




STUK-YTO-TR-210-2017: Requirements for Coatings of Nuclear Power Plant Controlled Area

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Summary		
<p>During an accident in a nuclear power plant, conditions in the reactor containment will be characterized by elevated temperature and pressure, as well as the presence of radiation environment. Water spray, with or without chemical additives, may be used in the primary containment to suppress the consequences of the incident, to scavenge radioactive products, and to return the containment to near-ambient conditions. It is important, that the coatings used will not have an unfavourable effect on accident management. Furthermore, it shall be demonstrated that coatings will not come off to an extent which would block flow paths and endanger core coolability or removal of residual heat. It must also be proved, that under accident conditions chemical changes, if any, in coating material do not create new risk factors.</p> <p>This publication presents the detailed and revised requirements for coatings inside the containment. The requirements are given for the following issues specified in Guide YVL E.6: radiation resistance, ease of decontamination, chemical resistance, durability under operating conditions, durability under postulated accident conditions and fire technical properties.</p> <p>The requirements are based on the referred standards and the Nordic TBY-criteria (Technical regulations for surface treatment). Only coatings which have passed tests demonstrating the meeting of these requirements can be used on concrete and steel structures inside the controlled area. Results from the Nordic project TBY-Technical Regulations for Surface Treatment can be utilized for approval of coatings.</p> <p>This publication will be applied for both new work and maintenance. Qualifications conducted before the availability of this document and according to the superseded version of STUK-YTO-TR-210 are considered valid as such.</p>		
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Foreword

This publication is the updated version of STUK-YTO-TR-210 and was prepared at VTT in co-operation with an executive group formed out of representatives from Fennovoima, Fortum, STUK, Teknos Oy and TVO. The updates were added in the report by VTT project team led by Konsta Sipilä. The executive group supervised the work and accepted the additions made to the previous version of STUK-YTO-TR-210, which this publication supersedes. Validations completed according to the superseded publication are considered to be valid as such, as long as the validation has been conducted before the availability of this document.

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1. Attestation of conformity

The paint manufacturer shall attest the conformity of the coating system. The evaluation of conformity involves the manufacturer and a third party.

1.1 Quality management system

The manufacturer shall have a documented quality management system. The system has to be certified according to ISO 9001-series or the manufacturer must have a quality control contract with an independent organization approved by the developer.

The factory production control shall be operated according to the documented system given in the quality manual. The traceability of the products must be ascertained.

1.2 Tests according to this publication

The testing shall be performed either by the manufacturer or by an independent laboratory approved by the licensee. All tests must be reported as given in respective clauses.

1.2.1 Tasks of manufacturer

The manufacturer may perform the following tests or may use an approved laboratory to perform these tests:

- chemical composition of coating (clause 2)
- chemical durability at operational conditions (clause 6)
- durability at operational conditions: initial tests for adhesion (clause 7)
- durability at operational conditions: abrasion resistance (clause 8).

1.2.2 Tasks of third party

The following tests must be performed by an independent laboratory approved by the licensee:

- radiation (gamma) resistance (clause 4)
- decontamination (clause 5)
- durability at simulated Design Basis Accident (DBA) conditions (clause 9)
- behaviour at fire (clause 10)

It should be noted that the DBA testing will only consider coatings that are applied inside containment buildings.

2. Chemical composition of coatings

Coatings and coating systems to be used in power plant containments must not contain more than a total of 1% by weight of lead, mercury, copper, cadmium, cobalt, antimony, chlorides and fluorides as measured of the dried coating. Analysis certificates from suppliers or independent laboratories, stating the actual concentrations and detection limits of the above substances, will be required. These analyses shall normally be carried out in connection with type testing of the coatings. A guarantee given by the paint manufacturer, that none of the above substances is added during the manufacturing process, will not be sufficient for approval.

3. General guidelines for sample preparation

General guidelines to prepare the concrete and metallic specimens as well as the actual application of the coating on the substrate are described in this section. Some clauses may require additional procedures that are indicated in the corresponding clause description.

3.1 Preparation of concrete specimens

The concrete specimens shall be prepared in accordance with standard ASTM D5139-12 Standard Specification for Sample Preparation for Qualification Testing of Coating to be Used in Nuclear Power Plants unless otherwise agreed.

The concrete blocks shall be allowed to cure for at least 28 days before coating unless otherwise specified.

The following information shall be documented:

- composition of concrete (i.e. concrete aggregate, type of cement, water/cement-ratio, additives)
- grade of concrete (compression strength).

The edges of the concrete specimens are recommended to be chamfered up to 6.5 mm maximum.

The recommended surface preparation method for the concrete sample surfaces where the coating is applied is surface grinding performed with suitable abrasive, such as diamond grinding. When relevant, the following standards may be applied:

- ASTM D4258-05(2012) Standard Practice for Surface Cleaning Concrete for Coating
- ASTM D4259 88(2012) Standard Practice for Abrading Concrete

3.2 Preparation of steel panels

The steel panels shall be of hot rolled carbon steel (yield stress min. 235 N/mm²) or the steel quality can be in due form agreed to be changed to correspond the testing practise in Finland or to the actual case.

The steel panels shall be blast-cleaned. The preparation grade is specified to fulfil the requirements of the actual coating system.

3.3 Preparation of coating system

All test samples shall be coated from one side with the full coating system according to written instructions given by the coating manufacturer. The film thickness range shall be representative of the specified work for which the testing is being conducted. The procedures and conditions used for the test sample preparation shall be documented.

As minimum the documentation shall include:

- product identification (trade name, batch number)
- product color (light color shades are recommended)
- preparation times and dates
- surface preparation details
- thinners, accelerators, additives, reinforcement, and fillers added during the mixing and application process.
- method of application
- coating sequence
- individual dry film thickness ranges of each coat (coatings on steel) or specified thickness range (coatings on concrete)
- total thickness range
- environmental conditions, including at least temperature and relative humidity
- cure times and temperatures.

In addition, any deviations or non-conformances during the application phase should be recorded.

4. Radiation (gamma) resistance

4.1 Determination according to standard ASTM D4082

The radiation tolerance of the coatings shall be evaluated. The radiation tolerance can be determined according to standard ASTM D4082-10 Standard test Method for Effect of Gamma Radiation on Coatings for Use in Nuclear Power Plants.

The test method given in standard ASTM D4082 is designed to provide a uniform test to assess the suitability of coatings used in nuclear power plants under continuous radiation exposure for the life of the facilities, including radiation during a DBA. There may be local factors such as variations concerning surface preparation, application and curing of coatings, that may affect the performance of coating system exposed to radiation. The performance of coatings at DBA-conditions shall additionally be evaluated according to clause 9.

4.2 Test specimens

4.2.1 Concrete specimens

The standard ASTM D5139 gives as the minimum size for the concrete test specimens 50 mm × 50 mm × 100 mm. If agreed, also thinner concrete specimens can be used, e.g. 25 mm × 50 mm × 100 mm.

One end of the concrete blocks shall be left uncoated. A suitable hanger compatible with the testing apparatus shall be fixed at the mid-point of the one end of the block where applicable.

Number of test specimens shall be at least 2.

4.2.2 Steel panels

The size of steel panels is 50 mm × 100 mm × 5 mm. Thinner specimens than 5 mm may be used if there is certainty that there will not be any distortion of the specimens.

Number of test panels shall be at least 2.

4.2.3 Coating of test specimens

The general guidelines for the coating procedure stated in clause 3 are applied. In addition to these guidelines, all the other sides of the test specimens that have not been coated with the full coating system under examination, shall be protected with a suitable coating.

4.3 Test method

The irradiation procedure is according to standard ASTM D4082-10.

- The gamma energy field at the position of the test specimen shall be 1×10^6 rads/h, or greater, unless otherwise agreed between the licensee and regulator.
- The total accumulated dose shall be 1×10^8 rads¹ ($= 1 \times 10^6$ J/kg = 1×10^6 Gy), unless otherwise agreed between the licensee and regulator based on design basis and/or researched information and/or circumstantial testing samples.
- Specimens shall be in air or water during exposure to gamma source, depending on the intended service as prescribed by the owner.
- The radiation source should be capable to produce the specified dose rate and total accumulated dose.

4.4 Assessment and reporting of results

The test specimens shall be examined and documented immediately after irradiation for the following defects:

- chalking ISO 4628-6
- cracking ISO 4628-4
- blistering ISO 4628-2

¹ (Gy): A gray, like the rad, measures the radiation absorbed by a mass unit. One gray is equal to 1 J of absorbed radiation per kilogram (of person or animal). Gy = 1 J kg⁻¹, 1 Gy = 100 rads.

- flaking ISO 4628-5

Any observation of unusual appearance or deterioration (e.g. delamination) shall also be reported.

4.5 Acceptance criteria

Unless otherwise specified, cracking, blistering and flaking, are not permitted.

5. Ease of decontamination (decontaminability)

5.1 Determination according to ISO 8690

The contamination with radionuclides and the ease of decontamination varies for different coatings. Also the decontamination methods may be different.

This test method ISO 8690 is designed to obtain data allowing the comparison of ease of decontamination of different surface materials.

The purpose of this test is to assess the ease of decontamination of surfaces under laboratory conditions. Further decontamination tests under simulated service conditions may be agreed about. In such case actual contamination and decontamination chemicals are used.

5.2 Test specimens

The test specimens are steel panels coated with the coating system as given in clause 3. In addition to these guidelines, all the other sides of the test specimens that have not been coated with the full coating system under examination, shall be protected with a suitable coating.

The size of the test panels is $(50 +10/-2)$ mm × $(50 +10/-2)$ mm.² The thickness of the test specimens should be between 3 and 10 mm. The thickness shall be ascertained with the testing laboratory.

Unless otherwise specified, 10 ordinary irradiated and 10 unirradiated test specimens are needed. These test specimens shall be kept in conditions and cleaned as given in standard ISO 8690.

5.3 Contamination and decontamination solutions

5.3.1 Contamination solutions

The test specimens shall be contaminated by the radionuclides ¹³⁷Cs and ⁶⁰Co, contained in separate solutions. The solutions shall be in accordance with standard ISO 8690 (i.e. an evaporated 100 µl sample produces a pulse rate of not less than 200 000 pulses per minute; an activity concentration of 0.2 MBq/ml will usually be sufficient to fulfil the requirement). If using other contamination solutions, this shall be separately agreed about between licensee and regulator.

² When tested at VTT, the recommended size is $(50 ± 2)$ mm × $(50 ± 2)$ mm, thickness 3–10 mm.

5.3.2 Decontamination agent

Demineralized water (maximum conductivity 3 $\mu\text{S}/\text{ml}$) shall be used as decontamination agent.

5.4 Procedure (contamination and decontamination)

According to standard ISO 8690 the specific pulse rate of each contamination solution is determined (pulse/minute/millilitre).

Contamination is performed with both contamination solutions for five (5) irradiated and five (5) unirradiated test specimens according to standard ISO 8690.

Then, the test specimens are decontaminated and the residual pulse rate is determined. The results are calculated as presented in standard ISO 8690:

- five (5) equally contaminated test specimens are decontaminated simultaneously with demineralized water using the test arrangements given in the standard
- after drying, the residual pulse rate of the test specimens is determined
- the arithmetic mean of the residual pulse rates of the five test specimens of each group is calculated separately for both radionuclides ^{137}Cs and ^{60}Co (standardized mean pulse rate)
- final result FRP (final residual pulse rate) is calculated as the arithmetic mean of standardized mean residual pulse rates for ^{137}Cs and ^{60}Co .

5.5 Assessment of ease of decontamination and reporting the results

The ease of decontamination is assessed according to Table 1. This assessment is valid only when the contamination is carried out using the radionuclides ^{137}Cs and ^{60}Co .

Table 1. Assessment of the ease of decontamination.

Final residual pulse rate (FRP), pulses/minute	Ease of decontamination
FRP < 3 500	Excellent
$3\,500 \leq \text{FRP} < 15\,000$	Good
$15\,000 \leq \text{FRP} < 60\,000$	Fair
$60\,000 \leq \text{FRP}$	Poor

The test report shall include the information and data specified in standard ISO 8690, Annex D.

5.6 Acceptance criteria

The ease of decontamination shall be at least “Good” (Table 1).

6. Chemical durability at operational conditions

6.1 Scope

The purpose of determination of chemical durability by immersion is to evaluate the resistance of coatings against saponification, demineralized water and some chemicals. If other chemicals are to be used in the nuclear power plants containment, the resistance of the coating against these chemicals shall be determined separately.

6.2 Test specimens

6.2.1 Concrete specimens

The standard ASTM D5139 gives as the minimum size for the concrete test specimens 50 mm × 50 mm × 100 mm.

The number of test specimens shall be specified and it shall be at least 2: one specimen for adhesion measurements and one for visual assessment of coating.

6.2.2 Steel panels

The minimum size of steel panels is 100 mm × 150 mm × 5 mm. Thinner specimens than 5 mm may be used if there is certainty that there will not be any distortion of the specimens.

The number of test specimens shall be specified and it shall be at least 2: one specimen for adhesion measurements and one for visual assessment of coating.

6.2.3 Coating of test specimens

The general guidelines for the coating procedure stated in clause 3 are applied. In addition to these guidelines, all the other sides of the test specimens that have not been coated with the full coating system under examination, shall be protected with a suitable coating. In case of adhesion testing, the minimum number of prepared test dollies is 3.

6.3 Resistance to saponification

Coating systems that are intended to be painted directly on to concrete must be tested for their resistance to saponification. The test panels shall be immersed in a saturated calcium hydroxide solution ($\text{Ca}[\text{OH}]_2$) at 50°C for three months.

6.4 Resistance to demineralised water

Testing for resistance to demineralised water is carried out at 40°C for six months. The electrical conductivity of the water must be less than 2 mS m^{-1} at 25°C for the duration of the test period. The water shall be replaced if at any time during the test it becomes turbid or coloured or its conductivity exceeds 2 mS m^{-1} (at +25°C). The conductivity of the water shall be determined during the test and the results of the determinations shall be reported. The test method shall be according to standard ISO 2812-2, water immersion method.

6.5 Resistance to chemicals

The resistance of the coating systems to chemicals shall be determined to all chemicals that the systems may be exposed to. This applies also to the chemicals used for decontamination surfaces.

The chemical resistance shall be determined at least to the extent given in Table 2.

Table 2. Chemical resistance testing: chemicals and test parameters.

Chemical	Concentration	Temperature °C	Test time h	Coatings on concrete	Coatings on steel
Sulphuric acid †	245 g/l	23	24	X	X
Nitric acid	5%	23	2	X	
Hydrochloric acid	5%	23	2	X	
Citric acid	5%	23	2	X	X
Boric acid	6%	23	2	X	X
Borax	10%	23	2	X	
Sodium hydroxide	250 g/l	23	24	X	X
Ferro(II)-sulphate	10%	23	2	X	
Ethanol	95%	23	0.1	X	X
Acetone	100%	23	0.1	X	X
Hydrazine	15%	23	2	X	

† Sulphuric acid, density 1.84 g/m³

6.6 Assessment and reporting of results

After removing the samples from the test solution, the test specimens are evaluated immediately (within 2 hours) and repeat the evaluation until at least 24 hours have passed for the following properties and defects:

- blistering ISO 4628-2
- flaking ISO 4628-5
- cracking ISO 4628-4
- stickiness and softening (testing by moderate finger pressure)
- adhesion ISO 4624 (notice details in clause 7.1).

6.7 Acceptance criteria

- Blistering max 2(S4). Blisters shall be limited to intact blisters that are completely surrounded by sound coating bonded to the surface
- No flaking, cracking or softening
- No stickiness may occur, the surface must be tack-free when tested by moderate finger pressure

- Adhesion, concrete structures: The type of breakage shall be cohesion breakage of concrete. The following values are valid:
 - floors min. 2.5 MPa
 - walls, pillars, beams, ceilings min. 1.5 MPa
- Adhesion, steel structures:
 - no adhesion break to substrate allowed unless pull-off values are 5 MPa or greater
 - for cohesion break of coating min. 3 MPa.

7. Durability at operational conditions/initial tests for adhesion

7.1 Testing according to ISO 4624

The adhesion of the coating shall be determined with appropriate initial tests.

The adhesion is determined with pull-off test according to standard ISO 4624. The tensile stress shall be applied in a direction perpendicular to the plane of the coated surface. The test results are not reproducible unless coaxial alignment of the tensile forces is ensured.

The test apparatus used shall be a hydraulic pull-off apparatus, or other type of adhesion tester (as long as it can provide similar results as hydraulic one), where the test cylinder is pulled off the surface using hydraulic pressure to provide the force.

The diameter of test cylinder shall be min. 20 mm for concrete surfaces and 10–20 mm for steel surfaces.

Before testing, cuts around the test cylinder are made through cured adhesive and the coating to the substrate round the circumference of the test cylinder. The internal diameter of the cutting device shall not exceed the diameter of the test cylinder by more than 2 mm. For cutting, also a sharp knife may be used.

At least three determinations shall be carried out for each test specimen.

7.2 Test specimens

7.2.1 Concrete specimens

The size of the specimens shall be such, that three adhesion determinations from each test specimen can be performed. Suitable size is for instance 300 mm × 300 mm × 50 mm.

The number of test specimens shall be specified and it shall be at least 2.

7.2.2 Steel panels

The minimum size of steel panels is 100 mm × 150 mm × 5 mm. Thinner specimens than 5 mm may be used if there is certainty that there will not be any distortion of the specimens.

The number of test specimens shall be specified and it shall be at least 2.

7.2.3 Coating of test specimens

The general guidelines for the coating procedure stated in clause 3 are applied.

7.3 Assessment and reporting of results

The test results are reported according to standard ISO 4624. The report shall include the following information at minimum:

- the type and identification of the product(s) tested
- a reference to the standard used
- the type of instrument and the diameter of the dolly
- the type of cutting tool employed to cut around the dolly
- the results of the test as indicated in ISO 4624.

7.4 Acceptance criteria

7.4.1 Concrete structures

The type of breakage shall be cohesion breakage of concrete. The following values are valid:

- floors min. 2.5 MPa
- walls, pillars, beams, ceilings min. 1.5 MPa.

7.4.2 Steel structures

- no adhesion break to substrate allowed unless pull-off values are 5 MPa or greater
- for cohesion break of coating min. 3 MPa.

8. Durability at operational conditions / abrasion resistance

8.1 Testing according to ISO 7784-2

The resistance to abrasion of coatings for floors shall be determined.

The abrasion resistance is determined according to standard ISO 7784-2 (so called Taber method). This method gives information of the ability of the coating to withstand mechanical stress during use.

8.2 Test specimens

Only steel panels are used, typically used substrate is metal (steel) sheet. The shape and size of the test panels shall be such that they can be fitted correctly on the apparatus. They shall have a central hole with suitable diameter. Typical size is 100 mm x 100 mm. The test panels shall be plane and free from distortion, otherwise the wear of the coating will not be uniform.

The general guidelines for the coating procedure stated in clause 3 are applied.

The number of test specimens shall be specified and it shall be 3 at minimum.

8.3 Test method

The test is performed according to standard ISO 7784-2 as follows:

- The abrasion wheel shall be a rubber wheel type CS-17
- The load on the wheels is adjusted to 1000 g.
- For resurfacing the abrasion wheels, an S-11 abrasive disc is used.
- The weight loss mg/1000 cycles is calculated.

The determinations are performed for three test panels.

8.4 Assessment and reporting of results

The results are reported according to standard ISO 7784-2. The report shall include the following information:

- identification of specimens
- conditioning of test panels before testing
- wheel load and the type of abrasive rubber wheel used
- date of testing and conditions during testing
- individual test results: weight loss mg/1000
- mean value of weight loss mg/1000 cycles.

8.5 Acceptance criteria

The mean value of weight loss must be less than 175 mg/1000 cycles.

9. Durability at simulated Design Basis Accident (DBA) conditions

9.1 Determination according to ASTM D3911

The durability of coatings during design basis accident (DBA) shall be evaluated. The durability at DBA-conditions can be determined according to standard ASTM D3911-16.

The method gives information concerning the general ability of coating to remain intact and not become debris at DBA-conditions which could compromise engineered safety systems. Variations in actual surface preparation and curing of the coating materials may require additional testing as deemed necessary by the specifying or qualifying agency, or both, if it is anticipated that the variations may adversely affect the performance of the coating system during a DBA.

The standard ASTM D3911 describes the conditions and apparatus for temperature-pressure testing.

9.2 Test specimens

9.2.1 Concrete specimens

The minimum size for the concrete test specimens shall be 50 mm × 50 mm × 100 mm. If agreed, also thinner concrete specimens can be used, e.g. 25 mm × 50 mm × 100 mm.

The number of test specimens is 4. Two of the specimens are irradiated in accordance with clause 4 prior to testing.

9.2.2 Steel panels

The minimum size for the steel test specimens shall be 100 mm × 50 mm × 5 mm. Thinner specimens than 5 mm may be used if there is certainty that there will not be any distortion of the specimens.

The number of test specimens is 4. Two of the specimens are irradiated in accordance with clause 4 prior to testing.

9.2.3 Coating of test specimens

The general guidelines for the coating procedure stated in clause 3 are applied. In addition to these guidelines, all the other sides of the test specimens that have not been coated with the full coating system under examination, shall be protected with a suitable coating.

9.3 Test method

The test procedure is given in standard ASTM D3911.

The testing parameters (temperature–time– pressure) shall be according to the safety analysis report (SAR) identified by the owner for the specific containment. The curves described in standard ASTM D3911 may be used if they represent conditions equal to or more severe than those of DBA conditions anticipated.³

Steam is used initially to achieve the desired thermal shock and to raise the test chamber and its environment to the prescribed test conditions. The inlet steam shall not be directed on the test specimens. The duration of steam injection should be minimized and where inlet steam temperatures exceed 188°C initial steam injection shall be no longer than 15 min.

Unless otherwise specified, deionized water shall be used.

9.4 Assessment and reporting of results

The test specimens are examined and evaluated within 4 h and again after 14 days following removal from test chamber for the following defects:

- blistering ISO 4628-2
- cracking ISO 4628-4
- flaking ISO 4628-5.

³ Examples of testing parameters according to ASTM 3911:

- Boiling water reactor: max 171°C/4.83 bar
- Pressure water reactor: max 152°C/4.14 bar

Total time of testing 7 days.

Moreover, any observations of unusual appearance shall be reported.

Disregard the condition of the edges and the plane areas within 6 mm from the edges of the steel or concrete test surfaces, and the top and bottom ends of the concrete surfaces.

9.5 Acceptance criteria

The following criteria represent the minimum standards for acceptance:

- No flaking is permitted
- Cracking is not considered a failure unless accompanied by flaking or loss of adhesion
- Blisters shall be limited to intact blisters that are completely surrounded by sound coating bonded to the surface

The licensee shall review the report generated according to clause 9.4 for coating acceptability.

9.6 Alternative methods

If alternative methods to ASTM D 3911 are used, these must be accepted by the licensee.

10. Behaviour at fire

10.1 Classification according to EN 13501-1

Regulations and guidelines for fire classification of coating materials are given in The National Building Code of Finland, part E1 (Fire safety of buildings). The classification procedure given in standard ISO 13501-1 is applied. For nuclear power plant containments, only coatings for floors are to be classified.

10.2 Test methods

For classification of the coating materials the following test are applied:

- ISO 9239-1 Reaction to fire test for floorings - Part 1: Determination of the burning behaviour using a radiant heat source.
- ISO 11925-2 Reaction to fire tests – Ignitability of building products subjected to direct impingement of flame – Part 2: Single-flame source test.

10.3 Test specimens

The number and size of test specimens is:

ISO 9239-1

- 230 ±5 mm × 1050 ±5 × 20 ±1 mm
- number of test specimens 6.

ISO 11925-2

- 90 ±2 mm × 250 ±2 mm × max 60 mm
- number of test specimens 6.

The general guidelines for the coating procedure stated in clause 3 are applied.

10.4 Assessment and reporting of results

The test results are reported according to the test method standards ISO 9239-1 and 11925-2. The content and form of the classification report is given in detail in standard EN 13501-1.

10.5 Acceptance criteria

The fire class for flooring materials shall be class Bfl-s1 according to EN 13501-1.

11. Summary of tests

Summary of the tests of coatings for nuclear power plant containments are given in Table 3.

Table 3. Tests and test specimens required for evaluating coating performance in nuclear power plant containments.

Test	Clause	Size (mm × mm × mm) and number of test specimens		Irradiation of specimens
		Concrete	Steel	
Radiation resistance	4	i.e. 100 × 50 × 25 2 pieces	100 × 50 × 5 2 pieces	All
Decontamination	5	—	(50 +10/-2) × (50 +10/-2) × (3...10) * 10 +10 pieces	10 pieces
Chemical durability	6	100 × 50 × 50	100 × 150 × 5	
• resistance to saponification	6.2 and 6.3	2 pieces	2 pieces	No
• resistance to demineralised water	6.2 and 6.4	2 pieces	2 pieces	No
• chemical resistance	6.2 and 6.5	2 pieces	2 pieces	No
Initial test for adhesion	7	i.e. 300 × 300 × 50 2 pieces	100 × 150 × 5 2 pieces	No
Abrasion resistance	8	—	100 × 100 × 5* 3 pieces	No
Durability at DBA conditions	9	i.e. 100 × 50 × 25 4 pieces	100 × 50 × 5 4 pieces	2 concrete specimens 2 steel specimens
Behaviour at fire	10	230 × 1025 × (20 6 pieces	—	No
• ISO 11925-2		90 × 250 × max 60 6 pieces	—	No

*Thickness may vary

References

- ASTM D3911-16 Test Method for Evaluating Coatings Used in Light-Water Nuclear Power Plants at Simulated Design Basis Accident (DBA) Conditions.
- ASTM D4082-10 Test Method for Effects of Radiation on Coatings Used in Nuclear Power Plants.
- ASTM D4258-05 (2012) Standard Practice for Surface Cleaning Concrete for Coating.
- ASTM D4259-88 (2012) Standard Practice for Abrading Concrete.
- ASTM D5139-12 Standard Specification for Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants.
- ISO 2812-2:2007 Paints and varnishes – Determination of resistance to liquids – Part 2: Water immersion method.
- ISO 4624:2016 Paints and varnishes – Pull-off test for adhesion.
- ISO 4628-1:2016 Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 1: General introduction and designation system.
- ISO 4628-2:2016 Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 2: Assessment of degree of blistering.
- ISO 4628-4:2016 Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 4: Assessment of degree of cracking.
- ISO 4628-5:2016 Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 5: Assessment of degree of flaking.
- ISO 4628-6:2011 Paints and varnishes – Evaluation of degradation of paint coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 6: Assessment of degree of chalking by tape method.
- ISO 4628-10:2016 Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 10: Assessment of degree of filiform corrosion.
- ISO 7784-2:2016 Paints and varnishes – Determination of resistance to abrasion – Part 2: Method with abrasive rubber wheels and rotating test specimen.
- ISO 8690:1988 Decontamination of radioactively contaminated surfaces – Method for testing and assessing the ease of decontamination.
- ISO 9239-1:2010 Reaction to fire tests for floorings – Part 1: Determination of the burning behaviour using a radiant heat source.
- ISO 11925-2:2010 Reaction to fire tests – Ignitability of products subjected to direct impingement of flame – Part 2: Single-flame source test.
- SFS-EN 13501-1+A1 Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests.

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