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**MMCMP
APPENDIX A**

Issue 1 rev E

**SPECIFIC REQUIREMENTS FOR THE
QUALIFICATION AND ASSESSMENT OF MARINE MACHINERY
CONDITION MONITORING PERSONNEL**

CONTENTS

1. Introduction..... 2
2. Classification of Personnel..... 2
3. Qualifications..... 2
3.1 Marine Machinery CM personnel (general) - Category 1..... 2
3.2 Marine Machinery CM personnel (advanced) - Category 2..... 3
3.3 Marine Machinery CM personnel (Specialist) - Category 3..... 3
4. Eligibility for Qualification 4
5. Certification Available..... 4
6. Assessment..... 5
Annex A- Training modules (normative)..... 6
Annex B – Reading References (informative)..... 9
Annex C Learning outcomes..... 10
Annex D Bibliography..... 13

1. Introduction

The marine industry has high standards of engineering competence, but personnel may lack adequate training in, and/or understanding of condition monitoring (CM) techniques and the diagnostics of the accumulated data. This PSS qualification specified by the Marine Machinery Condition Monitoring Personnel (MMCMP) series of documents, provides a three-category classification of competence for the general, advanced and specialist Categories, respectively, that are based on the technical areas delineated herein. If the qualification is to be awarded by an independent third party certification body, then that body shall conform to ISO/IEC 17024 and demonstrate its compliance. Conformity assessment may be awarded by certification from a 3rd party certifying body conforming to ISO/IEC 17024, or awarded by declaration by a 2nd party assessing body conforming to ISO/IEC 17050, providing the condition monitoring technical components of this qualification conform to the relevant technical parts of ISO18436 or other standard specified in clause 4 (for Category 1 only). All normative references specified in this Appendix are defined in the general requirements document to this PSS.

2 Classification of Personnel

2.1 General

Individuals classified in accordance with this specification are qualified to one of three Categories and have demonstrated competence in the concepts of marine machine condition monitoring (CM) and diagnostics for their Category, by way of provision of prerequisite certificates or declarations for each competency listed below for the relevant Category.

- 2.1.1 The competencies (skill sets) required for each Category shall comprise of condition monitoring methods and analysis of multiple methods, marine technology, marine terminology and health and safety in a marine environment at the appropriate Category
- 2.1.2 Classification to this qualification is to be issued by an assessing body or certifying body compliant to clause 1.
- 2.1.3 If personnel possess qualifications in most competencies listed below, but not in skill sets acquired through classroom training, then appropriate training module defined in Annex A shall be provided by an appropriately qualified training body. The training body shall award the appropriate declaration and proof of any prior qualification relevant to each module that must be submitted to the assessing body.
- 2.1.4 Personnel classified as Category 2 require all the knowledge and skills expected of personnel classified as Category 1, and personnel classified as Category 3 require all the knowledge and skills expected of personnel classified as Category 2.

3. Qualifications

3.1 Marine Machinery CM personnel (general) - Category 1

Marine Machinery CM personnel classified at Category 1 shall demonstrate the following competencies:

- 3.1.1 STCW-95 EOWW certificate or meets its prerequisites, or equivalent [*this will be determined by a suitably qualified marine body who advises the certifying or assessing body*] which inherently includes marine experience;
- 3.1.2 Documented 35 hours minimum of ship board engineering experience;
- 3.1.3 Marine technology and terminology- declaration from trainer conferring knowledge of significant features of ship structure and machinery;

- 3.1.4 At least two CM Category 1 ISO18436 compliant qualifications in VA, AE, LM or IRT, with an understanding of the remaining two methods. At Category 1, qualification in any of these methods in accordance with EN473, ISO9712, ISO/TR 25107, SNT-TC-1A or IAEA-628 will be accepted as equivalent to an award that conforms with ISO 18436 Category 1;
- 3.1.5 Fuel analysis and sampling- introductory qualification, or documented experience, validated by an appropriate senior, as a person competent to evaluate basic marine fuel analysis;
- 3.1.6 Basic health and safety in a marine environment qualification (eg: PSSR (personal safety and social responsibility on board ships course certificate or equivalent))

3.2 Marine Machinery CM personnel (advanced) - Category 2

Marine Machinery CM personnel classified at Category 2 shall satisfy all competency requirements for Category 1 and also demonstrate the following additional competencies:

- 3.2.1 STCW-95 [class II or equivalent] certificate or meets its prerequisites, or equivalent [*this will be determined by a suitably qualified marine body who advises the certifying body*] which inherently includes marine experience;
- 3.2.2 At least one CM Category 2 ISO18436 compliant qualification in VA, AE, LM or IRT, with a Category 1 qualification in any of the remaining methods. Qualification in these methods at Category 2 must conform to ISO18436, which is a CM specific standard that is also sector-specific that includes additional subjects such as CM procedures, CM management and CM standards etc, that are not included in other 2nd party NDT qualification programmes;
- 3.2.3 Relevant CM and associated marine standards and codes of practice and interpretation- Category 2 or equivalent qualification required;

Category 2 personnel will be competent to supervise or mentor Category 1 personnel=

3.3 Marine Machinery CM personnel (Specialist) - Category 3

Marine Machinery CM personnel classified at Category 3 shall satisfy all competency requirements for Categories 1 and 2 and demonstrate the following additional competencies:

- 3.3.1 STCW-95 [class I or equivalent] certificate or meets its prerequisites, or equivalent [*this will be determined by a suitably qualified marine body who advises the certifying body*] which inherently includes marine experience;
- 3.3.2 Satisfy all Category 2 requirements;
- 3.3.3 At least one CM Category 3 ISO 18436 compliant qualification in one of the following methods, VA, AE, LM or IRT, with at least one Category 2 qualification in one of the remaining ISO 18436 defined CM methods;
- 3.3.4 Multi-disciplinary analysis (interpretation, diagnosis and prognosis of results from multi-disciplinary inputs such as CM methods and marine maintenance management data) Category 3 or equivalent qualification;
- 3.3.5 Management practices (OEE analysis, whole life cycle costing protocols etc-see Annex A) qualification;
- 3.3.6 Codes, standards, procedures and best practices qualification;

3.3.7 Quality Management systems-fundamentals (ISO9001) introductory qualification;

3.3.8 Introduction to classification of ships Basic Surveyor Training or equivalent qualification.

Category 3 qualified personnel shall be competent to supervise or mentor Category 1 and Category 2 personnel and provide training for Category 3 candidates.

4. Eligibility for Qualification

4.1 General

The eligibility for qualification to this specification is defined in the general requirements document.

4.2 Education

It is recommended that Category 1 and 2 candidates have at least a secondary school science or technical qualification, or its equivalent. Personnel must be able to manipulate simple algebraic equations, use a basic scientific calculator (including trigonometric and logarithmic functions), and be familiar with the operation of personal computers to meet the basic requirements of education prior to qualifying in the CM methods specified.

4.2.1 Category 3

Category 3 candidates shall have, as a minimum, an appropriate 2-year engineering diploma with 4 years engineering industrial experience.

4.3 Training

4.3.1 If a person cannot provide all the prerequisite qualifications of competency specified for the relevant Category, then additional training and associated award of qualification is required to complete the missing competency. This training is dependent on the topic(s) that is (are) missing. Annex A defines the relevant training modules within this specification.

4.3.2 Assessment of the training modules may take the form of formal examination or assessment of 'learning outcomes' or 'knowledge statements', as indicated in Annex A.

4.3.3 Distance learning may constitute part of an integrated training programme but must comply with requirements of any technical specification document pertaining to the qualification in question (e.g.: ISO18436 allows 25% of training time to be from distance learning).

The training modules are defined in Annex A.

4.4 Mature Candidate Entry

4.4.1 Candidates at Category 2 only may apply for mature candidate entry (refer MMCMP-GEN) to any of the CM methods examinations without having to undergo any Category 2 training module, providing they can submit documentary evidence of experience in the CM method of interest for 5 years or more, without significant interruption, to the assessing body.

5. Certification Available

5.1 Category 1 (General- Marine Machinery condition monitoring)

5.2 Category 2 (Advanced- Marine Machinery condition monitoring)

5.3 Category 3 (Specialist-Marine Machinery condition monitoring)

6. Assessment

6.1 General

The assessment process undertaken by the assessing body or certifying body, shall use an elected 'assessment panel' of examiners, comprised of a minimum of 3 marine experts at Category 3 or equivalent (as determined by the assessing body). The application from each candidate, on PSL57-CM/marine, together with the submissions compliant to clause 3, meeting the requirements of clause 2.1.1 and clause 4.3, or clause 4.4.1 for mature candidates, shall be reviewed by the Marine Certification Manager (MCM) in accordance with clause 2.1.1. The approved portfolio is provided to the appointed assessment panel for technical and peer review and final recommendation submitted to the MCM within 21 working days. The assessing body shall issuing certificates of conformity to this standard in accordance with clause 2.1.2.

6.2 The management process from application to certification is facilitated with the appropriate PSL documents designated CM/Marine.

Annex A- Training modules (normative)

SUBJECT	Category 1 Hours	Category 2 Hours	Category 3 Hours	Learning outcomes [knowledge statements]
1. Marine Engineering and applications, ship construction and terminology	24			Annex C1
1.1 Awareness of basic ship types-3 hrs <ul style="list-style-type: none"> • Tanker • Container • Roll-on Roll-off • Passenger • Yacht • LNG/LPG • Bulk carriers • General cargo 	*			Annex C1.1
1.2 Awareness of main and auxiliary propulsion, auxiliary machinery-3hrs <ul style="list-style-type: none"> • Windlass • capstans • steering gear • Refrigeration (compressors, pumps etc) • Thrusters & stabilisers • Main and generator engines • Deck side machinery • Electrical power generation 	*			Annex C1.2
1.3 Awareness of deck and cargo handling <ul style="list-style-type: none"> • Cargo pumps • Controlled-atmosphere • Inert gas systems 	*			Annex C1.3
1.4 Awareness of hotel services <ul style="list-style-type: none"> • Heating • Ventilation • Air-con 	*			Annex C1.4

1.5 basic ship stability	*			Annex C1.5
1.6 Awareness of CMMS	*			Annex C1.6
1.7 Processes used in solving engineering problems- case studies	*			Annex C1.7
1.8 Unique working conditions on board ships	*			Annex C1.8
2. Awareness of Oil, Water (ballast, oily water, potable, oil feed, cooling, etc) and fuel Analysis and sampling	8			Annex C2
2.1 Sampling	*			Annex C2.1
2.2 Testing	*			Annex C2.2
2.3 Analysis [diagnostics]	*			Annex C2.3
2.4 Terminology	*			Annex C2.4
2.5 Corrective action	*			Annex C2.5
3. Monitoring Methods	8	8	8	Annex C3
3.1 method (VA, AE, LM, IRT)	*	*refer CMGEN times	*refer CMGEN times	Refer CMGEN outcomes
3.2 Performance monitoring (flow, pressure, temp, motor current analysis etc)	*	*	*	Annex C3.2
3.3 Awareness of Environmental issues and monitoring		*	*	Annex C3.3
3.4 Unique aspects of Marine Machinery <ul style="list-style-type: none"> Communications available between ship and shore 	*(awareness)	*(awareness)		Annex C3.4
4. Basic Health and Safety in marine environment	4			Annex C4
4.1 H&S on ships	*			Annex C4.1
5. Multi-Disciplinary Analysis		8	24	Annex C5
5.1 CM diagnostics		*	*	Annex C5.1
5.2 Fault diagnosis on engineering plant and equipment		*	*	Annex C5.2
5.3 CM prognostics			*	Annex C5.3
5.4 Maintenance data analysis		*	*	Annex C5.4
5.5 Machinery performance [history] and OEM baseline data		*	*	Annex C5.5
5.6 Relationship and inter-dependence of variables and testing techniques		*	*	Annex C5.6
6. Codes and Standards		2		Annex C6
6.1 Introduction		*		Annex C6.1
6.2 An understanding of available codes and standards; their		*		Annex C6.2

application and interpretation				
7. Management Practices			10	Annex C7
7.1 Reliability Centred Maintenance			*	Annex C7.1
7.2 Condition Based Maintenance			*	Annex C7.2
7.3 Preventative maintenance			*	Annex C7.3
7.4 Failure-based maintenance			*	Annex C7.4
7.5 Integrated Asset Management			*	Annex C7.5
8. Quality Management Systems-introduction			8	Annex C8
8.1 ISO9000			*	Annex C8.1
8.2 ISM code (International Safety Management)			*	Annex C8.2
8.3 SOLAS (Safety of Life at Sea) and MARPOL (Marine Pollutions Regulation)			*	Annex C8.3
9. Introduction to Classification of ships			2	Annex C9
9.1 Role of a Classification Society			*	Annex C9.1
9.2 Role of the surveyor			*	Annex C9.2
9.3 Continuous Survey of Machinery Items			*	Annex C9.3
9.4 Alternative routes to Classification			*	Annex C9.4
Total hours	44	18	52	

** at Category 1 only, qualification in AE, IRT and VA may also be acquired through compliance with either of the following standards EN473, SNT-TC-1A, AEA-628 or ISO9712.

Annex B – Reading References (informative)

Table B1 Textbooks and specifications

Title	Author	Publisher	ISBN (if applicable)
MNTB National Occupational Standards	MNTB	MNTB	
STCW-95 syllabus; STCW Reg III/2 Chief Engineer topics 1,2,3,4	MCA	www.mcga.gov.uk	
MNTB Basic Safety Training	MNTB	MNTB	
Forensic Engineering	B. S. Neale	Inst of Civil Engineers	0727727877
Merchant ship Naval Architecture	D A Taylor, A ST Tang	IMAREST	1902536568

Table B2 Codes and Standards

Note: The current version of each standard will be used

ISO/CD 20283-2: Mechanical vibration- Measurement of vibration on ships: Part 2: Measurement of structural vibration on ships
ISO 20283-3: Mechanical vibration- Measurement of vibration on ships: Part 3 Pre-installation vibratory noise measurement of shipboard equipment
ISO/CD 20283-4: Mechanical vibration- Measurement of vibration on ships: Part 4: Guidelines for the measurement and evaluation of ship propulsion machinery vibration
BS ISO 6954. Mechanical vibration. Guidelines for the measurement, reporting and evaluation of vibration with regard to habitability on passenger and merchant ships. [being re-written as part 5 of ISO 20283]
BS IEC 60092-101. Electrical installation on ships. Definitions and general requirements.
BS IEC 60092-301. Electrical installation on ships. Equipment. Generators and motors
BS IEC 60092-302. Electrical installation on ships. Equipment. Low voltage switchgear and control gear assemblies
BS IEC 60092-303. Electrical installation on ships. Equipment. Transformers for power and lighting
BS IEC 60092-305. Electrical installation on ships. Equipment. Storage batteries
BS IEC 60092-502. Tankers. Special features.
ISO 17359. Condition monitoring and diagnostics of machines- general guidelines
ISO 18436. Condition monitoring and diagnostics of machines. Requirements for qualification and assessment of personnel. Parts 2, 4, 5, 6 and 7 for vibration analysis, field lubricant analyst, laboratory lubricant analyst, acoustic emission and thermography, respectively.

Annex C Learning outcomes

Annex C1

Scope of the Unit:

Annex C1.1- Annex C1.5

Know and Understand:

- The layout of different ship types and the basic ship constructions (methods and materials) in ships at sea, of different weight categories and speed categories
- Basic principles and demands for buoyancy ballast/trim, floatation and stability of ships
- The implications of the need to maintain hotel services as a primary business activity for passenger vessels

Annex C1.6

- The types of manning arrangements that may be available as part of any scheduling activity

Annex C1.7- C1.8

- The tools and processes involved in the pursuance of actioning and reporting of engineering work to agreed housekeeping standards and with knowledge of required Category of training and individual responsibilities

Annex C2

Oil, Water (Ballast, oily water, potable, oil feed, cooling etc) and fuel Analysis and Sampling

Scope of the unit:

Know and Understand:

Annex C2.1

- The ideal frequency of sampling a given machine, asset or fluid (engine, compressor, fuel etc.), based on its criticality to the operation.
- The frequency of inspection of stored fluids
- Appropriate sampling methods for different types of equipment with minimum risk to safe working and disruption to operation.
- The appropriate information that should accompany each sample on labelling and additional submitted documents
- Correct process by which samples are submitted to the nominated laboratory.

Annex C2.2

- Which test methods are appropriate to monitor the particular type of machinery, asset or fluid
- How each test is performed in the laboratory
- Which tests are available & can be performed on-site or installed on the machinery or best performed in an off-site laboratory.

Annex C2.3

- The results of testing, their meaning and implications.
- How to interpret any trend data that may be generated
- How to set guidelines/limits/alarms for single or multiple test parameters

Annex C2.4

- The technical terms and abbreviations used within the test methods and procedures.

Annex C2.5

- What corrective action(s) to take based upon the results of analysis
- Which complimentary technique(s) (e.g. VA, TA, and AE) could be adopted to confirm the diagnosis?

Annex C3

Note: Annex C3.1 is a certificated competency under ISO18436 or equivalent standard, as specified in clause 4.

Scope of the Unit:

Know and Understand:

Annex C3.2

- The various methods of obtaining performance data from machinery, including, but not limited to, flow, pressure, temperature etc, for the purposes of assessing machinery condition

Annex C.3.3

- The basic principles and concerns of un-planned/ un-controlled outflow of material (exhaust, oily-water separator, ballast water, cooling, oil feed, potable water) from a monitoring perspective

Annex C3.4

- The different requirements specifically in regard to the condition monitoring of marine machinery. Eg: remote location, acquisition spares, skills available on board, training patterns, planned machinery intervention, etc
- Relationship between shore based monitoring stations or laboratories and shipboard staff in regard to transmission of CM data using broadband and satellite connection services

Annex C4

Scope of the Unit:

Know and Understand:

Annex C4.1

- The basic principles of health and safety, as defined in the MNTB Safety Training manual, or similar documentation (eg: Naval applications, or country specific manual) and how to find each individual companies health and safety policies and procedures.

Annex C5

Scope of the Unit:

Know and Understand:

Annex C5.1

- The fundamentals of CM diagnostics
- The various CM methods that are available and how they can be applied to the relevant machine
- Evaluation of the various types of information available for diagnostic analysis
- Evaluation of sensory information such as sight, sound, smell and touch and compare with any similar equipment that may be in service

Annex C5.2

- Usage of the various aids, reports and standards available for fault diagnosis (see Table B2)

Annex C5.3

- Usage of the various aids, reports and standards available for prognosis (see Table B2)

Annex C5.4

- How to use the information provided from previous maintenance activities in order to uncover any hidden maintenance trends

Annex C5.5

- How documented machinery performance history and OEM baseline data can be used to understand the current Category of performance of a machine or asset

Annex C5.6

- The importance of capturing multi-disciplinary data in order to reveal systemic changes which would not normally be evident using single technique approaches

Annex C6

Scope of the Unit:

Have an Awareness of:

Annex C6.1

- Marine industry specific standards applicable to condition monitoring (see Table B2)

Know and Understand:

Annex C6.2

- The application and terms of interpretation of the above standards

Annex C7

Scope of the Unit:

Know and Understand:

Annex C7.1

- The fundamentals of Reliability Centred Maintenance
- The functions and associated performance standards of the asset in its present operating context
- What ways can an asset fail to fulfil its function
- What causes each functional failure
- What happens when failure occurs
- What way does each failure matter
- What can be done to predict or prevent each failure
- What should be done if a suitable proactive task cannot be found

Annex C7.2

- The fundamentals of Condition-Based Maintenance
- Alarms and alarm methods

Annex C7.3

- The fundamentals of Preventative Maintenance
- Scheduled restoration tasks
- Scheduled Replacement tasks

Annex C7.4

- The fundamentals of Failure Based Maintenance

Annex C7.5

- The fundamentals of Integrated Asset Management
- The implications of integration of CM outputs within ship management systems

Annex C8

Scope of the Unit:

Have an Awareness Of:

- ISO9000
- ISM Code
- SOLAS
- MARPOL

Know and Understand:

Annex C8.1- Annex C8.4

- The implications of these standards in regard to Condition Monitoring of marine systems

Annex C9

Scope of the unit:

Know and Understand:

Annex C9.1

- The role of the classification society and its relationship to owners and operators
- The purpose of regulatory compliance and the implications of non-compliance
- The role of International Association of Classification Societies

Annex C9.2

- The role of the surveyor and their responsibilities within the process of classification
- Marine surveyors procedures in relation to alternative survey arrangements

Annex C9.3

- Which machinery items form part of the Continuous Survey Machinery list
- What make up the Master List items

Annex C9.4

- Alternative routes to classification; eg risk based approach to inspection survey

Annex D Bibliography

Aside from those references in clause 2 and Annex B, the following are additional reference material that could of value to candidates.

1. C Mathews, A practical guide to Engineering Failure Investigation, PEP, ISBN 1860580866
2. T M Hunt, The concise encyclopedia of Condition Monitoring, Coxmoor, ISBN 1901892190
3. R Barron, Engineering Condition Monitoring, Longman, ISBN 0582246563