

# **A Guideline to the Unified Technical File**

**Regulations for the Prevention of  
Air Pollution from Ships**

**First Edition, Nov. 2004**



## **Preface**

This booklet is intended for Licensees, ship operators, shipyards, and marine engineers in general to illustrate the Unified Technical File designed for all MAN B&W engines – required to meet the IMO regulation for the prevention of air pollution.

The Unified Technical File is a document that specifies a procedure, mainly based on performance measurements, by which the operator can verify compliance with the IMO ‘NO<sub>x</sub> Technical Code’ to the Flag State Authority (or their representative) when the engine is later checked in service.

MAN B&W Diesel has designed this booklet partly to explain survey procedures and partly as a look-up manual for IMO definitions. The first part concentrates on survey routines, from testbed to on board situations (the most important for the operator), describing the survey from start to finish. The second part expands on specific subjects and how to handle the most common tasks on board, e.g. the spare or reconditioning parts covered by the regulation.

Regarding general emission questions or emission control of MAN B&W two-stroke engines, reference is given to existing material issued by MAN B&W Diesel.



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In connection with the International Maritime Organization (IMO) Annex VI of Marpol 73/78 – Regarding the Prevention of Air Pollution from Ships, MAN B&W Diesel has prepared the following guidelines to a unified technical file.

## **A. Guidelines to the Unified Technical File (TF)**

Purpose:

1. To ensure that MAN B&W two-stroke engines are tested and can be surveyed in accordance with IMO Annex VI.
2. To inform shipowners and operators about the TF and how to comply with Annex VI by using the unified MAN B&W Diesel standard.

Questions or comments regarding the guidelines should be directed to Dept. 2110, Standards and Classification, see page 89.

## Introduction

The IMO has introduced a new Annex VI of MARPOL 73/78, concerning regulation for the prevention of air pollution from ships. Annex VI applies to all engines delivered since 1 January 2000, and enters into force **19 May 2005**.

MAN B&W Diesel has worked with the licensees and classification societies to find a uniform design for the TF – required under IMO Annex VI, in order to survey on board compliance.

Many of the first TFs produced by the engine builders varied due to different demands made by the different classification societies. This happened because the IMO Annex VI does not give sufficiently detailed instructions on how to draw-up the TF in practice.

MAN B&W Diesel has assumed the task of coordinating the work to prepare a uniform TF, to be used both by the licensees and the classification societies. The task also includes the necessary procedures for shipowners when later engine adjustments or changes of components have occurred.

## Advantages

The unified TF means:

- Certainty of market acceptance of the TF
- Satisfied customers, who can show engine compliance when checked at sea by the Flag State representatives
- A survey method based on principles familiar to the crew
- More engines can be accepted within the same engine Group, meaning reduced expenses
- Less money spent on emission measurements.

Parent engines can be shared between MAN B&W Diesel and the licensees. This will greatly reduce the number of emission measurements and future certification costs.

## TF design

The principle of the MAN B&W Diesel unified concept is that the defined 'NO<sub>x</sub> components' and performance data (measurement of  $p_{\max}$ ,  $p_{\text{comp}}$ ,  $T_{\text{scav}}$  and  $p_{\text{back}}$ ) can show that an engine complies with the NO<sub>x</sub> limit.

Some licensees have, in the past, used a component setting tolerance instead of performance data. However, if the operator has adjusted the engine, the engine might be out of compliance when the engine is later checked by the Flag State for compliance at sea.

Only extensive tests on Testbed can validate engine adjustments when component settings tolerances are used. It is important to note that when IMO Annex VI is ratified, the focus will be on follow-up at sea – where changes and adjustments will take place.

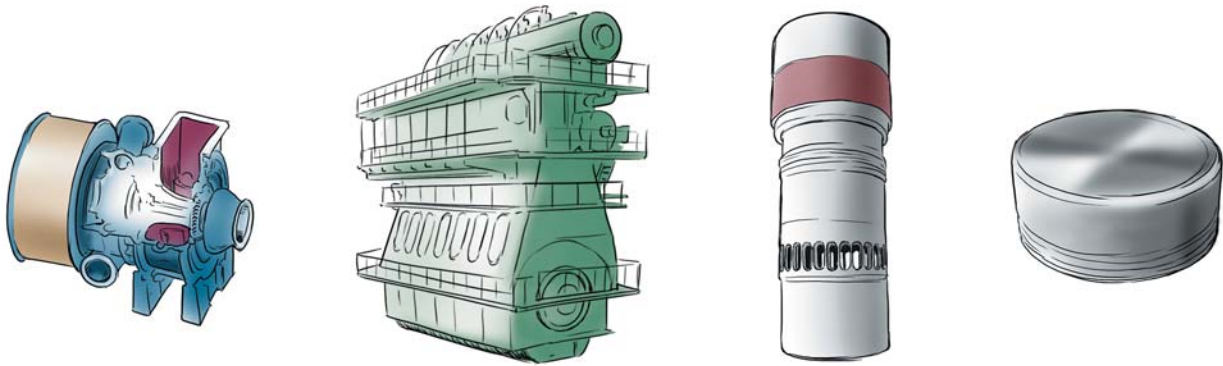
Some licensees have selected to use their own developed TF instead of the recommended MAN B&W Diesel common component ID numbers. This will make it much more difficult for the owners to purchase spare parts in the future, and still stay in compliance with the IMO regulation.

It is predicted that some engines already delivered will not be in compliance when they are surveyed. We suggest that all owners who have made changes to their engines contact the manufacturer regarding its status, before IMO Annex VI comes into force.

## Component changes

This unified TF will allow changes of the engine's NO<sub>x</sub> components, while maintaining compliance in cases where a shipowner changes components at sea.

Some owners have already demanded a unified system in order to avoid working with different TFs.



## **Adjustments**

The unified TF will allow all adjustments on board within the stated performance parameters.

## **Summary**

The Unified TF is the standard introduced by MAN B&W Diesel and it is accepted by the classification societies' headquarters. It should be followed by the licensees for all future engines.

## Concept (engine categories)

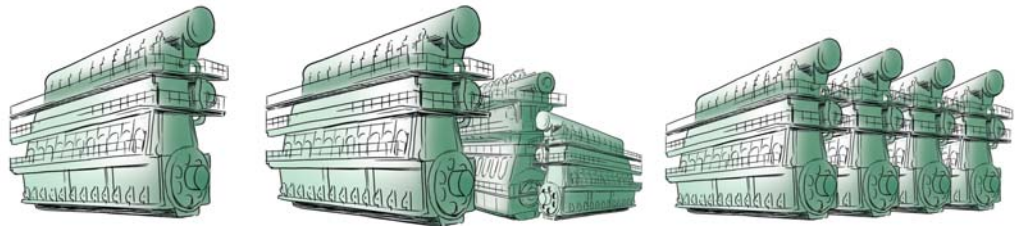
The IMO Annex VI NO<sub>x</sub> technical code defines three categories of engines:

1. Individual Engines
2. Engine Groups
3. Engine Families

Individual engines are handled on the Testbed in the same way as a Parent engine. However, a Group definition is not included in the TF.

Engine Groups and engine Families consist of a Parent engine and a number of Member engines. All Two-stroke engines can be defined in an engine Group, either as the Parent engine (representing the Member engines) or as a Member engine.

Most of the survey procedures made for the Member engines and the Parent engine application are the same. The difference for Member engines is that the emission testing is not necessary – neither on Testbed nor at sea.



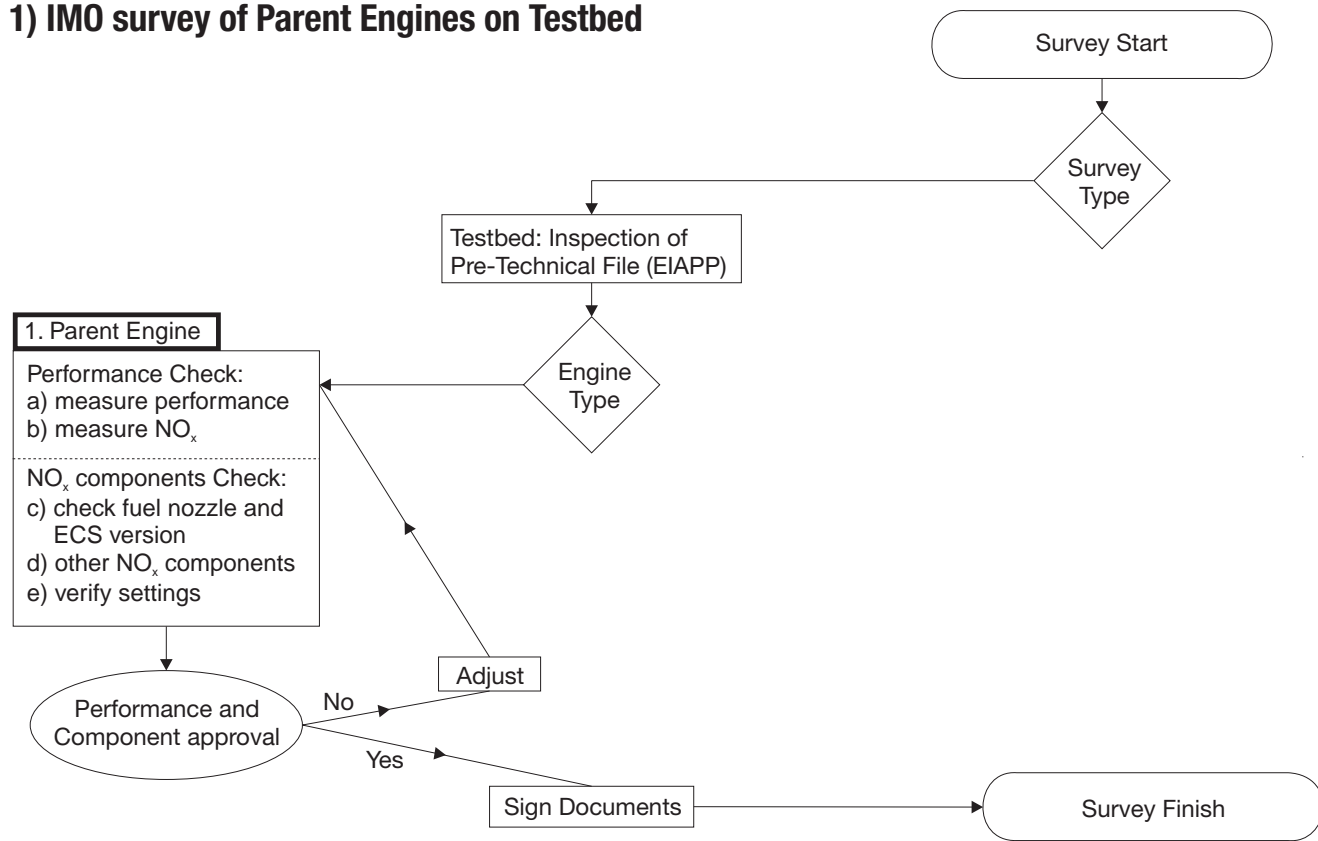
## B. Survey Methods

The survey methods include Testbed, Sea Trial and On-board inspections. The flow chart for survey methods has been split up into different sections to make a more detailed description. Refer to Fig. B1, Appendix B in the TF.





# 1) IMO survey of Parent Engines on Testbed



The performance parameter check is the basis of the survey methods. The measurements involved are used as reference for Member engines.

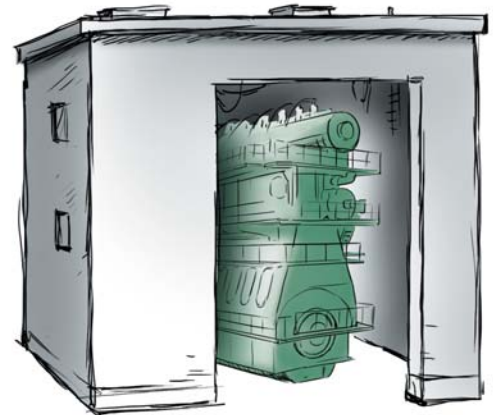
**Note.** A change in performance usually means a change in the NO<sub>x</sub> level.

Performance Check:

- a) measure performance
- b) measure NO<sub>x</sub>

'NO<sub>x</sub> component' Check:

- c) check fuel nozzle and ECS version (for ME engine types)
- d) check other NO<sub>x</sub> components
- e) verify settings



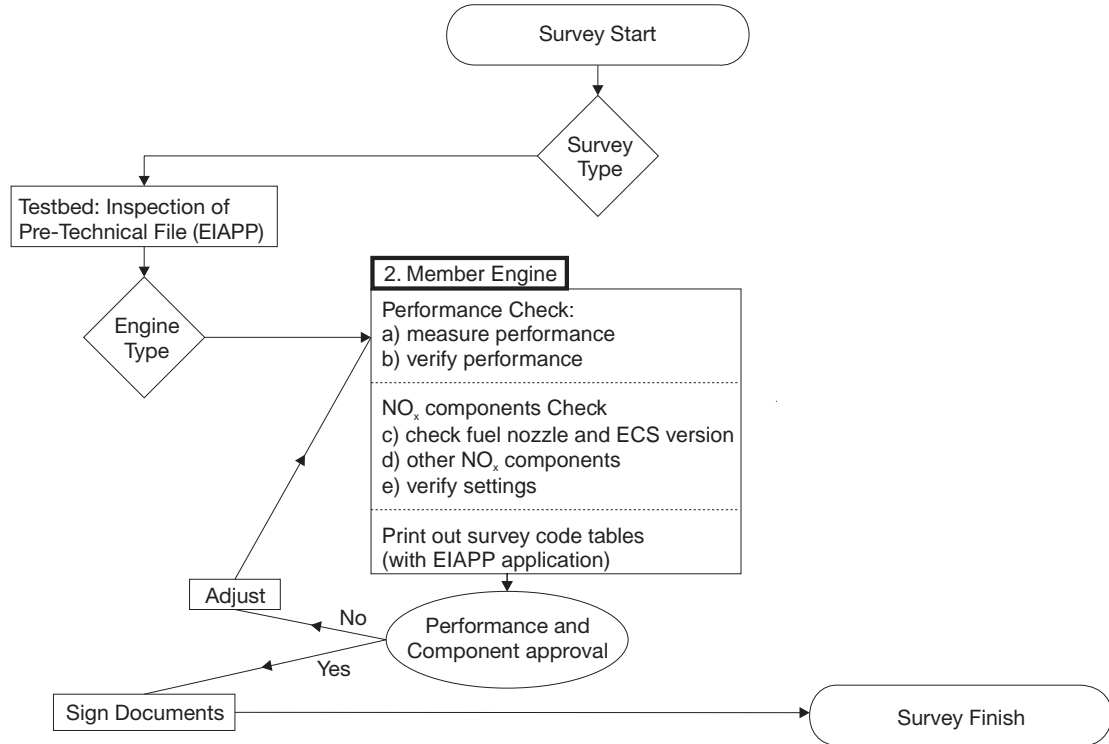
a+b) Performance and NO<sub>x</sub> measurements:

$p_{\max}$ ,  $p_{\text{comp}}$ ,  $T_{\text{scav}}$  and  $p_{\text{back}}$  and NO<sub>x</sub> measured (and corrected) at the four load points in accordance with the E2/E3 IMO cycle.

- c) The Electronic Control System (ECS) software is important for correct operation of the engine and, therefore, the emission levels.  
To extend the group of engines that can be associated with a Parent engine, different types of fuel nozzles are tested for different engine types.
- d) Approved IMO compliant NO<sub>x</sub> components are listed in the engine TF (or pre-TF).
- e) The setting values are verified for guidance only and are not a verification of the engine's actual NO<sub>x</sub> emission level. The value includes the 'IMO Chief Checksum' value on the Main Operating Panel for the ME engine types. The values are to be used only as guideline indications for later adjustments after, for example, overhauls comprising the fuel cam or exhaust cam position.

A survey code is established by data gained from the official Testbed tests in order to ease an on board survey. The results, therefore, cannot be printed until later – together with the EIAPP application with the Parent TF.

## 2) Survey of Member Engines on Testbed



The main difference between surveying Parent and Member engines is that the NO<sub>x</sub> emission is only being measured for the Parent engine. For the Member engine, the performance check verifies compliance based on the parent engine NO<sub>x</sub> data.

Performance Check:

- a) measure performance
- b) verify performance (Testbed version)

'NO<sub>x</sub> component' Check:

- c) check fuel nozzle and ECS version (for ME engine types)
- d) check other NO<sub>x</sub> components
- e) verify settings

Print out survey code tables

a) Performance measurements:

$p_{\max}$ ,  $p_{\text{comp}}$ ,  $T_{\text{scav}}$  and  $p_{\text{back}}$  are measured (and corrected) at the four E2/E3 load points.

b) Verify performance:

The survey code (Testbed version), which is based on the Parent engine data will automatically correct the performance values and perform a  $\text{NO}_x$  estimate when performance measurements and ambient conditions are entered into the program.

If the ISO ambient corrected performance values are within the TF specified tolerances, the engine is in compliance with the IMO regulation.

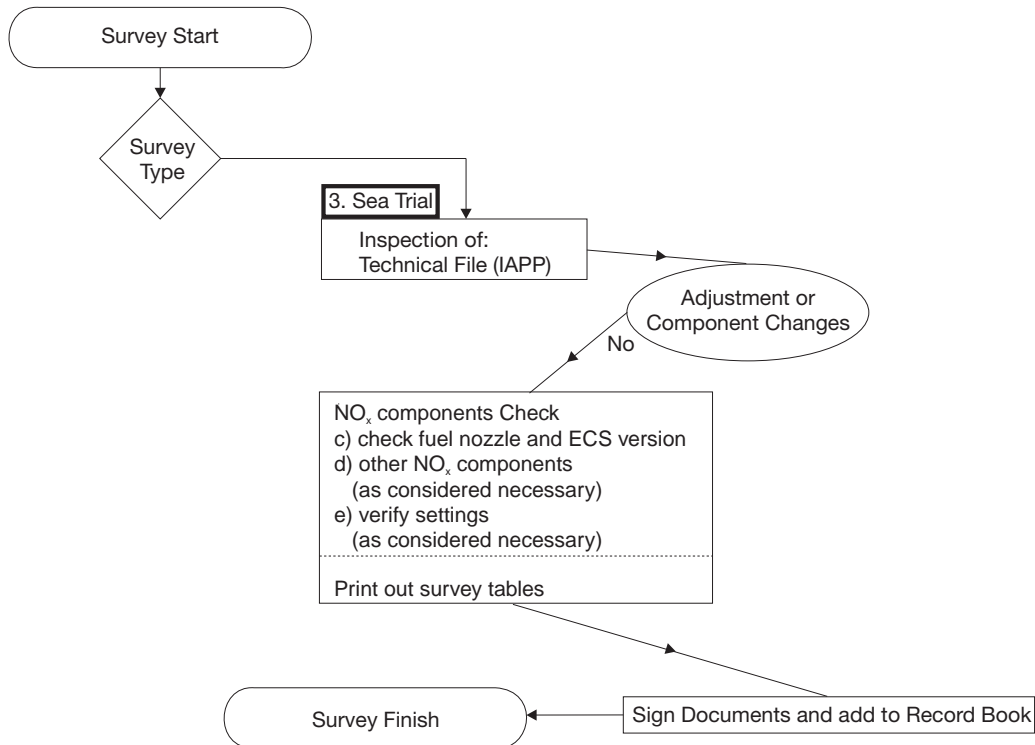
c+d) The approved IMO  $\text{NO}_x$  components are listed in the engine TF.

e) The setting values are verified for guidance only, and are not a verification of the engine's actual  $\text{NO}_x$  level. The value includes the 'IMO Chief Checksum' value on the Main Operating Panel for the ME engine types. The values are to be used only as guideline indications for later adjustments after, for example, overhauls comprising the fuel cam or exhaust cam position.

The survey tables document the survey and are printed for later reference and are included in the Member engine's TF.

### 3) Survey on Sea Trial

(without component or adjustment changes)



A NO<sub>x</sub> component check is sufficient to verify that the engine is in compliance.

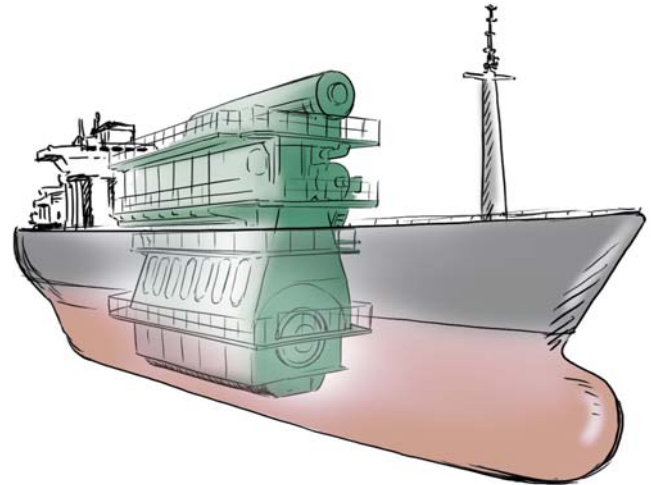
All documentation established so far, including the certificate, TF and eventual Record Book (see Chapter E for definition of Record Book) should be inspected, and the outcome should be included in the IAPP documentation for later reference on board.

'NO<sub>x</sub> component' Check:

- c) check fuel nozzle and ECS version (for ME engine types)
- d) check other NO<sub>x</sub> components (when considered as necessary)
- e) verify settings (when considered as necessary)

Print out survey code tables to document compliance.

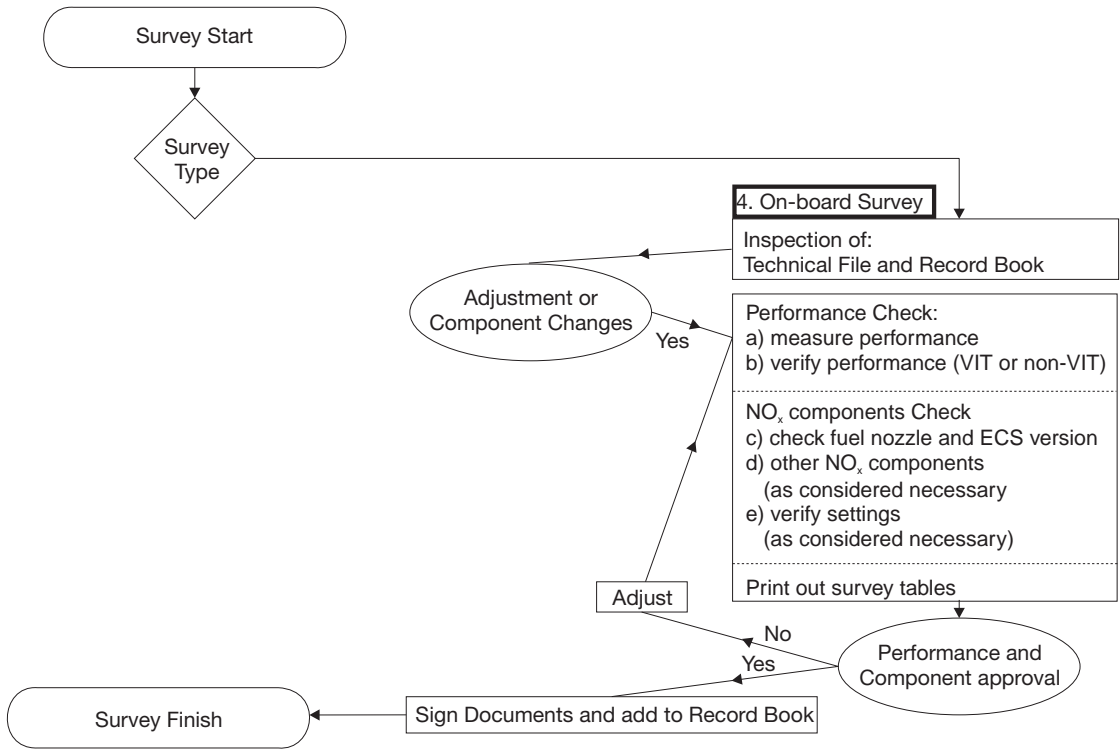
If changes to components or settings were introduced, see survey method 4 (On board survey).





## 4) On-board Survey

(to be used when adjustments have been made to components or settings)



All established documentation (EIAPP, TF, IAPP and eventual Record Book) must be inspected. The outcome must be filed in the on board Record Book for later reference.

Performance Check:

- a) measure performance
- b) verify performance (onboard VIT or non-VIT versions)

'NO<sub>x</sub> component' Check:

- c) check fuel nozzle and ECS version (for ME engine types)
- d) check other NO<sub>x</sub> components (when considered as necessary)
- e) verify settings (when considered as necessary)

Print out survey code tables to document compliance.



a) Performance measurements:

For engines with VIT, the 75% load point and one load point above the VIT break point are to be measured. For engines without VIT, and the ME engine types, only the 75% load point is measured (the performance data measured are as stated above).

b) Verify performance:

The survey code (on board version), which is based on the Parent engine data will automatically correct the performance values and perform a  $\text{NO}_x$  estimate when performance measurements and ambient conditions are entered into the program.

If the ISO ambient corrected performance values are within the TF specified tolerances, the engine is in compliance with the IMO regulation.

c) The fuel nozzle, being the component having most influence on  $\text{NO}_x$ , must be checked by identification of its ID number, as well as the ECS version for the ME engine types.

d) The Flag State representative can check other  $\text{NO}_x$  components, when considered as necessary, by identification and comparison with the TF component ID numbers.

- e) The setting values, comprising the fuel cam and exhaust cam positions and the 'IMO Chief Checksum' values on the Main Operating Panel (for the ME engine types), may be verified, when considered as necessary by the Flag State representative. However, the values are for guidance only.

**Note.** Three versions of the on board survey code exist – depending on the engine fuel pump system (VIT, non-VIT or ME).

The survey tables document the survey and are printed for later reference and included in the 'Record Book'.

## C. Case Story

An engine Group was established on the basis of the Parent engine tested as engine No. 1. Member engine No. 2 was delivered in agreement with the established TF, but for Member engine No. 3 it was decided to perform comparison tests for a new fuel nozzle.

1. Parent engine
2. Member engine
3. Member engine (new fuel nozzle tests)
4. Member engine

Two different possibilities exist for maintaining the engine Group certificates:

The new fuel nozzle can be added to the TF with an amendment for the nozzle, but only if the new nozzle demonstrates a lower  $\text{NO}_x$  value than the original fuel nozzle.

A new engine Group can be established on the basis of engine No. 3 as a new Parent engine (if the engine was surveyed as a Parent engine on Testbed). In this case, new Member TFs for the previous Member engine need to be established.

Engine No. 4 can be certified to either engine Group depending on the fuel nozzle used (provided that both nozzles are entered in the TF).

A detailed description of the survey methods can be found in the TF (Chapter 3 and Appendix B).

## D. Glossary

### IMO Annex VI

The IMO Annex VI is a new annex to MARPOL 73/78 – the International Convention for the Prevention of Air Pollution from Ships – and which applies to every ship of 400 gross tons and above.

The rules on NO<sub>x</sub> emission are specified in Conference Resolution 2, the NO<sub>x</sub> Technical Code.



## Engines covered by the IMO NO<sub>x</sub> regulation

1. All diesel engines with an output of more than 130kW and installed in a ship built on or after 1 January 2000.
2. All engines (above 130kW) that undergo a *major conversion*:
  - an engine replaced by a new engine built on or after 1 January 2000
  - any *substantial modification*, as defined in the NO<sub>x</sub> Technical Code, made to the engine, or
  - the engine rating (MCR) is increased by more than 10%

Emergency engines and Navy vessels are not covered by IMO, and engines entirely for use in internal State waters are not covered if an alternative NO<sub>x</sub> control measure is applicable.

## Vessels covered by the IMO SO<sub>x</sub> regulation

All.



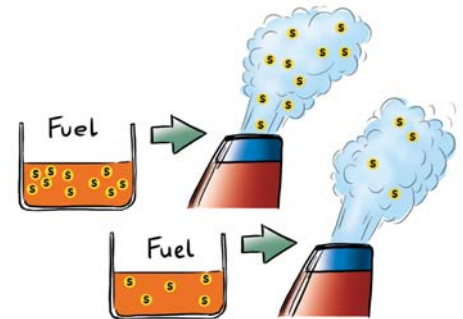


## Emissions regulated

**NO<sub>x</sub>:** Regulation 13 describes a speed-related IMO NO<sub>x</sub> limit (from 17gNO<sub>2</sub>/kWh to 9.8gNO<sub>2</sub>/kWh depending on rated engine speed or an exhaust gas cleaning system which provides an equivalent NO<sub>x</sub> reduction).

**SO<sub>x</sub>:** Regulation 14 describes the sulphur limit. The sulphur content of the fuel shall not exceed 4.5%. In defined SO<sub>x</sub> control areas, an HFO fuel with equal or less than 1.5% sulphur content, or an after-treatment system that limits the exhaust SO<sub>x</sub> to equal or less than 6gSO<sub>2</sub>/kWh are required. To document the sulphur content in the fuel, a new bunker delivery note is required, accompanied by a representative sample of the fuel oil delivered, as specified in Regulation 18.

However, individual countries (Flag States) may have special mandatory or voluntary requirements within local waters, and certain businesses require information on different emission components.



## **NO<sub>x</sub> limits**

The MAN B&W Diesel unified TF specifies three NO<sub>x</sub> values:

1. The MCR speed-related IMO NO<sub>x</sub> limit (see previous)
2. The actual Parent engine reference NO<sub>x</sub> value
3. The actual Parent engine NO<sub>x</sub> value at maximum tolerance conditions.

The last value must be less or equal to the IMO NO<sub>x</sub> limit to comply with the IMO Annex. However, for On board surveys, the simulated Member engine NO<sub>x</sub> value must be less than the Parent engine maximum value (with allowed tolerances).

## The IMO NO<sub>x</sub> Technical Code defines three categories of engines

- 1 Individual engines
- 2 Engine Groups
- 3 Engine Families

Engine Groups and Families consist of a Parent engine and a number of Member engines.

Large two-stroke engines belong to either category 1 or 2 because of the necessity for adjustments on board.

In principle, most of the survey procedures made for the Individual and the Parent engine application will be the same. The main difference for Member engines is that the emission testing is not required – neither on the Testbed nor at sea.

The more engines that can be included in the same engine Group, the easier and lower the costs for the engine builder. Furthermore, having a Unified TF will facilitate sharing of engine Groups among MAN B&W Diesel and the engine builders, saving more costs.

## **Performance parameters**

Following extensive testing, MAN B&W Diesel has established the NO<sub>x</sub> sensitivity of different performance parameters. This knowledge has been utilised to establish the defined allowed maximum IMO tolerances. These tolerances must be met always, independent of (or in addition to) the specified service tolerances in the instruction books for the engine.

## Local areas

SO<sub>x</sub> emission control areas (SECA).

IMO defined area with a SO<sub>x</sub> limit of 1.5%.

**Note.** The Baltic Sea and the North Sea have been defined as special restricted-SO<sub>x</sub> areas.



## Required IMO NO<sub>x</sub> components marking

MAN B&W Diesel has defined 12 standard engine components as IMO NO<sub>x</sub> components that might influence the NO<sub>x</sub> emission.

A listing of the components (including a few major sub supplier components: T/C, charge-air cooler, auxiliary blower and the governor) is given in Table 1.1 in the TF together with the allowed ID numbers.

The marking position on each component is described in the TF's Appendix A and is specified in a standard MAN B&W Diesel marking specification.

Except for the fuel nozzle, none of the defined IMO components are easy to replace with a different design and, consequently, are not likely to change the NO<sub>x</sub> characteristics. Therefore, if the engine performance is kept within the specified tolerances (see TF Table 1.3) the engine will comply with the IMO limit.

Only the nozzle ID number might need verification (this is always at the discretion of the surveyor). For ME engines, the Electronic Control System (ECS) version and the selected engine mode also need to be surveyed.

MAN B&W Diesel has defined the 'Part Number' as the IMO ID number for the component. Many of the defined NO<sub>x</sub> components are already stamped with the part number.

**Note.** Only the main part number is used – not the revision number (see circled number in TF Appendix A.)

**Part**

Cylinder liner

**Certified  
Marking**

Part Mo.

**Marking  
Instruction**

0742637-8

**Required Marking**Either manufacturer's Name  
or Trademark, plus Part No.**Notes**Marking is on  
manoeuvring side

<b>Part</b>	<b>Certified Marking</b>	<b>Marking Instruction</b>	<b>Required Marking</b>	<b>Notes</b>
Cylinder cover	Part No.	0742634-2	Either manufacturer's Name or Trademark, plus Part No., Year and Week of manufacture	Marking is on manoeuvring side





**Part**

Piston crown

**Certified  
Marking**

Part No.

**Marking  
Instruction**

0743260-7

**Required Marking**Either manufacturer's Name  
or Trademark, plus Part No.**Notes**Marking is on  
manoeuvring side

**Part**

Fuel pump  
barrel

**Certified  
Marking**

Part No.

**Marking  
Instruction**

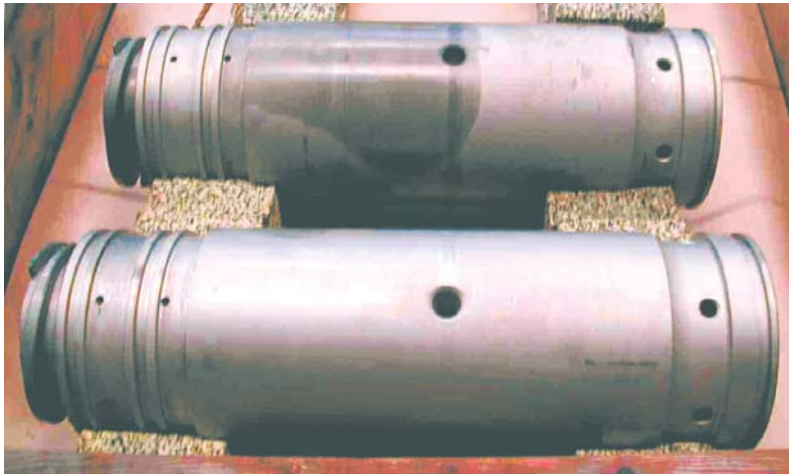
0742843-8

**Required Marking**

Manufacturer's Name  
or Trademark, plus Part No.,  
and Engine Type

**Notes**

On ME engines:  
The barrel and the  
plunger are paired



**Part**

Fuel pump  
plunger

**Certified  
Marking**

Part No.

**Marking  
Instruction**

0742845-1

**Required Marking**

Manufacturer's Name  
or Trademark, plus Part No.  
and Engine Type

**Notes**

On ME engines:  
No marking required.





0985946.2.0

MS X 6269  
98TT12471  
C.A2281  
16NC6



0985946.2.0



MS X 6269  
98TT12471  
C.A2281  
16NC6

<b>Part</b>	<b>Certified Marking</b>	<b>Marking Instruction</b>	<b>Required Marking</b>	<b>Notes</b>
Fuel cam	Part No.	0742636-6	Either manufacturer's Name or Trademark, plus Part No.	Marking is on Bearing side
Exhaust cam	Part No.	0742635-4	Either manufacturer's Name or Trademark, plus Part No.	Marking is on Bearing side

Inserted pictures shows marking example

**Part**

Fuel nozzle

**Certified  
Marking**

Part No.

**Marking  
Instruction**

0742639-1

**Required Marking**

Manufacturer's Name  
or trademark, plus Part No.,  
and hole diameter (mm)



**Marking Location**

## Part

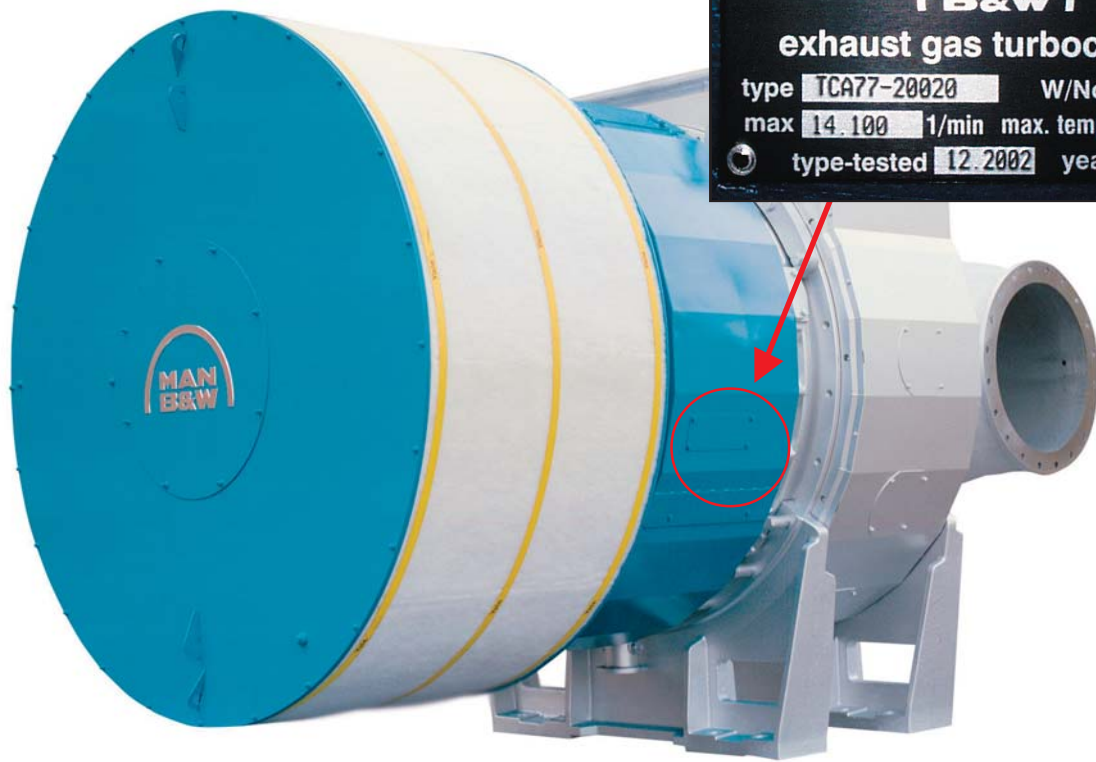
Scavenge air cooler

## Required Marking

Manufacturer's Name, Type,  
Contract number,  
Year of manufacture,  
Water side and Air side figures  
for: Op. Exc. Press. (bar),  
Test Exc. Press. (bar),  
Op. Temperature (°C) and  
Content (L)

## Notes

Marking is on  
Name Plate



**MAN B&W**

**exhaust gas turbocharger**

type	TCA77-20020	W/No.	1191620
max	14.100	1/min	max. temp. 500 °C
type-tested	12.2002	year	2003



## Part

Turbocharger

## Required Marking

Manufacturer's Name, Type,  
Serial number(s),  
Manufacturing date,  
Specification,  
Max. cont. speed and  
Max. cont. gas temperature

## Notes

Marking is on  
Name Plate

T/C manufacturer is  
responsible for  
marking 4 internal  
components and  
issues a specific IMO  
certificate for the T/C

## Part

Auxiliary  
blower

## Required Marking

Manufacturer's Name, Model,  
Capacity, Pressure, Temp.,  
Density, Serial number(s),  
Speed, Power, Date of build  
and Electrical Source.

## Notes

Marking is on  
Name Plate



## Part

Governor

## Notes

Manufacturer/  
Installer is  
responsible for  
marking



## **Licensee's own numbering**

Some licensees have introduced their own IMO ID numbering system. However, the MAN B&W Diesel ID number is always required along with the licensee number in the TF.

The ME engine has certain different components, but the On board survey exactly follows same procedures as for the MC engine.

## Emissions from non-IMO engines or for other purposes

Engines that do not fall within the IMO regulation (i.e. 'old engines' built before 1 January 2000) are not required, from the IMO point of view, to document the emission characteristics.

Incentives from individual states or customers may urge Owners to obtain actual emission values.

It is possible, but very difficult, to measure emissions on board for different Flag State/customer purposes. The specific requirements (components and accuracies) should be stated clearly. The ship Owners will have an obligation to ensure safe access for personnel and provide the equipment and exhaust sampling gear necessary for taking the measurements.

On board IMO engine certification should only be carried out if absolutely necessary. In order to obtain an EIAPP certificate after installation on board, the engine must be certified either as an Individual engine or an engine Group. In principle, most of the survey procedures made for the Individual and the Parent engine application will be the same.

The measurement procedures must follow normal Testbed procedures (for measurements and load cycle) and without any tolerance allowances.

For IMO-compliant engines, all gaseous emission must be stated (at the four load points in the E2/E3 cycle) in Chapter 4 of the TF (for the common MAN B&W Diesel TF).

## **E. Description of Documents**

## Pre-certificate

The interim Engine International Air Pollution Prevention Certificate (EIAPP) is the legal document that approves the engine on the Testbed in accordance with the NO<sub>x</sub> Code and Regulation 13 of Annex VI.

This preliminary or interim certificate ('statement of compliance') will only be issued until the enforcement date of 19 May 2005, and will have to be exchanged with a final EIAPP certificate since Annex VI has been ratified.

All of the original documents must be available on board at all times.

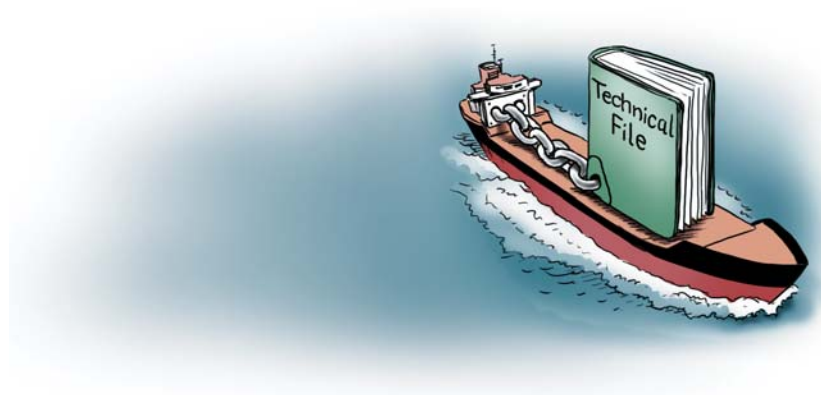


## TF

An approved document that specifies the actual engine's performance data, the engine Group (a number of engines defined by the engine with the highest NO<sub>x</sub> emission – the Parent engine), the emission characteristics of the Group, and how to survey the engine on board for NO<sub>x</sub> compliance.

MAN B&W Diesel has introduced a Unified TF as the standard common TF set-up for all MAN B&W Diesel Two-stroke engines. This was done in order to simplify the IMO Annex VI for Owners and to ensure similar TFs for all MAN B&W Diesel engines, independent of the various licensees.

To ensure compliance with the MAN B&W Diesel standard, an example of a Unified TF can be obtained by contacting Department 2110.





## On-board Survey

A survey of the engine, as defined in the TF, to verify continuous compliance with the NO<sub>x</sub> emission limits of IMO Annex VI.

Different survey methods are specified in the IMO NO<sub>x</sub> Technical Code – dependent on the purpose of the survey (pre-certification survey on Testbed, initial survey on board or, periodical or intermediate surveys on board).

## **Engine parameter check method**

MAN B&W Diesel has defined an Engine Parameter Check Method as a combination of a performance parameter check and a component survey (see Service Letter No. SL03-428).

The On board survey is described in detail in TF, Chapter 3, and Appendix B, Fig. B.1. This presents an overview of the different mandatory survey procedures.

## Parameter survey

A manufacturer defined survey procedure.

MAN B&W Diesel has defined four performance parameters for the On board survey for verification of engine compliance with the IMO NO<sub>x</sub> regulation:

- maximum pressure
- maximum compression pressure
- scavenge air temperature
- turbocharger backpressure.

To verify compliance, these parameters (adjusted to ISO ambient conditions) must stay within the tolerances specified in TF, Table 1.3.

The survey follows standard MAN B&W Diesel procedures for engine performance checks (see TF, Appendix B). However, for scheduled surveys, all sensors and gauges used in the survey code must be reliable and calibrated in accordance with the manufacturers specifications (and the IMO NO<sub>x</sub> Technical Code requirements).

## Survey code

A dedicated code for the actual engine Group that facilitates easy On board surveys.

In connection with the On board survey (see TF, Chapter 3 and Appendix B), MAN B&W Diesel has introduced a small Microsoft® Excel® code that, automatically, either shows compliance, or points to necessary adjustments of the engine setting/performance values.

When the engine is surveyed (Testbed or On board), the setting values are measured in accordance with the procedures in the instruction book, and documented through the survey code, which is printed out to the Record Book. The performance parameter survey automatically approves the setting values. For MAN B&W two-stroke engines, these are for guidance only (i.e. for use in cases where the performance data can not be obtained – e.g. during docking).

When using the MAN B&W Diesel-defined on board parameter survey method for large two-stroke engines, the setting values are for guidance only. For other survey methods, either TF-defined tolerances (based on additional measurements for the individual settings) or amendments are necessary.

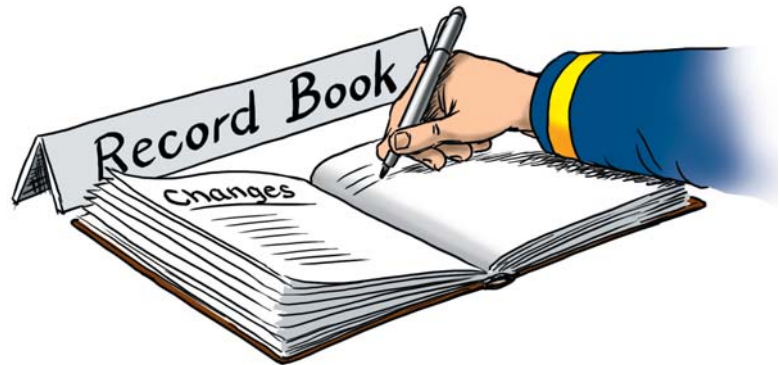
The actual readings are registered in the survey code for future reference.

## Record Book of engine parameters

An Owner-established 'log book' to document any changes (including recorded On board surveys) to IMO components or engine settings that may influence NO<sub>x</sub> emissions.

With a few modifications, the standard on board 'log book' can be used as the Record Book.

Together with the TF, MAN B&W has introduced a survey code that lists the necessary documentation from the On board survey to be included the Record Book.



## **F. Parameters in the Documents**

## IMO ID-number

A manufacturer specified unique number for an engine component that may have an influence on the engine NO<sub>x</sub> emission characteristics.

MAN B&W Diesel has defined the 'Part Number' as the IMO ID-number for the component. Many of the defined NO<sub>x</sub> components (MAN B&W Diesel has defined 12 standard engine components as IMO NO<sub>x</sub> components) are already stamped with the Part Number. However, only the main Part Number is used – not including the revision digit (see encircled number in TF, Appendix A).

Some licensees have introduced their own IMO ID-number system. However, the MAN B&W Diesel ID-number is always required along with the licensee number in the TF. Components with any one of the numbers defined in TF, Table 1.1 are valid.

Only the components marked with an IMO ID-number and specified in TF, Table 1.1 (or in the dedicated survey code for the engine Group) are accepted as common replacement spare parts.

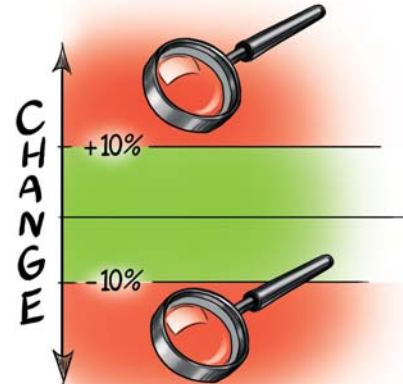
New components or modified spare parts to replace the existing component (i.e. components with a different IMO ID-number) must be amended to the TF. MAN B&W Diesel are responsible for ensuring that original spare parts can be used on board.

Always make sure that MAN B&W Diesel ID-numbers are added to the licensee's TF in order to obtain the flexibility for purchasing and updating parts.

## Performance tolerances

The tolerances defined in TF, Table 1.3 for the four performance parameters that affect the engine NO<sub>x</sub> emission characteristics.

Following extensive testing, MAN B&W Diesel has established the NO<sub>x</sub> sensitivity of different performance parameters (maximum pressure, maximum compression pressure, scavenge air temperature and turbocharger backpressure). This knowledge has been utilised to establish the defined allowed maximum IMO tolerances. These tolerances must be met always, independent of (or in addition to) the specified service tolerances in the instruction books for the engine.





## Performance reference values

The 'ideal' Parent engine performance reference values are defined in TF, Table 1.3.

When the Parent engine is run on the Testbed, ambient conditions and, perhaps, not precisely adjusted engine setting values may lead to slightly 'off-performance' values. This is normal, therefore to define the engine Group in the best possible way, a set of slightly different values – the performance reference values – has been defined. The engine NO<sub>x</sub> emission is now corrected to reflect this condition, just as the NO<sub>x</sub> emission is corrected to ISO ambient conditions.

## Engine setting values

Mechanical or electrical adjustment features of the engine providing certain engine performance characteristics.

When the engine is surveyed (Testbed or On board), these values are measured (following the procedures in the instruction books) and documented through the survey code (and printed out to the Record Book). With a few modifications, the standard 'log book' on board can be used as the Record Book. The performance parameter survey automatically approves the engine setting values, which for MAN B&W two-stroke engines are for guidance only (i.e. for use in cases where the performance data cannot be obtained, e.g. during docking).

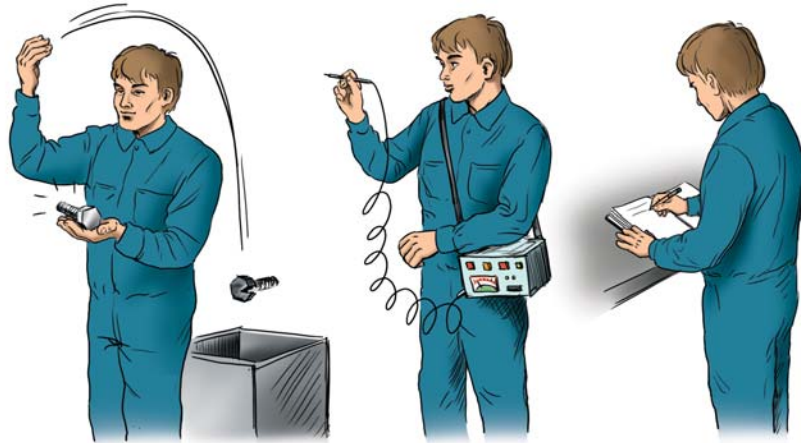
Adjustment of the ME engine setting values is done on the Engine Control System panel and verified by means of 'checksum' values. Two checksums are defined for emissions, an 'IMO Design checksum' and an 'IMO Chief checksum'. The IMO Chief checksum is verified (and approved) through the On board parameter survey, whereas the 'IMO Design checksum' is a manufacturer responsibility, which might require an amendment to be in compliance. This amendment usually consists of one page referring to engine Group, engine Type, and the authorised company approval number introducing a new IMO ID-number on a component.

## Changing of setting values

Setting values can be changed, depending on the survey method as defined in the TF.

The actual readings are registered in the survey code for future reference.

When the engine is surveyed (Testbed or On board), these values are measured (following the procedures in the instruction books and documented through the survey code (and printed out to the Record Book). The performance parameter survey automatically approves the setting values, which for MAN B&W two-stroke engines are for guidance only.



## Influence on engines in operation

Modifications to engine are allowed within IMO defined constraints.

IMO Annex VI uses specific definitions related to engine modifications (*spare parts, major conversion and substantial modification*).



## Spare parts

Always use spare parts from authorised MAN B&W Diesel spare part suppliers and drawings.

Only the components marked with an IMO ID-number and specified in TF, Table 1.1 (or in the dedicated survey code for the engine Group) are allowed as common replacement spare parts.

New components or modified spare parts to replace the existing components (e.g. components with a different IMO ID-number) must be amended in the TF. The amendment usually consists of one page referring to an engine Group, engine Type, and the authorising company (Classification Society) approval number introducing a new IMO ID-number on a component.



MAN B&W Diesel is responsible for ensuring that original spare parts can be used on board.

New IMO NO<sub>x</sub> components will be filed by MAN B&W Diesel with the class societies when engine Groups (using the unified TF set-up) are filed to MAN B&W Diesel. This will require that our licensees report back to MAN B&W Diesel regarding introduced engine Groups.

Always make sure that MAN B&W Diesel ID-numbers are added to the licensee TF, in order to obtain flexibility when buying and updating parts.

## Major conversions

As defined in IMO Annex VI, Regulation 13:

- When the engine is replaced with a new engine (built after 1 January 2000)
- When the engine undergoes a *substantial modification*
- When the MCR rating is increased by more than 10%.

In cases of a *major conversion* of an 'old' engine (an engine built before 1 January 2000), this engine must now fully comply with Annex VI, Regulation 13.

Engines that already comply with the Regulation 13 might, in the worst case, need a new Parent engine, but in most cases, an *amendment* will be sufficient.

Engines that are derated (e.g. by more than 10%) might have a change in their emission characteristics (possibly, increased NO<sub>x</sub> emissions) and, therefore, also be considered as a *major conversion*.

## Substantial modifications

For 'IMO compliant' engines where the modification will increase the NO<sub>x</sub> emission level to exceed the IMO limit set out in Regulation 13 of Annex VI, and for 'old' engines where the modification increases their existing NO<sub>x</sub> emission level beyond the tolerances allowed for a *simplified measurement method*.

Due to the difficult conditions for taking measurements on board, certain measurement tolerances are allowed in connection with this method (see NO<sub>x</sub> Technical Code §6.3.11), e.g. 10% due to the measurement method and 10% due to the possibility of a different fuel, but maximum of 15% in total.

For compliant engines, if the Parent engine's maximum NO<sub>x</sub> tolerance is exceeded, a new Parent engine must be introduced.

For 'old' engines, if NO<sub>x</sub> increases, it would require major efforts (if possible at all) to establish a TF and certify the engine on board. Fortunately, most modifications (introduction of new techniques and technologies) will reduce emissions and, therefore, not result in a requirement for the engine to comply with the IMO regulation.



## Amendments

An *amendment* is the formal instrument to introduce changes to the original IMO components and settings defined in the engine's TF.

The amendment usually consists of one page referring to the engine Group, engine Type, and the Flag State representative approval number introducing a new IMO ID-number.

For new Members to an existing engine Group to which amendments have been issued, the amended component will be introduced directly into the Member TF.

## Reconditioning of engine parts

Engine parts can be reconditioned as usual, provided the repair shop is authorised and uses original MAN B&W Diesel drawings.

The components must be machined to the same dimensions as specified for original parts. If the component ID-number is not readable, the number must be re-established in agreement with the standard MAN B&W Diesel marking procedures.

Reconditioning is usually performed only on major large components, where the dimensions do not have the stronger influence on the emission characteristics.



## Maintenance on an IMO engine

Maintenance should be performed in accordance with the engine's instruction books, i.e.:

- Exchange of spare part as necessary
- Performance checks as specified.

However, attention needs to be kept on the tolerances specified in TF, Table 1.3.

It should be emphasised that proper maintenance is required, and that it is a part of keeping engine emissions within the specified limits. Unless the engine is maintained in accordance with the engine instruction books, and is compliant with the TF specifications, the manufacturer bears no responsibility for the engine with regard to IMO compliance.



## **Simplified measurement method**

Emission measurements for on board confirmation tests only and periodical and intermediate surveys, see IMO NO<sub>x</sub> Technical Code §6.3.

The second method for On board surveys as defined in the NO<sub>x</sub> Technical Code and also the method for verifying the emission status for non-compliant 'old' engines with back-to-back measurements.

Following the procedures above, it is possible, but very difficult, to measure emissions on board for different Flag State/customer purposes. The specific requirements (components and accuracies) should be stated clearly. The ship Owners will have an obligation to ensure safe access for personnel, equipment and the exhaust sampling equipment necessary for the measurements.

Only if absolutely necessary should an engine be IMO certified on board. In order to obtain an EIAPP certificate on board, the engine must be certified as either an Individual engine or an engine Group, the measurement procedures must follow 'normal' Testbed procedures (for measurements and load cycle) and without any allowances.

For IMO-compliant engines, all gaseous emissions are stated (at the four load points in the E2/E3 cycle) in the TF, Chapter 4.

## Continuous On-board monitoring

NO<sub>x</sub> emission measurements (and monitoring) applied for On board periodical and intermediate surveys (see IMO NO<sub>x</sub> Technical Code §2.1.2.5) to demonstrate compliance with Regulation 13 of Annex VI.

The third method for On board surveys defined in the NO<sub>x</sub> Technical Code (pre-certification survey on Testbed, initial survey on board, or periodical and intermediate surveys on board).

Measurements of similar quality to the *simplified measurement method* are required.

A sub-committee under the Marine Environment Protection Committee (MEPC) has recently drafted the 'Guidelines for On board NO<sub>x</sub> Verification Procedure – Direct Measurement and Monitoring Method,' DE46/WP.3, 17 March 2003, which were adopted as draft guidelines.

It should be emphasised that continuous on board monitoring does not imply continuous measuring during the entire operation of the engine, but only during defined sequences.

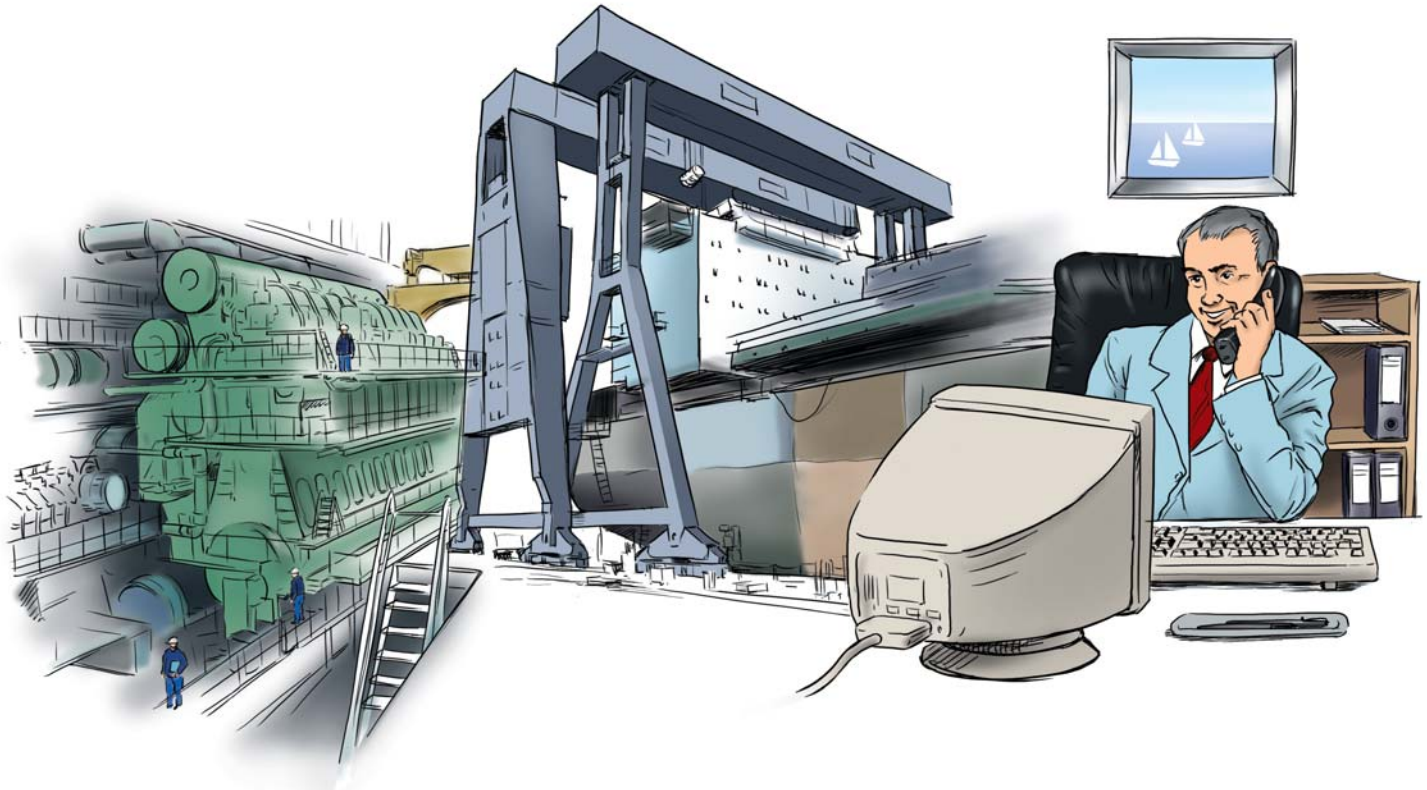
## **Is continuous On-board emission monitoring needed?**

No!

As long as surveys are performed as defined in the Unified TF are in compliance with IMO Annex VI, there is no need for complicated emission measurements on board to verify compliance. In all cases and at all times, the engine must always be maintained appropriately, and performance data be recorded to ensure proper operation.

The *continuous on board monitoring method* is an option which the Owner, who will bear the costs, must decide on. It will be difficult to establish the method without the cooperation of the manufacturer.

## G. Responsibilities



## Licensee's responsibilities

- Marking of components in accordance with MAN B&W Diesel specifications
- Performance testing of all engines to verify compliance with IMO Annex VI, and emission testing of the Parent engines on the testbed
- Preparing the TF and applying for an EIAPP certificate
- Ensuring continuous compliance when engine is installed in the vessel (See note).

All final official Testbed measurements must be performed under survey conditions.

**Note.** Provided that the Owner maintains and operates the engine according to MAN B&W Diesel instructions, the licensee must guarantee an IMO compliant engine throughout the engine warranty period (the US EPA Regulation operates with a 'useful life' warranty, where the useful life is defined as three years or 10,000 hours of operation).



## Yard's responsibilities

- Assist with or perform the initial engine survey on board, depending on the agreement with the licensee
- Apply for the vessel certificate (the IAPP certificate).

Now that the IMO Annex VI is ratified (enforced from 19 May 2005), the common practice (and an IMO requirement) will be to perform the initial On-board Survey in connection with the vessel's Sea Trial, where the authorised surveyor is already on board. This has not been the case so far, except in certain special cases to verify the correct adjustment of the main engine.

## **Owner's responsibility**

- Decide on the unified TF issue
- Maintain the engine in accordance with the instruction books and IMO requirements (not limited to IMO components and performance surveys)
- Keep and update the on-board engine Record Book
- Calibrate necessary sensors/gauges used in the surveys
- Survey the engines on board and apply for future certificates.

In case of emission measurements being taken on board, the owner takes on additional responsibility.

## H. Other

Can emissions on 'old' engines be reduced?

Most likely, Yes.

Low-NO<sub>x</sub> nozzles and new Slide Fuel Valves designed to improve HC and PM emissions are available for many MC engines today. However, the emission reduction potential, as well as the cost, should be evaluated case by case.

The benefit for the environment is unquestionable, but the Owner will also benefit from improved cylinder conditions. Whereas the benefit from meeting IMO or Flag State emission regulations may require difficult measurements taken on board.

## ME engines

The MAN B&W ME engine range has certain different components than the 12 standard engine MAN B&W Diesel-defined IMO NO<sub>x</sub> components (a listing of the components is given in TF, Table 1.1), but the on board survey follows exactly same procedures as for the MC engine.

Adjustment of the *engine setting values* is effected on the Engine Control System panel and is verified by means of checksum values. Two checksums are defined for emissions, an 'IMO Design checksum' and an 'IMO Chief checksum'. The 'IMO Chief checksum' is verified (and approved) through the on board parameter survey, whereas the 'IMO Design checksum' is a manufacturer responsibility, which may require an *amendment* to be in compliance.



## Future regulations

Today, all new engines comply with the IMO emission regulation from the Testbed (EIAPP certification), however, they lack the initial on board survey (the IAPP certification).

Now Annex VI has been ratified, all vessels must be surveyed to obtain the final IAPP certificate. New engines will be surveyed during the Sea Trial, whereas engines introduced since 1st January 2000 shall be surveyed no later than the the first dry docking, but in no case later than 3 years after entry into force.

The discussion on new emission limits will start again within the IMO. First of all, with regard to additional NO<sub>x</sub> reductions, but also other emission components. The issue of the existing 'old' engines could surface again.

Additional Local Areas for further SO<sub>x</sub> control could be introduced.

The work involved in issuing the final IAPP certificate is extensive, first for the Owners to ensure compliance (following the onboard TF procedures) and, next, the Authorised Companies to participate in the surveys and issue the certificates.



Owners might want to introduce 'new type' spare parts (e.g. the Slide Fuel Valve) to improve engine conditions. Accordingly, MAN B&W Diesel will prepare *amendments* for such cases.

Further requirements for additional emission reductions, as used on some stationary power plants, are possible, but will unavoidably lead to increased first cost or/and operational costs. For many years, MAN B&W Diesel has been working on different aspects of emission reductions (see MAN B&W Diesel paper, P.333-97-04; 'How to deal with Emission Control').

The next level of emission limits have already been proposed by the leading environmentally-active countries and associations (the US, Japan and EU). A further NO<sub>x</sub> reduction of some 25% to 30% and, eventually, include other emission components like CO, HC and soot.

The new ME engine concept offers a high level of flexibility to optimise the engine for different emission regulations in Local Areas without penalising the fuel consumption or other emission components elsewhere.

## I. Assistance from MAN B&W Diesel

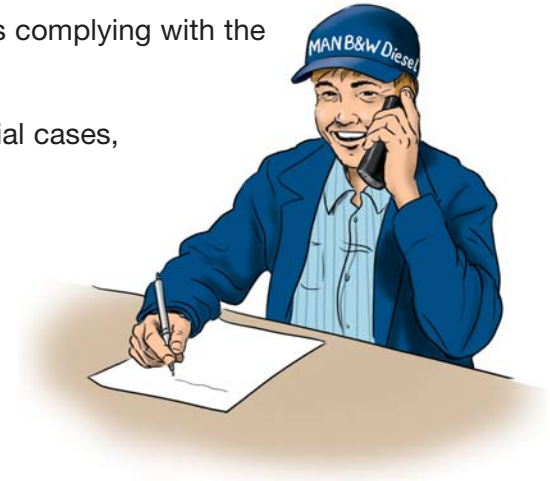
Department 2110 (Classifications) can inform you about the procedures for the TF.

Department 4100 (Diesel Service) offers the following services:

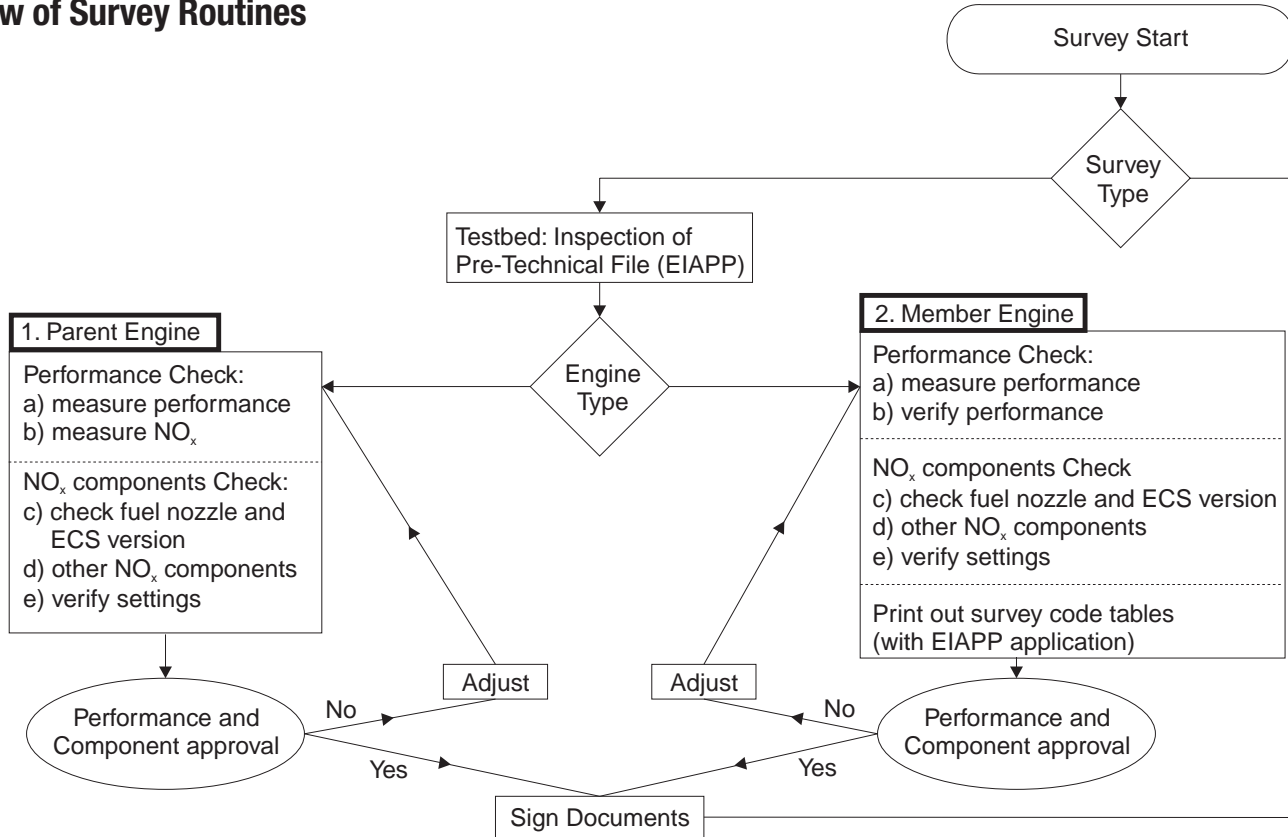
- Review and assistance to Owners to ensure on board compliance (engines with 'IMO certificates' before and after the Annex enters into force)
- Guiding emission measurements (for other purposes than IMO certification/amendments).

Departments 4220/30/40 ensure delivery of genuine spare parts complying with the IMO regulations.

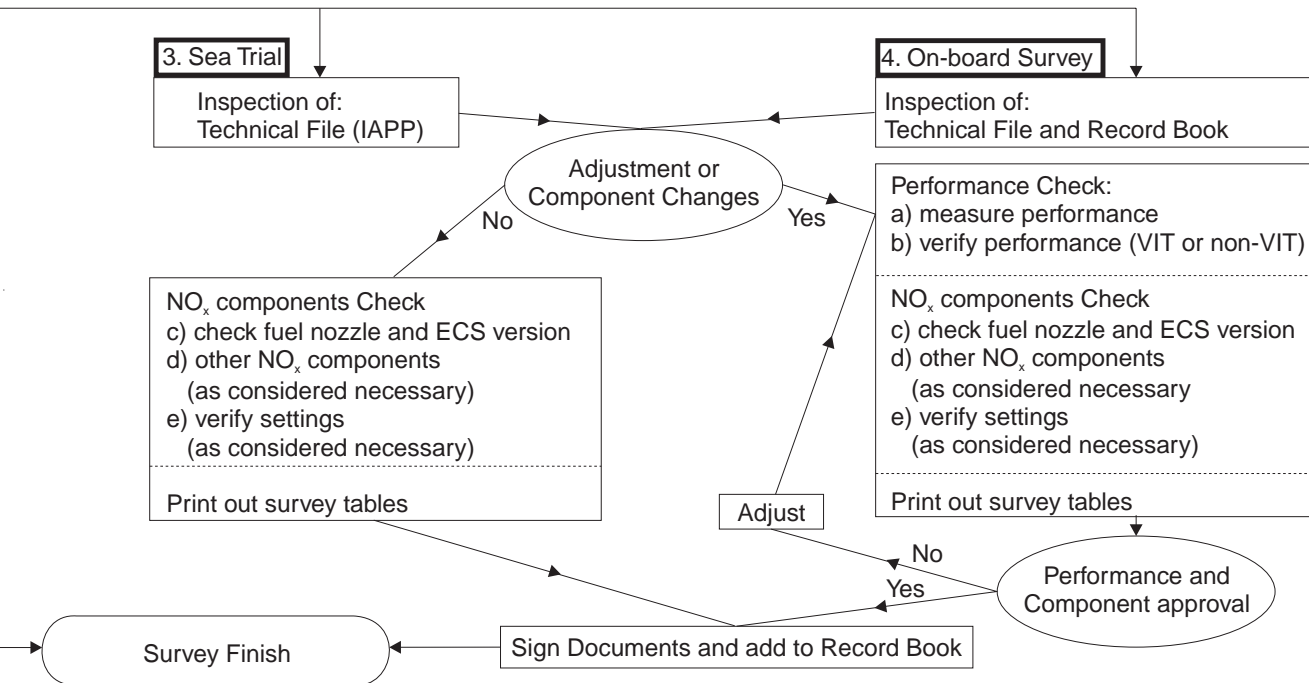
Department 2431 (Basic Research and Emissions) can, in special cases, perform IMO-compliant emission measurements on board.



## J. Overview of Survey Routines







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