



CERTIFICATION NOTES

No. 2.9

Type Approval Programme 8-899.10.1

COMPUTER BASED DIESEL ENGINE PERFORMANCE ANALYSERS AND PERFORMANCE MONITORING SYSTEMS

OCTOBER 2000

DET NORSKE VERITAS

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FOREWORD

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DET NORSKE VERITAS AS is a fully owned subsidiary Society of the Foundation. It undertakes classification and certification of ships, mobile offshore units, fixed offshore structures, facilities and systems for shipping and other industries. The Society also carries out research and development associated with these functions.

DET NORSKE VERITAS operates a worldwide network of survey stations and is authorised by more than 120 national administrations to carry out surveys and, in most cases, issue certificates on their behalf.

Standards for Certification

Standards for Certification (previously Certification Notes) are publications that contain principles, acceptance criteria and practical information related to the Society's consideration of objects, personnel, organisations, services and operations. Standards for Certification also apply as the basis for the issue of certificates and/or declarations that may not necessarily be related to classification.

A list of Standards for Certification is found in the latest edition of the Introduction booklets to the "Rules for Classification of Ships", the "Rules for Classification of Mobile Offshore Units" and the "Rules for Classification of High Speed and Light Craft". In "Rules for Classification of Fixed Offshore Installations", only those Standards for Certification that are relevant for this type of structure, have been listed.

The list of Standards for Certification is also included in the current "Classification Services – Publications" issued by the Society, which is available on request. All publications may be ordered from the Society's Web site <http://exchange.dnv.com>.

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1. Scope

Type Approval is a procedure for assessment of a product against a set of predetermined requirements.

The requirements are based on the Rules for Classification of Ships, Mobile Offshore Units and High Speed, Light Craft and Naval Surface Craft.

The procedure for assessment of conformity of manufactured products (production) is not part of the scope for the type approval programme.

This type approval programme gives the requirements on which the Society bases its type approval of engine performance analysis equipment (sensor and signal conditioner, and data acquisition unit with software).

Note

Type approval of parts of the equipment is possible, e.g. a sensor.

1.1 Definitions/abbreviations

TDC	Top dead centre
MIP	Mean Indicated Pressure
P_{comp}	Compression pressure
P_{max}	Maximum pressure
α_{Pmax}	Cylinder crank angle at maximum pressure

2. Conformity Assessment of Design of Product Type

2.1 Procedure

Type approval procedure consists of the following elements:

- design assessment
- type testing
- certificate retention survey.

2.2 Documents to be submitted

The following documentation is to be submitted in triplicate:

1. Drawings showing the inter-relationship between all parts of the equipment (including power supplies), and interfaces to other systems.
2. Drawings, schematics and functional description as necessary to describe the various parts of the equipment.
3. Equipment data sheet or specification for sensor, data acquisition, and analysis equipment.
4. Explanation of calculation of: derived parameters, extrapolation curves, trend curves, crank twist (if implemented in system), TDC (Top Dead Centre) location method, etc.
5. Operating limits to be clearly defined, if any.
6. Maintenance and or condition requirements applying to engine indicator cock, if any.
7. Information on equipment self-check/failure detection facilities and testing/calibration requirements.

8. Software/firmware description, including list of all main software modules installed with name, version number and module identification.
9. Software system installation requirements. (Operating system, memory, disk space etc.).
10. Working copy of the software system (single copy only) with installation instructions and sample database.
11. Type testing programme:
 - Environmental test program and results.
 - Performance test program and results.
12. Installation, operation and maintenance manuals.
13. Software quality assurance plan.
14. Product marking.
15. Specification of qualification and training requirements for users.

2.3 Design or functional requirements

The equipment or system shall comply with relevant requirements of the following:

Instrumentation and automation requirements

The rules on instrumentation and automation in Pt.4 Ch.5.

Note

Computer equipment used for data handling (data storage, data reduction, presentation of results etc) does generally not need to be type approved. If, however, the computer feeds results back to the ship/engine room automation system, type approval is required.

Environmental requirements

Standard for Certification No. 2.4 - Environmental test specification for instrumentation and automation equipment.

The equipment is to comply with the environmental requirements of Pt.4 Ch.5 of the rules. Equipment installed or utilised in special locations, e.g. on or inside engine room equipment is to withstand the entire range of expected environmental exposure. Equipment ruggedness (in particular cabling and connectors) is to be given particular attention.

Condition monitoring requirements

- The measurement equipment is to have a dynamic response sufficiently fast to accurately measure the true maximum cylinder pressure. This implies that systems based on mechanical measurement principles will not be type approved.
- Pressure sensor linearity is to be equal to or better than 1.0%.
- The system shall utilise a physical reference point as a basis for determining TDC. The reference is to be dedicated specifically to that purpose.
- The pressure sampling frequency is to be equal to or better than:
 - 360 samples/rev for medium and high speed 4-stroke engines
 - 720 samples/rev for slow speed 2-stroke engines.
- Pressure resolution shall be equal to or better than 0.2 bar.

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- The analysis system is as a minimum to have facilities so as to provide the following performance related parameters: P_{comp} , P_{max} , a_{pmax} , P_{scav} , MIP/cylinder power, engine speed.
- Performance diagrams are to be available on the system, as a minimum pressure vs. crank angle, and pressure vs. cylinder volume. For 4-stroke engines both power cycle and air cycle is to be shown, I.e., averaging, summation, or similar combination of power and air cycles is not accepted.
- The system is to be designed so as to allow analysis and presentation of data for both in-line engines and V-engines.
- The operator shall have password protected system privileges allowing set up and configuration of both new and existing engines.
- The system is to include a database for storage of historical data.
- The system is to allow comprehensive on-screen presentation of all collected data, both current and historic. Both graphic and tabular forms should be available. The system/software should be capable of presenting all cylinders at the same time in the diagrams.
- Facilities to allow easy comparison between measurements should be available.

Systems with permanently installed pressure sensors

Systems utilising permanently installed pressure sensors are to demonstrate a minimum of one year trouble free operation prior to being granted final type approval. The equipment is to be operated under realistic conditions, precise details are to be agreed with the Society.

Calibration requirements

The manufacturer is to specify calibration requirements, both for the pressure sensor itself and the system signal conditioning electronics.

Note

Calibration intervals for sensors based on piezo-electric crystals should not exceed 5 years, intervals for sensors based on strain gauges should not exceed 2 years.
Calibration intervals for signal conditioning electronics should normally not exceed 2 years.

2.4 Requirements to identification of type of product with certificate

The manufacturer is to specify type, type number, model, etc., which completely identifies the product and its components according to drawings/equipment specification. All optional features for which type approval is requested are to be listed, either by separate type numbers or by suffixes to the equipment's basic type number.

All drawings and descriptions are to be marked with drawing reference number, item name, issue date, etc., which identify the documentation as such.

The final product shall be provided with visible marking, giving at least the following information:

- identification of manufacturer
- equipment type number or model identification
- serial number
- production year
- power consumption/supply voltage
- software version identification (if applicable).

2.5 Elements of type approval

2.5.1 Design assessment

Design assessment is to assess that the design of the product conforms with the rules and standards as described in item 2.3 above.

2.5.2 Type testing (TT)

When design assessment has been carried out, type testing according to an approved test programme is to be carried out in the presence of a surveyor from the Society.

Detailed test reports based on a relevant test programme and carried out in the presence of an independent surveyor from a recognised authority may be accepted.

The type testing includes visual inspection, performance type testing and environmental type testing

2.5.2.1 Performance type testing

Tests are to be carried out to verify that the performance of the test unit conforms with the requirements of the Rules for Classification of Ships.

2.5.2.2 Environmental type testing.

Tests are to be carried out to verify that the test unit conforms with the requirements of the Rules for Classification of Ships and Standard of Certification 2.4. Prior to testing the laboratory shall be verified and accepted by the Society. Guidance for the form of the test report is EN45001.

2.5.3 Routine tests (RT)

The routine tests, including commissioning tests on board, constitute the final production control and the manufacturers standard RT are to be described in the submitted documentation. These tests are normally carried out by the manufacturer or his representative unless otherwise is stated on the type approval certificate.

2.6 Type approval certificate

When the design assessment and type testing are successfully completed a type approval certificate will be issued to the manufacturer for the conformity of the design of the product type.

2.6.1 Certification retention survey

Certificate retention survey is required in front of renewal of type approval certificate. The objective is to verify that the product has not been altered with respect to design and functions covered by the type approval.

Upon receipt of the request for renewal, the Society will perform a certificate retention survey as stated above.

The certificate retention survey report will constitute the basis for renewal of the type approval and the issuance of a new certificate.

2.6.2 Renewal of type approval certificate

At least three months before the period of validity expires, the certificate-holder has to apply for renewal of the certificate.

3. Appendix, tables of type tests for engine performance analysis equipment

Recommended test procedures are specified in the following publications:

- Rules for Classification of Ships, Pt.7 Ch.8 Sec.4, on condition monitoring

- Standard for Certification No. 2.4, Environmental test specification for instrumentation and automation equipment.

Tests are to be carried out at test sites accepted by the Society. The manufacturer shall, unless otherwise agreed, set up the equipment and ensure that it is operating normally before type testing commences.

E. Environmental tests

No	TEST	Specification of test	TT	RT
E.1	Dry heat test	CN 2.4 - 3.7 (not required if 3.8 is performed) For engine mounted combustion pressure transducers: IEC 60068-2-2 test Ba severity +200°C	x	
E.2	Low temperature test (Cold test)	CN 2.4 - 3.9	x	
E.3	Damp heat test	CN 2.4 - 3.8	x	
E.4	Vibration test	CN 2.4 - 3.6 For engine mounted combustion pressure transducers: IEC 60068-2-6 severity to be discussed	x	
E.5	Acoustic noise test (may be waived if it is evident that the EUT satisfy the test)	IEC 60945 - 11.1(peak level is not to exceed 62dB(A))	x	
E.6	Power supply variation test	CN 2.4 - 3.4, 3.5, 3.13, 3.14.2/3 (IEC 60092-504)	x	
E.7	Electrostatic discharge test	CN 2.4 -3.14.6	x	
E.8	Enclosure (minimum IP22)	IEC 60529	x	
E.9	Insulation resistance test	CN 2.4 – 3.12	x	
E.10	High voltage test	CN 2.4 – 3.12	x	
E.11	Radiated susceptibility	CN 2.4 – 3.14.5	x	
E.12	Conducted susceptibility	CN 2.4 – 3.14.4	x	
E.13	Compass safe distance	IEC 60945, 11.2	x	
E.14	Conducted emissions	IEC 60945, 9.2	x	
E.15	Radiated emissions	CISPR 16-1, CISPR 16-2	x	

<i>P. Performance tests</i>				
<i>No</i>	<i>TEST</i>	<i>Specification of test</i>	<i>TT</i>	<i>Comments</i>
P.1	Preparation and verification of calibration and adjustment. Test of field calibration kit	Hardware set-up and configuration to be demonstrated for two-stroke and four-stroke engines. Demonstration of equipment calibration.	x	
P.2	Data acquisition and processing – normal test.	The system is to demonstrate the capability of acquiring and processing measurement data in accordance with requirements for accuracy and resolution. This shall be carried out for both two-stroke and four-stroke configurations.	x	As a general rule this test shall be carried out on engines of relevant generic type. Simulated input data is normally not accepted.
P.3	Data acquisition and processing – stress test	The system is to demonstrate the capability of acquiring and processing measurement data at the defined max. limits of engine speed, with the specified max. number of input signals. This shall be carried out for both two-stroke and four-stroke configurations.	x	The test may be carried out using simulated data sources when necessary, however, as realistic signals as possible are to be utilised
P.4	Software functionality testing	Software installation, set-up and configuration testing. Software security test (i.e. password functionality) Data transfer from acquisition equipment to computer system. Validation of accuracy of calculated parameters. Verification of MMI behaviour. Verification of data and curve presentation for new and old data sets.	x	Should be performed together with test P.2 If necessary, P.4 tests may be performed on simulated data sets.