in several thousand readings being required. It is therefore recommended that readings are only taken on 1 in every 3 members, selected at random, and covering the range of member types and material specifications. If readings obtained from any member are found to be outside specification tolerances as defined in section 4.6, additional readings should be taken to establish whether or not the required specification(s) has been achieved.

4.6 Acceptance Criteria

- 4.6.1 The overall average measured dry film thickness on any member should not be less than the specified thickness.
- 4.6.2 The average measured DFT of any face of any member should not be less than 80% of the specified thickness.
- 4.6.3 Where any single thickness reading is found to be less than 80% of the average thickness a further three readings should be taken within a 300mm radius of the low reading. If one or more of the additional readings are also less than 80% of the average thickness further readings should be made to establish the extent of the area of underthickness and the whole area should be brought up to the required thickness.
- 4.6.4 The average measured DFT of any face of any member should not exceed by more than 10% the manufacturer's maximum thickness for the particular steel shape and orientation. (i.e. section or hollow section; beam or column)

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5. CORRECTION PROCEDURE

5.1 Where the intumescent coating thickness is found to be below that required by the specification as previously defined remedial application(s) will be necessary. These must be carried out fully in accordance with the manufacturer's instructions.

5.2 As stated earlier it is normal practice for the dry film thickness checks to be made prior to the application of any protection/decorative top coat(s). Where such a coating has already been applied detailed guidance should be obtained from the intumescent coating manufacturer.

5.3 Where the intumescent coating thickness exceeds the limits stated in 4.6.4 guidance should be obtained from the intumescent coating manufacturer.

6. DISPUTES PROCEDURE

6.1 A dispute as to the achieved thickness of an intumescent coating may arise for a variety of reasons, including:-

- a. Misinterpretation of specification.
- b. Faulty or inappropriate measurement equipment.
- c. Incorrect calibration of measurement equipment.
- d. Misinterpretation of the guidance given on measurement.

6.2 Where the parties are unable to agree, the following procedures are recommended:-

- a. The basis of the dispute is set out in written format.
- b. Where appropriate the coating manufacturer's advice is sought.
- c. Where appropriate, measurement instruments are re-checked for accuracy/calibration.
- d. The extent of the disputed area(s) is clearly defined by increasing the frequency of readings in the vicinity of exceptionally high or low readings.
- e. Where appropriate the manufacturer/engineer is approached to explore the use of a fire engineering solution.
- f. Where correction of the application is required, the procedures set out in Section 5 of this document are followed.

7. PROCEDURES FOR SITE RECORDS AND CERTIFICATION

Where appropriate site records should contain the following information:

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7.1 Basic Contract Information

- 7.1.1 Contract location
- 7.1.2 Building owner
- 7.1.3 Architect
- 7.1.4 Main/Management contractor
- 7.1.5 Fire protection contractor
- 7.1.6 Building Control Authority
- 7.1.7. District Surveyor
- 7.1.8 Fire protection materials used - manufacturer and product type
- 7.1.9 Inspection agency

7.2 Contract Documentation Covering the Fire Protection Product and its Installation

- 7.2.1 Substrate type (i.e. section shape, orientation, Hp/A value, etc.)
- 7.2.2 Substrate location
- 7.2.3 Surface preparation (i.e. degreasing, blast cleaning, etc.)
- 7.2.4 Identification of any primer and information concerning compatibility with intumescent coating
- 7.2.5 Certificates of conformance covering the fire protection products used
- 7.2.6 Thickness of intumescent coating required for the specified fire resistance period.

7.3 Quality Control Records

All records should identify the areas inspected with reference to the relevant drawings. They should include:

- 7.3.1 Environmental conditions, including measurement of substrate temperature, air temperature, relative humidity and dew point.
- 7.3.2 Final dry film thickness measurements.
- 7.4 Area Completion Certificates
 - 7.4.1 On large contracts, area completion certificates may be issued by an inspection authority. These certificates should be dated and define the extent of finished works by reference to the drawings.
 - 7.4.2 Documentation covering completion of all works should include all area completion certificates and quality control records.

Compliance with this document does not of itself confer immunity from legal obligation.

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