Coatings for protection of FRP structures with heavy rain erosion loads
FOREWORD

DNV GL class programmes contain procedural and technical requirements including acceptance criteria for obtaining and retaining certificates for objects and organisations related to classification.

© DNV GL AS May 2016

Any comments may be sent by e-mail to rules@dnvgl.com

This service document has been prepared based on available knowledge, technology and/or information at the time of issuance of this document. The use of this document by others than DNV GL is at the user’s sole risk. DNV GL does not accept any liability or responsibility for loss or damages resulting from any use of this document.
This is a new document.
CONTENTS

Changes – current........................................................................................................ 3

Section 1 General........................................................................................................ 5
  1 Introduction............................................................................................................ 5
  2 Documentation....................................................................................................... 6

Section 2 General requirements.................................................................................... 7
  1 Requirements to production and quality control arrangement...................... 7
  2 Description of type testing.................................................................................. 7
  3 Requirements to the coating system................................................................. 8
  4 Requirements to marking of product................................................................. 9

Changes – historic..................................................................................................... 10
SECTION 1 GENERAL

1 Introduction

1.1 Objective
The objective of this class programme (CP) is to describe the type approval (TA) scheme for coatings for protection of FRP structures with heavy rain erosion loads.

The general requirements for obtaining DNV GL type approval certificate is given in class programme DNVGL CP 0338 Type approval scheme.

The procedures and requirements described in this CP are applicable for obtaining TA certificate based on requirements given by the Society’s standards, including:

— DNV GL’s standard for rotor blades for wind turbines.

Guidance note:
This class programme is not applicable for obtaining EU marine equipment directive (MED) certificates. Visit www.dnvgl.com for information on MED certification.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.2 Scope
This CP gives a description of the procedures and requirements related to documentation and type testing applicable for TA of coatings for protection of FRP structures with heavy rain erosion loads. It shall be applied for coatings based on duromeric plastics. Other protection systems like adhesive foils or rubber based materials may be approved following this CP but only subject to agreement with the Society.

TA is based on compliance with requirements given in the DNV GL standards. The CP describes the applicable requirements and how to document compliance with the requirements in order to obtain a TA certificate for the coating system. This includes, where relevant, technical requirements for how the type tests shall be performed.

1.3 Application
DNV GL standard for rotor blades for wind turbines requires that surface finish materials (e.g. coating systems) provides good compatibility to the substrate and resistance against environmental conditions like UV radiation, rain erosion etc.

A TA certificate issued based on this CP will confirm compliance with the requirements in standards as specified in [1.1].

1.4 References
— ISO 4624: Paints and varnishes – Pull-off test for adhesion
— ISO 527-3: Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets
— ISO TS 19392-3: Paints and varnishes – Coating materials for wind-turbine rotor blades
— ISO 2813: Paints and varnishes – Determination of gloss value at 20 degrees, 60 degrees and 85 degrees
— ISO 16474-3: Paints and varnishes – Methods of exposure to laboratory light sources – Part 3: Fluorescent UV lamps
— ISO 4628-2: 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
1.5 Renewal

Provided an approval of manufacturer certificate (see DNVGL CP 0425 Manufacturer of Fibre Reinforcements) which is still valid for at least one year is available, an exemption from the obligation concerning retention and renewal surveys listed in the class programme DNVGL CP 0338 Type Approval scheme will typically apply.

2 Documentation

For TA of coatings for protection of FRP structures with heavy rain erosion loads the following additional documentation shall be submitted by the manufacturer at initial approval and updated at renewal of the approval:

1) type designation, i.e. product name with list of variants that are to be included in the type approval and stated on the type approval certificate
2) if relevant, DNV GL approval of manufacturer certificate (see DNVGL CP 0425 Manufacturer of laminating resins, adhesives and coatings) which is still valid for at least one year
3) product description (type of base resin, curing conditions etc.)
4) field of application and special limitations of the product (curing procedure, shelf life, compatibility /non-compatibility with other materials, etc.)
5) manufacturers recommended coating thickness which is the basis for type tests (if applicable)
6) product specification, data sheets for all variants (mechanical properties, material safety data sheet, etc.), including at least those properties for which requirements are given in Sec.2
7) nominal value for all properties
8) tolerances, as specified by the manufacturer
9) test reports with type test results for all variants including a summary
10) information regarding application procedures (manual and/or automated application, surface treatment etc.)
11) description of quality control arrangement *)
12) information regarding marking of the product or packaging *).

*) To be verified during the audit for Approval of manufacturer prior to the issuance of the type approval certificate.
SECTION 2 GENERAL REQUIREMENTS

1 Requirements to production and quality control arrangement

The manufacturer should have a quality system that meets ISO 9001 standards, or equivalent. If this quality standard is not fulfilled, the extent of testing and assessment will be considered separately.

Quality control arrangements, including requirements in Table 1, will be checked particularly with respect to the following:

— control on incoming material
— test equipment, test methods, test samples, and references to standards used
— system for identification
— production test reports from delivery testing.

The extent of the manufacturer’s quality control during production shall as a minimum be as listed in Table 1 to ensure even product quality.

Table 1 Manufacturer’s quality control for coatings in liquid condition. Specify tolerances for base resin and each variant

<table>
<thead>
<tr>
<th>Control on:</th>
<th>Test standard 1)</th>
<th>Acceptance criteria</th>
<th>Minimum level of verification</th>
<th>Frequency of control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>ISO 2884-1</td>
<td>msv</td>
<td>Production log available at assessment</td>
<td>Each batch</td>
</tr>
<tr>
<td>Density</td>
<td>ISO 2811-1</td>
<td>msv</td>
<td>Production log available at assessment</td>
<td>Each batch</td>
</tr>
<tr>
<td>Glass transition temperature</td>
<td>ISO 11357-2 or</td>
<td>msv</td>
<td>Initial and renewal of approval</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ISO 6721-4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Other methods/standards may be agreed upon with the responsible approval centre prior to testing.

The manufacturer shall carry out delivery testing of each consignment and measured values shall be filed and be made available to the Society’s surveyor.

2 Description of type testing

The objective of type tests is to verify the ability of the product to meet specified requirements by subjecting the test sample to physical, chemical, environmental or operational stresses. The extent of type testing covers the cured coating system properties in Table 2.

Type testing results from all variants shall be submitted to the Society’s responsible approval centre for evaluation. If there are several similar variants a less extensive test programme can be agreed upon with the Society’s responsible approval centre.

2.1 Definitions

\[ ms v = \text{manufacturer’s specified value} \]
\[ mn v = \text{manufacturer’s nominal value} \]
\[ ms m v = \text{manufacturer’s specified minimum value} \]
2.2 Assessment of type test results

The assessment determines the values to be stated on the type approval certificate (if applicable). Type tests shall be carried out and verified in one of the following ways:

— at an accredited and independent laboratory or accepted by the Society
— at the manufacturer’s premises in the presence of the Society’s surveyor, after consultation with the Society’s responsible approval centre. It is recommended to test at external testing laboratories due to the long duration of some tests.

The type test results shall be submitted to the Society’s responsible approval centre for evaluation, in form of a test report according to ISO 17025 and the additional requirements of the relevant test standard.

3 Requirements to the coating system

For preparation of test samples the coating system shall be applied to a glass fibre reinforced epoxy resin test panel, see Table 2. The test panel should be built up as a quasi-isotropic panel and the surface condition should be based on peel-ply. The coating system shall be applied with a thickness as specified by the manufacturer and following the curing procedures.

Table 2 Requirements for type testing

<table>
<thead>
<tr>
<th>Property</th>
<th>Test standard 1)</th>
<th>Test conditions</th>
<th>Number of specimen</th>
<th>Acceptance criteria</th>
<th>Unit</th>
<th>Minimum level of verification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Initial tests</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhesive strength</td>
<td>ISO 4624</td>
<td>23/50</td>
<td>6</td>
<td>≥5 for cohesion fracture 2)</td>
<td>MPa</td>
<td>Initial approval and renewal</td>
</tr>
<tr>
<td>Tensile test</td>
<td>ISO 527-3 (specimen type 2)</td>
<td>23/50 -40°C</td>
<td>6</td>
<td>Elongation at fracture ≥ 10</td>
<td>%</td>
<td>Initial approval and renewal</td>
</tr>
<tr>
<td>Rain erosion</td>
<td>ISO TS 19392-3 (method B with vertical rotating axis)</td>
<td>at least 10°C below Tg</td>
<td>6</td>
<td>≥ 8 5)</td>
<td>h</td>
<td>Initial approval and renewal</td>
</tr>
<tr>
<td>Gloss at 60°</td>
<td>ISO 2813</td>
<td>23/50</td>
<td>6</td>
<td>&lt; 30</td>
<td></td>
<td>Initial approval and renewal</td>
</tr>
<tr>
<td>Hardness</td>
<td>DIN EN 59</td>
<td>23/50</td>
<td>3</td>
<td>msv</td>
<td></td>
<td>Initial approval and renewal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Aging tests</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhesive strength</td>
<td>ISO 4624</td>
<td>exposure to UV light according to ISO 16474-3 Type 1A, method 1 for at least 3000 hours 4)</td>
<td>6</td>
<td>≥5 for cohesion fracture 2)</td>
<td>MPa</td>
<td>Initial approval</td>
</tr>
<tr>
<td>Tensile test</td>
<td>ISO 527-3 (specimen type 2)</td>
<td></td>
<td>6</td>
<td>Elongation at fracture ≥ 10</td>
<td>%</td>
<td>Initial approval</td>
</tr>
<tr>
<td>Rain erosion</td>
<td>ISO TS 19392-3 (method B – with vertical rotating axis)</td>
<td></td>
<td>6</td>
<td>≥ 4 5)</td>
<td>h</td>
<td>Initial approval</td>
</tr>
<tr>
<td>Gloss</td>
<td>ISO 2813</td>
<td></td>
<td>6</td>
<td>&lt; 30% loss</td>
<td>--</td>
<td>Initial approval</td>
</tr>
<tr>
<td>Blistering</td>
<td>ISO 4628-2</td>
<td></td>
<td>6</td>
<td>0(S0)</td>
<td>--</td>
<td>Initial approval</td>
</tr>
<tr>
<td>Property</td>
<td>Test standard 1)</td>
<td>Test conditions</td>
<td>Number of specimen</td>
<td>Acceptance criteria</td>
<td>Unit</td>
<td>Minimum level of verification</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>--------------------</td>
<td>---------------------</td>
<td>------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Chalking</td>
<td>ISO 4628-4</td>
<td></td>
<td>6</td>
<td>0(S0)</td>
<td></td>
<td>Initial approval</td>
</tr>
<tr>
<td>Colour</td>
<td>ISO 11664-4</td>
<td></td>
<td>6</td>
<td>ΔE*&lt;1</td>
<td></td>
<td>Initial approval</td>
</tr>
<tr>
<td>Hardness</td>
<td>DIN EN 59</td>
<td></td>
<td>3</td>
<td>Msv</td>
<td></td>
<td>Initial approval</td>
</tr>
<tr>
<td>Adhesive strength</td>
<td>ISO 4624</td>
<td>1000 hours at wet / cold / humidity 3, 4)</td>
<td>6</td>
<td>≥5 for cohesion fracture 2)</td>
<td>MPa</td>
<td>Initial approval</td>
</tr>
<tr>
<td>Blistering</td>
<td>ISO 4628-2</td>
<td></td>
<td>6</td>
<td>0(S0)</td>
<td></td>
<td>Initial approval</td>
</tr>
<tr>
<td>Adhesive strength</td>
<td>ISO 4624</td>
<td>1000 hours according to ISO 6270-2 (CH) 5)</td>
<td>6</td>
<td>≥5 for cohesion fracture 2)</td>
<td>MPa</td>
<td>Initial approval</td>
</tr>
<tr>
<td>Blistering</td>
<td>ISO 4628-2</td>
<td></td>
<td>6</td>
<td>0(S0)</td>
<td></td>
<td>Initial approval</td>
</tr>
</tbody>
</table>

1) Other methods/standards may be agreed with the Society prior to testing
2) in case of adhesive failure a minimum values of 8 MPa is acceptable upon agreement with the Society
3) conditioning cycle: 2h at 5°C >> down to -40°C in 2h >> 6h at -40°C >> up to 5°C in 2h >> 2h at 5°C >> up to 60°C / 98% in 2h
   >> 6h at 60°C / 98% >> down to 5°C in 2h
4) after aging reconditioning at 23/50 for 24h is required before mechanical tests will be carried out
5) the rain erosion test is finished when the laminate is visible
6) if the coating shall be applied to other substrates than glass fibre reinforced epoxy laminates the substrate used for testing shall be agreed with the Society prior to testing

### 4 Requirements to marking of product

The product or package shall be marked. The marking shall at least include the following information:

- manufacturer’s name and address or trade mark
- production plant
- product name
- production date.
- batch number.

The marking shall be carried out in such a way that it is visible, legible and indelible. The marking of product shall enable traceability to the TA certificate.
CHANGES – HISTORIC

There are currently no historical changes for this document.
Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.