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SPECIFICATION FOR ANTI-CORROSION COATINGS ON THREADED FASTENERS

FOREWORD

This specification has been prepared by WRc plc under the direction of the Engineering and Operations Committee. Representatives of the UK Water Industry, coatings material suppliers and applicators, and suppliers of threaded fasteners were regularly consulted during the development of the document through the Materials and Standards Group's Threaded Components Liaison Group.

The specification has been issued to satisfy the needs of both users and suppliers for a national Water Industry performance based specification for long-term corrosion protection for threaded fasteners. This specification is designed to complement WIS No. 4-52-01, which is for coatings on larger, non-threaded items.

This specification calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Where reference is made to a British Standard or other specification, this shall be understood to refer equally to any other equivalent specification.

Enquiries regarding the availability of third party certification to this specification should be addressed to an appropriate third party NACCB or equivalent accredited certification body or to WRc Swindon.

It has been assumed in the drafting of this specification that the execution of its provisions is

entrusted to appropriately qualified and experienced people.

Information contained in this specification is given in good faith but neither the Water Services Association nor WRc plc can accept any responsibility for actions taken as a result.

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APPENDICES

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Subcontractor: Subcontractor employed by the Applicator to prepare, pre-treat and coat work pieces.

Test piece: A single test specimen (to consist of a bolt, nut and, if applicable, washer).

Work piece: A test piece processed as part of the Production Procedure Qualification.

1. SCOPE OF THE SPECIFICATION

This document specifies the requirements for factory applied anti-corrosion treatments for bolts, nuts and washers.

The specification is intended primarily to apply to buried pipeline applications, such as bolts used in flanges and fittings.

The anti-corrosion treatments covered are organic coatings which are adhered to the substrate, and which fully cover the item (inside threads on nuts, and jig marks of no more than 1mm width on the bore of washers, may be left uncovered). These coatings may be complete systems in themselves or may form part of a system together with sacrificial metals.

2. DEFINITIONS

Coating System: Details of coating, priming and other intermediate layer materials, together with production procedures pertaining to the pre-treatment and coating work or test pieces.

Applicator: Applicator of the coating system to the product. This may be the complete coating system or the outer layer(s) only.

Coating System Materials: Coating materials, intermediate layers and primers identified in the declaration of Coating System Details.

Holiday: A discontinuity in the coating.

Manufacturer: Manufacturer of the Coating System Materials.

Sample: A group of test pieces or work pieces taken from a larger collection or population. The term may also be used to describe a portion of material taken from a larger bulk of material.

3. COATINGS SYSTEM DETAILS

3.1 General

Together with each coating system submitted for evaluation, the following corresponding information shall be declared to the certifying body by the Applicator.

It is recognised that the Applicator may not apply the whole coating system. Section 4 applies only to those parts of the coating system which the Applicator applies.

3.2 Substrate material

The substrate material(s) to which the coating system is being applied shall be declared. The substrate in this case refers to the material on top of which the coating system is to be applied. This may be, for instance, a layer of zinc plating.

3.3 Thickness

The range of coating thicknesses which can be expected to conform to the requirements specified in Section 6 shall be declared.

Where a multi-layer system is used, the range of thicknesses for each layer (or other relevant measurable quantity) shall be declared.

4. PRODUCTION PROCEDURE QUALIFICATION

4.1 General

The Applicator shall develop and specify production procedures for all stages of the process in consultation with the Manufacturer. Processed work pieces shall then be tested in accordance with, and meet, the requirements of section 6.

The production procedures shall be qualified only when the work pieces submitted have met the requirements of section 5.

4.2 Work piece preparation and pre-treatment

The preparation and pre-treatment procedures shall take account of both the Manufacturer's recommendations and any special requirements relating to the actual work pieces to be coated.

The preparation procedure shall include minimum requirements for such aspects as the removal of surface scale or corrosion product and the removal of surface contamination, etc.

The pre-treatment procedure shall include details of any abrasive blasting requirements, dust, sliver and grit removal and any other surface treatments which take place prior to the application of primers or coating materials.

4.3 Application

The priming (where relevant) and coating procedures shall include details of critical process parameters together with production tolerances. Where a primer is used, the maximum time allowed to pass before coating is carried out shall be in accordance with the Manufacturer's recommendations.

4.4 Rework of non-conforming coated work pieces

The procedure for rework of non-conforming production items where required shall take account of the Manufacturer's recommended procedure for stripping non-conforming coatings.

4.5 Production procedure qualification testing

A number of work pieces shall be processed in accordance with the specified preparation, pre-treatment, priming and coating procedures declared in 4.2 to 4.4. This number shall be sufficient to provide enough work pieces on which to carry out the qualification tests. These work pieces shall meet the requirements of the qualification tests described in section 6.

5. WORK PIECES

5.1 Design and suitability for coating

As far as possible, work pieces should be designed so as to be suitable for coating.

5.2 Work piece quality

Prior to coating, work pieces shall be inspected. The work pieces shall conform to the relevant product quality requirements.

5.3 Handling and storage

It is recommended that work pieces and finished products should be handled and stored in accordance with the guidance given in IGN No. 4-52-02. This guidance includes recommendations for handling and storage within the factory and during transportation.

Particular attention shall be paid to protecting both the work pieces being handled in the factory and the finished products from contamination and mechanical damage.

6. COATING SYSTEM PERFORMANCE REQUIREMENTS

6.1 Properties of the applied coating

Coated test pieces shall be tested to and meet the requirements of clauses 6.3.1 to 6.3.9. The test pieces shall have been prepared, pre-treated and coated in accordance with the procedures and thickness requirements declared in Section 4.

All tests shall be carried out at ambient temperature unless specifically stated otherwise. In case of dispute, these tests shall be carried out at $23 \pm 2^\circ\text{C}$.

6.2 Test samples

The number of samples required for testing is given in Table 6.1. Test samples shall consist of a bolt, nut and a washer. The washer shall be either coated or stainless steel for test purposes. These

shall be between sizes M12 and M20 inclusive, unless an Applicator normally coats only items outside this range, in which case a size within the Applicator's range shall be chosen. Only one size within the range need be tested.

Table 6.1 - Test samples

Clause no.	Test	No. of samples
6.3.2	Visual appearance	All
6.3.3	Thickness	All
6.3.4	Holidays	All
6.3.5	Adhesion	5
6.3.6	Cure	5
6.3.7	Salt spray	5
6.3.8	Resistance to damage	5
6.3.9	Torque-load behaviour	5
	Total	25

NOTE: The manufacturer shall supply an uncoated test sample for calibration purposes. This should be representative of the samples coated for testing.

6.3 Performance testing

6.3.1 Effect on water quality

Coating materials which are used in the treatment and distribution of public water supplies must be used in accordance with the requirements of Regulation 25 of the Water Supply (Water Quality) Regulations 1989, Water Supply (Water Quality) Amendment Regulations 1989 and Amendment Regulations 1991.

In Practice, new materials must be proven to satisfy the requirements of BS 6920 and be approved under the Water Byelaws Scheme. If the surface area in contact with the water is small, the above requirements are likely to be sufficient for the product to be used under regulation 25(1) (b). If the surface area is relatively large, then Secretary of State approval under Regulation 25(1) (a) is required. This involves consideration of the product by the 'Department of the Environment Committee on Chemicals and Materials of Construction for Use in Public Water Supply and Swimming Pools'. If the coating is to be applied in situ (e.g. on-site repair materials), the approval of the Secretary of State must be sought.

A list of approved substances and products is published annually and is available from the Technical Secretary of the Committee at the Drinking Water Inspectorate, Room B153, 43 Marsham St, London SW1 3PY.

6.3.2 Visual appearance

Each coated test piece shall be examined visually. The coating shall be free from any defects which are likely to be detrimental to coating performance, e.g. pinholes, blisters, uncoated areas (except those intentionally left uncoated). The coating shall conform to manufacturer's tolerances for colour, gloss etc.

6.3.3 Thickness

The coating thickness of all test pieces shall be measured and recorded in accordance with Appendix A. Only test pieces having coating thicknesses within the declared range (see 3.3) shall be used in subsequent performance tests. In addition, a nut shall be run up the thread of each bolt used. Only those bolts up which the nut can run freely shall be used in subsequent tests. The action of running the nut up the thread without tightening it shall not damage the coating on the thread.

6.3.4 Holidays

This clause only applies to those coating systems which include an organic layer of thickness greater than 10µm.

Each coated test piece shall be tested for holidays in accordance with Appendix B. Only holiday/pinhole-free coated test pieces shall be used in subsequent performance tests.

For Quality Control testing, a batch shall be deemed to have passed this test if at least 50% of the sample tested is holiday-free.

6.3.5 Adhesion

Coated test pieces shall be tested in accordance BOTH with clause 6.3.5.1 AND with clause 6.3.5.2. A failure of either test will be considered a failure of this clause.

Tests can be carried out on the shank and/or head of the bolt.

6.3.5.1 V-cut test

When tested in accordance with Appendix C, the coating shall exhibit no adhesive disbondment.

6.3.5.2 *Cross-hatch test*

When tested in accordance with BS 3900: Part E6, the coating shall exhibit not less than 95% adhesion.

6.3.6 Cure

This test applies only to thermosetting coatings, including liquid thermosets. After an appropriate combination of time and conditions (both to be defined prior to the test by the manufacturer) from the point of coating application, thermosetting coatings on coated test pieces shall be demonstrated to have been cured within the Manufacturer's declared limits. The method used shall also be declared. The method chosen shall provide a clearly defined pass criterion.

6.3.7 Salt spray

Coated test pieces shall undergo 1000 hours exposure to salt spray in accordance with ASTM B117. After exposure, no more than 5% of the surface area of the test samples shall exhibit red rust.

(NOTE: White corrosion deposits are acceptable.)

6.3.8 Resistance to damage

Coated test pieces, when tested in accordance with Appendix D, shall exhibit no red rust.

6.3.9 Effect on torque-load behaviour

Bolts which are sold for use with flanges shall, when tested in accordance with BS 7371: Part 2, reach the clamping force specified in Table 1 of that standard within the upper torque limit set in that Table. It is acceptable for the clamping force to be reached at a torque below the lower limit specified in that Table.

Bolts which are sold for use as components for fittings shall conform to the fitting manufacturer's requirements for torque/ load.

7. QUALITY ASSURANCE REQUIREMENTS

Coating system applicators shall operate a quality system relating to this specification in compliance with BS EN ISO 9002.

8. COATING SYSTEM MATERIALS

All coating system materials shall be stored in accordance with the Manufacturer's recommendations. Batches shall be used in the order in which they were manufactured and before the respective shelf life expiry date.

9. PRODUCTION QUALITY CONTROL

Once the coating and associated production procedures have been qualified (see Section 6) production coating may commence in accordance with these procedures. This section specifies the minimum inspection and testing requirements which are necessary in order to demonstrate a continuing satisfactory level of product quality.

Inspection and testing procedures shall be written by the Applicator based on the details of the qualified production procedures and the requirements of Section 6.

9.1 Control of work piece preparation

Prior to being pre-treated, the sample (see 9.4), shall be inspected and tested to ensure that the required level of preparation (specified in the qualified production procedure) has been carried out.

9.2 Control of work piece pre-treatment

Prior to being coated, the sample (see 9.4), shall be inspected and tested to ensure that the pre-treatment requirements (specified in the qualified production procedure) have been met.

9.3 Inspection and testing of the finished coated work piece

Finished work pieces shall be inspected and tested in accordance with the sampling plan (see 9.4) to ensure that they meet the requirements of clauses 6.3.2 to 6.3.6.

9.4 Sampling frequency

Production quality control activities shall be carried out in accordance with an appropriate sampling plan. This sampling plan shall take account of both the particular batch size or equivalent quantity, and the acceptable quality level which is to be agreed between the Applicator and either the Purchaser's representative or the Certification Authority.

Sampling procedures are described in BS 6000 and BS 6001.

The Applicator shall not knowingly supply a defective unit in any batch.

10. REWORK

Where non-conforming coated work pieces are to be reworked this shall be done in accordance with the prequalified procedures (see 4.5) and subject to tightened production quality control inspection levels (see 9.4).

All re-coated work pieces shall meet the requirements of this specification.

11. SUBCONTRACTED WORK

Where the coating operation is to be subcontracted, the Applicator is required to:

Ensure that the requirements of this specification are met.

Demonstrate control over the point of subcontracted manufacture (for preparation, pre-treatment and coating of work pieces).

Ensure that the subcontractor operates a quality system relating to this specification in compliance with BS EN ISO 9002.

12. REFERENCES

WIS 4-52-01 Water Industry Specification for Polymeric Anti-Corrosion (Barrier) Coatings

IGN 4-52-02 Information and Guidance Note on the Use of Polymeric Anti-Corrosion (Barrier) Coatings

BS 3900: Part E6 Cross cut test

ASTM B117 Standard Test Method of Salt Spray (Fog) Testing

BS 7371: Part 2 Coatings on Metal Fasteners: Torque/clamping force relationship

BS EN ISO 9002 Quality systems: Specification for production and installation

BS 6000 Guide to the use of BS 6001. Sampling procedures and tables for inspection by attributes

BS 6001 Sampling procedures and tables for inspection by attributes

BS 5781: Part 1 Measurement and calibration systems: Specification for system requirements

APPENDIX A - COATING THICKNESS MEASUREMENT

A.1 General

This appendix specifies methods and equipment requirements for non-destructive measurement of coating (dry film) thickness.

A.2 Equipment

A.3 Accuracy

Once calibrated (using a representative uncoated surface) for the range of thicknesses (maximum and minimum) to be measured, the thickness measuring gauge shall be capable of repeatably indicating coating thicknesses within this range to an accuracy of $\pm 5\%$.

NOTE: Accuracy shall be determined by reference to coating thickness measurements taken from a section of the coated work piece. The plane of this section shall be perpendicular to the plane or tangent of the coated surface.

A.3.1 Calibration

The thickness measuring gauge shall be calibrated for the specified range of thickness (maximum and minimum) at the start of each period of work (or hourly during continuous operation).

A.3.2 Records

Records shall be kept of all accuracy checks and calibration adjustments made at the start of each period of work. These records shall include dates, the thickness range considered, the actual thickness measurements noted and any adjustments made. The requirements of BS 5781 shall apply.

A.4 Measurement procedure

A.4.1 Test pieces

The test pieces shall be bolts as described in section 6.2. The coating thickness on each sample shall be measured at five sites on the unthreaded portion of the shank of the bolt and/or on the head of the bolt.

A.4.2 Records

For each piece measured, the maximum, minimum and mean coating thicknesses shall be recorded together with the standard deviation of the measurements.

In production situations, thickness measurements may be carried out on a pass/fail basis. In these cases the coating thickness acceptance limits shall be recorded together with the pass/fail results.

APPENDIX B - HIGH VOLTAGE HOLIDAY DETECTION

B.1 General

This appendix specifies methods and equipment requirements for the detection of holidays in coatings.

B.2 Equipment

Holiday detection shall be carried out using electrical detection equipment having the following facilities:

- Variable test voltage (typically 0-1000 V dc)
- Audible and/or visible holiday alarm signals
- Sensitivity adjustment
- Splayed steel *wire or conducting neoprene probe electrode
- Earth electrode with clamp or magnet

* Probe electrodes may be shaped to conform to the profile of coated products.

B.3 Test voltage

The holiday detector output voltage shall be adjusted to give at least 5V per μm of coating thickness. The coating thickness considered shall be the actual minimum measured thickness for the surface in question. For coating systems which include a metallic layer, holiday detectors shall be calibrated using a surface which includes this metallic layer.

B.4 Procedure

Identify a site on the work piece to which the earth electrode can be fixed. It will be necessary to remove the coating on this area to achieve an electrical contact. The threaded portion of the shank may be masked off.

Fix the earth electrode to the substrate and ensure that a good electrical contact is made. When the probe is brought into contact with the exposed substrate alongside the earth electrode connection the holiday alarm signal should be activated.

Pass the probe over the unthreaded portion of the bolt shank at a maximum rate of 10mm/s, paying particular attention to visible irregularities in the coating.

APPENDIX C - RESISTANCE TO DAMAGE

C.5 General

This appendix specifies the procedure for evaluating the resistance of coatings on bolts to damage caused by impact.

C.6 Equipment requirements

- A drop height impact tester with an indenter assembly having a total mass of approximately 0.5-1.0 kg. The indenter shall conform to Figure C.1 and shall be made of hardened steel, to Rockwell C 58-60. The equipment shall be securely mounted on a rigid support structure. A vee block should be placed so as to hold the bolts which are to be impacted. The mount should prevent the bolt from moving in any direction when impacted.
- High voltage holiday detector (see B.2).

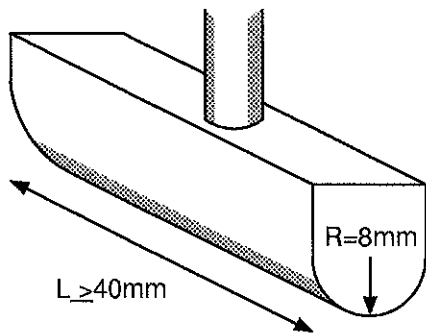


Figure C.1 - Indentor

C.7 Procedure

C.7.1 Test pieces

Coated bolts, which should be conditioned at 20-25°C for 24 hours prior to the test.

C.7.2 Test method

Mark a point on the unthreaded part of the shank of the bolt using a means which is indelible and waterproof. Check the area for holidays with the holiday detector set at a minimum of 5V/μm. Test only at holiday-free sites. Position the bolt to be tested in the vee block so that the impact spot is underneath the indenter. The bolt shank and indenter head shall be horizontal and perpendicular to each other in the horizontal plane.

Raise the impact weight to a height calculated to impart 1.5J of impact energy to the bolt. The impact height may be calculated using the following formula:

$$H = \frac{1.5}{9.81 W}$$

where H = impactor height, in m
W = impactor mass, in kg.

Allow the indenter assembly to fall. Repeat this on the other four samples.

After impacting the samples, immerse them in a bath containing 5% w/w sodium chloride solution at 40°C. The bath should be aerated using air bricks or a stirrer. After 24 hrs of immersion, remove the samples from the bath and examine them for any signs of red rust.

C.8 Reporting

The report shall include the following:

- The mass of the impact weight;
- The drop height used;
- Confirmation of the time, temperature and composition of the water bath;
- Extent to which red rust was present after immersion.