CLASS PROGRAMME

Type approval

DNVGL-CP-0089 Edition March 2016

Epoxy resin systems
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.

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

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Changes - Current

This is a new document.
SECTION 1 GENERAL

1 Introduction

1.1 Objective

The objective of this class programme (CP) is to give a description for the type approval (TA) scheme for epoxy resin systems.

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

The procedures and requirements described in this CP are applicable for obtaining the Society’s TA certificate based on requirements in the Society’s rules and standards, e.g.:

— DNV GL rules, RU SHIP Pt.2 Ch.3
— DNVGL ST 0189, Lifeboats and Rescue Boats
— DNVGL ST 0342, Craft.

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.

1.2 Scope

This CP gives a description of the procedures and requirements related to documentation, design and type testing applicable for TA of epoxy resin systems.

This CP does not set the design requirements to the Epoxy resin systems. TA is based on compliance with design requirements given in the DNV GL rules and standards. The CP describes how to document compliance with the requirements in order to obtain a TA certificate for the equipment. This includes, where relevant, technical requirements for how the type tests shall be performed.

An epoxy resin system is in the context of this class programme defined as: “Cured, non-reinforced, 2-component material based on a specified epoxy resin (modified or non-modified A component) cross-linked by a specified curing agent (B component, based on amine, amide, etc.)”.

The above definition implies that the type approved system may represent an intermediate and not final product, e.g. the epoxy matrix material only in a fibre reinforced, laminate product (not the final laminate).

This class programme for epoxy resin systems includes optional requirements for fire retardant materials for use in lifeboats, see Sec.2 [4.3].

A DNV GL type approval certificate will be valid for one grade or quality of the actual product with the possibility to include variants.

For epoxy resin systems this means:

Grade: One base resin (A component) with one curing agent (B component).

Variants: Modifications within a grade as defined above with different viscosity, pot life, curing time, etc. All variants shall fulfil the requirement to the same grade.

The following properties will be printed in the certificate:

— fracture elongation
— tensile strength
— water absorption
— heat deflection or glass transition temperature
— curing procedure used for type testing.

Deviation from the requirements will be stated in the certificate.
A DNV GL type approval certificate is normally limited to one manufacturer at one production site, however, other arrangements may be agreed with the Society.

Type tests as specified in Sec.2 [3], shall be carried out and verified in one of the following ways:

— at a DNV GL laboratory
— at a recognized and independent laboratory or a laboratory accepted by DNV GL
— at the manufacturer's premises in the presence of a surveyor.

1.3 Application

DNV GL rules and standards, see [1.1], require that epoxy resin systems are DNV GL type approved in accordance with this CP.

A TA certificate in accordance with this CP will confirm compliance with the requirements in the DNV GL rules as specified in [1.1]. The TA certificate will not confirm compliance with requirements in other parts of the rules or standards. In case additional requirements in other parts of the rules shall be covered by the TA certificate, this shall be specified in the application for TA and will be stated in the TA certificate.

1.4 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 References

Other standards referred to in this document:

— ISO 9001:2008, Quality management systems - Requirements
— ISO 3001:1999, Plastics -- Epoxy compounds -- Determination of epoxy equivalent
— ISO 3219:1993, Plastics -- Polymers/resins in the liquid state or as emulsions or dispersions -- Determination of viscosity using a rotational viscometer with defined shear rate
— ISO 2555:1989, Plastics -- Resins in the liquid state or as emulsions or dispersions -- Determination of apparent viscosity by the Brookfield Test method
— ISO 1675:1985, Plastics -- Liquid resins -- Determination of density by the pyknometer method
— DIN 16945:1989, Testing of resins, hardeners and accelerators, and catalyzed resins
— ISO 5660-1:2015, Reaction-to-fire tests -- Heat release, smoke production and mass loss rate -- Part 1: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement)
— ISO 178:2010, Plastics -- Determination of flexural properties
— LSA Code, MSC/Circ.1006.

3 Documentation

For TA of epoxy resin systems the following additional documentation shall be submitted by the manufacturer at initial type approval, and updated at renewal (general requirements for documentation are given by DNVGL CP 0338). The documentation shall, to the extent possible, be submitted as electronic files. The manufacturer shall keep one (1) copy of type approval documentation in their own file. The documentation that forms the basis for the TA shall be easily available to the Society’s surveyor at the TA applicant’s premises. When documentation is submitted in paper format, normally two copies of the documentation shall be submitted to the Society. No documentation will be returned to the applicant for TA.

Please number documentation according to below list to facilitate review:

1) type designation, i.e. product name (grade) with list of variants to be included in and stated on the type approval certificate
2) Basis for approval. A reference to applicable rules and standards, see Sec.4 [1], which the product shall comply with.
3) product description: epoxy system; epoxy resin (A component) and curing agent (B component). The epoxy resin shall be described in accordance with a designation as per ISO 3673-1, or equivalent standard (e.g. ASTM D1763). The curing agent shall be described equally detailed.
4) field of application of the epoxy resin system (intended end use) and key properties of separate components A, respectively B (e.g. viscosity, shelf life, storing and conditions of use), as well as mixed liquid resin A + B (e.g. mixing equipment and conditions, curing agent, pot life, wetting properties, curing conditions and time, application procedure)
5) product specification, including data sheets (TDS and MSDS) for all variants
6) description of production processes, including standard operating procedures (SOP)\(^1\)
7) description of quality assurance system or copy of ISO 9001 certificate
8) quality plan for material intended to be installed on board ships\(^1\)
9) test results (from tests already carried out) with references to standards, methods etc.
10) information regarding marking of the product or packaging\(^1\)
11) any relevant certificates with their issue number and/or date (e.g. quality management system certificate)
12) list of test and measuring equipment, including calibration certificates\(^2\)
13) in-service experience, if available
14) witnessed type test results and the Society surveyor’s initial assessment report shall be submitted when completed.

\(^1\) Will be verified by initial assessment prior to issuance of type approval certificate
\(^2\) Will be verified by surveyor during type testing
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 type testing and assessments will be specially considered.

The quality control arrangement in production will be checked with respect to:

— control of incoming materials
— scope of quality control, i.e. proof that test methods, test quantity and test equipment complies to the applicable standard EN or ISO
— traceability and marking system
— production records
— storage condition and procedure.

The extent of the manufacturer's quality control during production shall as a minimum be according to Table 1.

Table 1 Manufacturer's quality control

<table>
<thead>
<tr>
<th>Test</th>
<th>Test standard</th>
<th>Acceptance Criteria</th>
<th>Minimum level of verification</th>
<th>Frequency of control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy equivalent</td>
<td>ISO 3001</td>
<td>msv (g/mol), see ISO 3673-1, Table 1</td>
<td>Production log available during assessment</td>
<td>DNV GL assessment</td>
</tr>
<tr>
<td>Viscosity</td>
<td>ISO 3219 or ISO 2555 (Brookfield)</td>
<td>msv (mPas) ± 20% and as above</td>
<td>Production log available during assessment</td>
<td>Each batch</td>
</tr>
<tr>
<td>Density</td>
<td>ISO 1675, ISO 1183 or manufacturer's standard</td>
<td>msv (g/cm³) and as above</td>
<td>Production log available during assessment</td>
<td>Each batch</td>
</tr>
<tr>
<td>Gel time</td>
<td>DIN 16945, Section 6.2, 6.3 DIN EN ISO 2535</td>
<td>msv</td>
<td>Production log available during assessment</td>
<td>Each batch</td>
</tr>
</tbody>
</table>

1) the table is relevant for both epoxy resin (A component) and curing agent (B component) in liquid condition, separately, for the basic epoxy resin system and each of any variants, see ISO 3673-1, Table 1

msv = manufacturer's specified value, verified to be within ±10% of mean of type test results

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

2 Description of type testing

The extent of type testing covers both the liquid resin (A component) and liquid curing agent (B component) properties in Table 1, and the cured epoxy system (A + B) properties in Table 2. The tests shall ensure that the product properties are as stated by the manufacturer.

Type testing results covering all variants shall be submitted to the Society for evaluation, including a summary of the type tests results. If there are several similar variants a less extensive test program can be agreed upon with the Society.
Other standardised test methods than those given for the respective materials may be used upon agreement. Liquid properties of resins will be checked for compliance with the product specification during the assessments by the Society.

3 Requirements to material

3.1 For epoxy resin system in liquid condition – final mix (A + B comp.)

The manufacturer's description of the product shall contain information about the intended end use and manufacturing methods: e.g. moulding, lamination, spraying, vacuum bagging, etc.

The wetting properties of the mixed liquid system (mixed A + B components) shall be documented for the actual areas of use, with relevant fibre reinforcements.

Pot life and curing time shall be documented at normal room temperature and/or at other specified curing condition.

3.2 Epoxy system in cured, solid, non-reinforced condition

For preparation of test samples the epoxy resin (A component, as delivered), curing agent (B component, as delivered), mixing ratio and full curing procedure shall be specified. The test samples for each variant shall be made of the cured, solid epoxy material. The curing time and temperature shall normally be:

a) 7 days at 23°C, normally considered to be full curing
b) curing procedures requiring higher temperature or longer time for full curing may be approved upon special consideration

The cured epoxy system in solid, moulded, sprayed, etc., but not reinforced condition shall be tested according to Table 2 at initial approval and at change of specification. The curing procedure will be stated in the type approval certificate.

Table 2 Testing of mechanical properties of the cured epoxy system

<table>
<thead>
<tr>
<th>Test</th>
<th>Test standard 1)</th>
<th>Number of parallels</th>
<th>Acceptance criteria/ data format</th>
<th>Minimum level of verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumetric curing shrinkage</td>
<td>ISO 3521</td>
<td>min. 3</td>
<td>msv %</td>
<td>DNV GL assessment</td>
</tr>
<tr>
<td>Ultimate tensile strength 2)</td>
<td>ISO 527-1</td>
<td>min. 5</td>
<td>msmv min. 55 MPa</td>
<td>DNV GL assessment</td>
</tr>
<tr>
<td>Tensile modulus</td>
<td>ISO 527-1,2</td>
<td>min. 5</td>
<td>msv min. 2 700 MPa</td>
<td>DNV GL assessment</td>
</tr>
<tr>
<td>Fracture elongation</td>
<td>ISO 527-1,2</td>
<td>min. 5</td>
<td>msmv min. 2.5 %</td>
<td>DNV GL assessment</td>
</tr>
<tr>
<td>Ultimate flexural strength</td>
<td>ISO 178</td>
<td>min. 5</td>
<td>msmv min. 100 MPa</td>
<td>-</td>
</tr>
<tr>
<td>Flexural modulus</td>
<td>ISO 178</td>
<td>min. 5</td>
<td>msv min. 2 700 MPa</td>
<td>-</td>
</tr>
<tr>
<td>Heat deflection temperature HDT 3)</td>
<td>ISO 75-1,2 or ASTM D648</td>
<td>min. 5</td>
<td>msmv min. 65 °C</td>
<td>DNV GL assessment</td>
</tr>
</tbody>
</table>
Epoxy resin systems

3.3 Fire retardant epoxy system for use in lifeboats (optional)

The finally mixed and fully cured resin (A + B components) including all fillers shall comply with the requirements for liquid resin in Table 1, or be on an equivalent level. Cured epoxy materials shall comply with Table 2 and the requirements to combustibility in Table 3.

Fire retardant and flame resistant materials used for the construction of lifeboats shall comply with the requirements in Table 3.

Table 3 Testing of fire retardant epoxy system (solid material)

<table>
<thead>
<tr>
<th>Test</th>
<th>Test method</th>
<th>Requirements</th>
<th>Minimum level of verification</th>
<th>Frequency of verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustibility</td>
<td>ASTM D2863 or equivalent standard</td>
<td>Oxygen index min. 23</td>
<td>DNV GL assessment</td>
<td>Initial assessment, Change of specification</td>
</tr>
<tr>
<td>Fire retardant test *)</td>
<td>ISO 5660-1, Cone calorimeter method Also see LSA Code, MSC/Circ.1006</td>
<td>Average ignition time &gt; 40 s</td>
<td>DNV GL assessment</td>
<td>Initial assessment, Change of specification</td>
</tr>
<tr>
<td></td>
<td>LSA Code, MSC/Circ.1006</td>
<td>Area of flame impingement should not support combustion more than 30 s after being removed from the burner</td>
<td>DNV GL assessment</td>
<td>Initial assessment, Change of specification</td>
</tr>
</tbody>
</table>

*) Laminates to be prepared as per LSA Code, MSC/Circ.1006

4 Coating for UV light protection

A coating on e.g. acrylic or polyurethane basis may be needed on top of epoxy laminate structures such as boat hulls in order to protect the epoxy structure against UV light. The coating shall be able to withstand long term exposure to weathering without any visible signs of crazing, wash-out of matter or significant
colour change. In case of fire retardant applications of the epoxy resin system, e.g. in life boats, the coating material shall be documented to be fire resistant as per Table 3.

5 Requirements to packaging and 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 (grade)
— storage instruction
— production date/batch number
— quality guarantee period, if any.

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 type approval certificate.
CHANGES – HISTORIC

There are currently no historical changes for this document.
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