TÜRK LOYDU

GUIDELINES for SELECTIVE CATALYTIC REDUCTION SYSTEMS

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A. SCR – Selective Catalytic Reduction Systems

1. General

This guideline provides requirements on the arrangements and system design for SCR systems primarily designed for the removal of NO_x emissions using SCR systems. The intent is that these requirements supplement the statutory emissions performance testing, survey, and certification requirements of the applicable IMO Regulations and Guidelines. At the time of issuance of this Guide, the applicable supplementary Guidelines to MARPOL Annex VI Regulation 13 and the NO_x Technical Code for SCR systems are IMO Resolution MEPC.198(62) – 2011 Guidelines Addressing Additional Aspects to the NO_x Technical Code 2008 With Regard to Particular Requirements Related to Marine Diesel Engines Fitted With SCR Systems, adopted 15 July 2011. Compliance with the applicable IMO Regulations is a pre-requisite for **TL** approval of the SCR system in accordance with the requirements of this Guide.

1.1 Objectives

The objective of this Guide is to provide criteria for the design, construction, installation, survey, and operation of machinery and equipment associated with SCR systems in order to minimize risks to the vessel, crew, and the environment. The intent is that these requirements supplement the statutory emissions performance testing, survey, and certification requirements of the aforementioned IMO Regulations and Guidelines. Detailed requirements are provided in following sections to achieve this objective in accordance with the following key principles and requirements:

- Installation and operation of an SCR system is to be compatible with the FOCU (Fuel Oil Combustion Unit) and not to cause any adverse effects on the FOCU performance, such as excessive back pressures/temperatures, or is to incorporate additional features to mitigate such effects.
- Materials of construction and workmanship are to be in accordance with the requirements of **TL** Rules for Materials and Welding (TL, Part A, Chapter 2 and Chapter 3) .
- SCR systems are to be designed to enable continued operation of the FOCU at the times the EGC (Exhaust Gas Cleaning) system is not in operation, either through operational selection, equipment failure, or system deterioration through partial blocking/clogging, or be designed with suitable exhaust bypass arrangements to enable continued operation of the FOCU.
- Where applicable, SCR units and their associated equipment and systems are to be designed to minimize the risks associated with the storage, handling, consumption, and disposal of hazardous or non-hazardous chemicals or consumables essential for operation of the EGC system. Appropriate personnel protection arrangements and equipment are to be provided.
- Redundancy of equipment is to be provided for those rotating and reciprocating components that form part of the SCR unit supplementary systems, such as pumps, fans, blowers, etc., and due diligence is to be exercised and demonstrated in the assessment of critical components, equipment, and systems. Alternatively the carriage of spare parts onboard or alternative means of compliance or operation will be accepted to meet this objective.
- Means are to be provided to prevent the passage or leakage of exhaust gases to other equipment or spaces that may then pose a safety risk to that equipment or a health risk to the vessel's crew or passengers.
- SCR systems are to be arranged for easy inspection and maintenance and where applicable the ability to replace internal components is to be provided.
- Hot surfaces of SCR units or their associated equipment or systems likely to come into contact with the crew during operation are to be suitably guarded or insulated. Where the surface temperatures are likely to exceed 220°C (428°F), they are to be suitably insulated with non-combustible materials.

- Safe storage and operational arrangements and procedures are to be in place for any specialized or hazardous gases used in SCR units or monitoring systems.
- Automation, instrumentation, monitoring, and control systems are to be provided to enable safe operation of SCR systems.

1.2 Alternatives

Equipment, components, and systems for which there are specific requirements in this Guide, or its associated references, may incorporate alternative arrangements or comply with the requirements of alternative recognized standards, in lieu of the requirements in this Guide. This, however, is subject to such alternative arrangements or standards being determined by **TL** as being not less effective than the overall safety requirements of this Guide or associated references. Where applicable, requirements may be imposed by **TL** in addition to those contained in the alternative arrangements or standards so that the intent of this Guide is met. In all cases, the equipment, component, or system is subject to design review, survey during construction, tests, and trials, as applicable, by **TL** for purposes of verification of its compliance with the alternative arrangements or standards. The verification process is to be to the extent as intended by this Guide.

1.3 Definitions and Abbreviations

1.3.1 CO_2

CO_2 means Carbon Dioxide.

1.3.2 EGC

EGC means Exhaust Gas Cleaning.

1.3.3 EEMS

EEMS means Exhaust Emissions Monitoring System.

1.3.4 Fuel Oil Combustion Unit

Fuel Oil Combustion Unit (FOCU) means any engine, boiler, gas turbine, or other fuel oil fired equipment, excluding shipboard incinerators.

1.3.5 MARPOL

MARPOL means the IMO International Convention for the Prevention of Pollution from Ships, 1973, as modified by the protocol of 1978.

1.3.6 MSDS

MSDS means Material Safety Data Sheet. Sometimes referred to as Safety Data Sheet (SDS) or Product Safety Data Sheet (PSDS).

1.3.7 NO_x

NO_x means Nitrogen Oxides. Predominantly containing NO and NO_2 components and typically calculated as the total weighted emission with mass reference for NO_2 and determined using the relevant test cycles and measurement methods of the IMO NO_x Technical Code or ISO 8178.

1.3.8 Recognized Organization (RO)

A Recognized Organization (RO) is an organization that has been delegated by an Administration to undertake surveys and certification on the Administrations behalf in accordance with the IMO guidelines adopted by Resolution A.739(18), as amended, and the specifications adopted by IMO Resolution A.789(19), as amended.

1.3.9 Recognized Standard

A Recognized Standard is an international or national standard acceptable to **TL**.

1.3.10 Rules

Rules means the applicable edition of the **TL** Rules.

1.3.11 SCR

SCR means Selective Catalytic Reduction. An exhaust aftertreatment system whereby the exhaust gases are mixed with a reductant, such as ammonia introduced in a urea/water solution, and passed over a catalyst, such as vanadium, located in the downstream exhaust system for the purposes of NO_x reduction of the exhaust gases.

1.3.12 SO_x

SO_x means Sulfur Oxide emissions. All sulfur emissions from fuel oil combustion machinery are caused by the combustion reactions with the sulfur introduced by the fuel which predominately include SO_2 and SO_3 emissions and are typically quantified as SO_2 emissions.

1.3.13 Urea

Urea or carbamide is an organic compound widely used as a nitrogen source for fertilizers or used in SCR applications where ammonia and water are mixed, typically as 32% or 40% urea solutions, for use as a reductant enabler for the catalytic process.

1.3.14 FMEA

FMEA means Failure Modes and Effects Analysis.

1.3.15 PVC

PVC means Polyvinyl Chloride.

1.3.16 FRP

FRP means Fiber Reinforced Plastics.

1.3.17 PPE

PPE means Personal Protective Equipment.

1.4 Classification Notations

1.4.1 SCR

Selective Catalytic Reduction catalysts is designed, constructed, and tested in accordance with this guide, the **SCR** notation may be assigned.

2. Plans and Data to be Submitted

Plans and specifications covering the SCR arrangements are to be submitted and are, as applicable, to include:

- General arrangement of the SCR installation, layout, and systems
- Documentation detailing the SCR specification, including details of the SCR catalyst reaction chamber and catalysts, reductant specifications, exhaust system components/modifications, mixing arrangements, reductant injection nozzles/injectors, and soot blowing details,
- Analyses demonstrating compatibility of the SCR system with the engine (see A. 4.2)
- Hull plans showing the foundation and attachments to the vessel's structure including scantlings, welding details, and foundation details of principal components
- Material specifications for the SCR unit, pumps, valves, reductant tanks, piping, distribution systems, filters, and associated components, including a corrosion assessment detailing the corrosive effect of system liquids, vapors, and gases on the materials used in the SCR system
- Arrangement and capacity of reductant storage tanks
- Details of all piping systems, including details of piping and associated components, pumps, reductant dosing systems, air supply systems, design pressures, temperatures, insulation, and drip trays
- Descriptions and schematic diagrams for the control and monitoring systems, including set points for abnormal conditions and details of the location and position at which exhaust emission monitoring probes are to be located
- Details of all electrical equipment installed for the SCR unit and associated systems, including computer-based systems
- FMEA to determine possible failures and their effects in the safe operation of the SCR exhaust emission abatement system [see A. 7.1ii]. Note: This can be a standalone document, or for those integrated SCR units, be incorporated in the engine FMEA required by TL, Part B, Chapter 4, Machinery, Section 2, B.
- Emergency shutdown arrangements
- CR FMEA integration test report (see A.8)
- Operating and maintenance instruction manuals, including MSDS sheets and details for handling of hazardous and non-hazardous chemicals used in the SCR exhaust emission abatement system
- Testing procedures during installation and commissioning trials

3. SCR Operation and Maintenance Manuals

Detailed instruction manuals are to be provided onboard, covering the operations, safety, and maintenance requirements and occupational health hazards relevant to the SCR exhaust emission abatement equipment and associated systems.

These manuals are to include, but not necessarily be limited to, the procedures and schedules for operation, inspection, testing, and maintenance of the SCR and associated systems, the regular testing and maintenance

procedures for the monitoring systems, safety shutoff systems, and the integrity of backup systems, together with special instructions for the bunkering, storage, and use of hazardous or non-hazardous chemicals that may be used in the exhaust emission abatement system and identification of the relevant responsible parties.

The manuals may be produced as standalone documents or incorporated within the general engine operation and service manuals.

The manuals are to be submitted for review solely to verify the presence of all the information required by this guideline.

4. SCR System Configuration and Vessel Integration

4.1 General

i) SCR units are typically installed in the exhaust system of a diesel engine, if applicable, before the exhaust gas economizer and as close as possible to the engine because of the relatively high exhaust gas temperatures required by the catalysts for effective NO_x reduction reactions.

The SCR units may be installed in place of the conventional exhaust silencer or in parallel to the silencer where incorporated in a SCR bypass configuration. The exhaust systems from a number of fuel oil combustion units may be led to a common SCR unit (see A. 6.1.3).

For slow speed diesel engines with inherently low relative exhaust gas temperatures, this may necessitate the integration of the SCR reaction chamber and catalysts before the turbocharger exhaust turbine. The SCR catalysts may also be integrated with the engine by close coupling to the engine, typically applicable to small high-speed diesel engines. In these cases, the SCR unit is considered a primary exhaust emission reduction technique that forms part of the total engine design and as such is to be integrated by, or under authorization of, the engine designer. In those instances, the applicable requirements for SCR systems contained within this guide are supplementary to, and to be applied in association with, the requirements for diesel engines under TL, Part B, Chapter 4, Machinery, Section 2. The integration of a SCR system to an already approved diesel engine is not considered an engine type defining parameter change as per TL, Part B, Chapter 4, Machinery, Section 2, A 2.1.

It is to be noted that exhaust emission abatement systems that cause diesel engines to operate outside the exhaust backpressure limits detailed in the approved IMO Annex VI Regulation 13 Technical Files may invalidate the emissions certification and will require a re-approval of the engine NO_x certification by the Administration or RO responsible for the original certification.

ii) SCR systems are to be designed to enable continued operation of the engine at the times the SCR system is not in operation, either through operational selection, equipment failure, or system deterioration through partial blocking/clogging, or be designed with suitable exhaust bypass arrangements to enable continued operation of the engine.

iii) The response of the mechanical and electrical systems of the first SCR unit in a particular design series is to be demonstrated by the FMEA integration test of Section A.8 of this Guide.

4.2 Compatibility with the Engine

i) Installation and operation of an exhaust emission abatement system is to be compatible with the engine and not to cause any adverse effects on the engine performance such as excessive back pressures or temperatures during operation.

ii) Details are to be submitted demonstrating the exhaust flow compatibility of the SCR unit with the connected engine over the whole operational range of the engine. This data should demonstrate that the operating

parameters of the engine do not exceed the approved design limits with the SCR system in operation. In the case of multi-engine SCR units, this compatibility evaluation is to show that the SCR unit is capable of accommodating the maximum combined exhaust flows of all the connected engines for the worst case scenario for that particular vessel arrangement and operational profile. Consideration will be given to those SCR units that incorporate extractive exhaust fans or air blowing systems to maintain the FOCU operating parameters within the approved design limits.

It is to be noted that the normal and limit values for exhaust back pressure of engines fitted with SCR exhaust emission abatement systems, together with other regulatory aspects, are to be detailed in the approved IMO Annex VI Regulation 13 Technical Files by the Administration or RO responsible for the NO_x certification.

iii) The range of suitable fuels and oils for which the SCR unit is capable of continual operation, in particular with respect to sulfur content or other elements known to cause catalyst clogging, is to be declared by the SCR or engine manufacturer and included in the SCR or engine specification documentation and instruction manuals required by sections A.2 and A.3 of this Guide.

Minimum exhaust gas temperatures, reductant flow rate limits, or other operating parameters that prohibit or limit SCR operation with the indicated range of suitable fuels and/or sulfur content are to be clearly defined in the manuals.

4.3 Redundancy

Redundancy of equipment is to be provided for those rotating and reciprocating components that form part of the exhaust emission abatement unit essential supplementary systems, such as pumps, fans, blowers, etc. (see A 5.1 and A 5.6.3 of this Guide).

Consideration will be given to alternative means of compliance or operational measures to meet this objective on a case-by-case basis. As applicable, documentation is to be submitted demonstrating that the reliability of the system or component provides continued serviceability of the exhaust emission abatement system or the alternative means of operation provides continued compliance with the statutory environmental requirements, without compromising the vessel propulsion and maneuvering capability. The provision of sufficient spare parts onboard is an example of vessel specific arrangements that may be considered by **TL** as meeting this objective and should be justified with reference to the FMEA required by A.7.1ii) of this Guide.

4.4 Essential Services

For the purposes of design, construction, testing, and survey, SCR units and associated components and systems are considered secondary essential services in accordance with TL, Part B, Chapter 5, Electrical Installation, Section 1, B, 2.3.2.

4.5 Inclinations

Exhaust emission abatement systems are to be designed for proper operation at the inclination requirements of TL, Part B, Chapter 4, Machinery, Section 1, C, Table 1.1.

4.6 Inspection and Maintenance

Exhaust emission abatement systems are to be arranged for easy inspection and maintenance with at least one inspection port available for internal inspection of the main reaction chamber and where applicable the ability to replace internal components is to be provided. Exemptions may be granted to those small SCR units not intended to be dismantled in service and typically integrated with high speed mass produced diesel engines.

5. SCR System Equipment

5.1 Pumps/Fans

i) Unless alternative means of compliance in accordance with A.4.3 are applicable, redundant pumps, essential for the continual operation of the SCR system, are to be provided. There are to be at least two of these essential pumps, and the capacity of the pumps, with any one pump out of service, is to be sufficient for continuous operation of the exhaust emission abatement system at full rating see also A.5.6.3.

For vessels fitted with two or more identical exhaust emission abatement systems, the provision of a common standby pump (for each essential system) capable of serving all SCR units will suffice rather than providing individual standby pumps for each SCR unit.

ii) Unless alternative means of compliance in accordance with A.4.3 are applicable and where exhaust fans form part of the SCR system and are essential for continual operation of the exhaust emission abatement system at full rating, such fans are to be installed in a redundant arrangement. The number and power of the fans should be such that if one fan, or a group of fans, is out of service the capacity of the remaining fan(s) is not to be less than 100% of the total required.

5.2 Heat Exchangers

Where provided, heat exchangers are to be designed, constructed, and certified in accordance with TL, Part B, Chapter 4, Machinery, Section 14. Suitability of the heat exchanger materials for the intended media is to be demonstrated.

5.3 SCR Reductant System

The SCR manufacturer is to detail the specification of the reductant solution(s) appropriate for use with the SCR system and any specific installation considerations that may be applicable for storage, handling, and use of the reductant. Urea is typically not classified as dangerous according to MSDS but can be an eye, skin, and respiratory irritant, and hence there is a need for the provision of appropriate safety features and personnel protective equipment.

The key fluid media components of the SCR reductant system typically comprise reductant storage tank, pumps, filters, dosing units, and injectors with associated control system. The specific requirements for SCR reductant system components using urea as a reductant are given under A 6.2.

Arrangements using alternative reductant solutions, such as aqueous ammonia or anhydrous ammonia, will be considered on a case-by-case basis.

5.4 SCR Reaction Chamber

i) Details of the SCR catalyst specifications, geometry, and fixing arrangements of the catalyst elements in the reaction chamber are to be submitted.

ii) The catalyst elements are to be securely mounted in the reaction chamber to provide effective gas sealing under all operational temperatures to provide effective reaction processes and prevent the passage of unreacted ammonia to the atmosphere.

iii) Access arrangements for the catalyst elements are to provide easy removal and maintenance in service. Sufficient space around the SCR reaction chamber for replacing the catalyst elements is to be provided.

iv) Provision is to be made to indicate that catalyst elements have been removed from the reaction chamber so that reduction injection may be stopped.

v) Arrangements are to be provided to prevent the blocking or clogging of SCR catalyst elements which could create excessive exhaust backpressures for the connected engine, a reduction in catalyst reaction efficiency, and a fire hazard through soot accumulation. In general, this is expected to be achieved by control system limits on reductant injection strategies and by the inclusion of soot blowing arrangements for the catalyst chamber. Details of the soot blowing arrangements, where provided, are to be submitted for review.

The reductant injection strategies are to monitor exhaust temperatures and prevent reductant injection at those operating temperatures and modes that would cause excessive fouling of the catalyst elements by, for example, the formation of ammonia sulfates.

Arrangements are to be such that blocked catalyst elements will not prevent operation of the engine.

vi) Monitoring, alarm, and shutdown arrangements are to be provided to indicate:

a) An abnormal pressure rise across the SCR reaction chamber

b) Reductant injection rates above the conversion capability of the catalysts elements

c) Injection of reductant when the engine is not running or there is a fault with the catalyst elements or the associated SCR reductant components or systems

5.5 Pneumatic Systems

i) Details of the pneumatic systems used for reductant injection, soot blowing, and any other associated SCR systems are to be submitted. Pneumatic systems are to comply with the requirements of TL, Part B, Chapter 4, Machinery, Section 16.

ii) Air supply for these systems may be taken from existing vessel infrastructure provided it does not compromise the air start supply and reserve requirements of TL, Part B, Chapter 4, Machinery, Section 2, H.

5.6 Electrical System

The electrical system and electrical equipment requirements in this guideline are to be applied in association with the requirements of TL, Part B, Chapter 5, Electrical Installation.

5.6.1 Electrical Motors and Controllers

Motors and motor controllers of 100 kW (135 hp) and over are to be certified in accordance with TL, Part B, Chapter 5, Electrical Installation.

5.6.2 Electrical Load Analysis

The number and capacity of generators are to be sufficient under normal seagoing conditions with one generator in reserve to carry those loads for essential services, which include the SCR system, and for minimum comfortable conditions of habitability as per TL, Part B, Chapter 5, Electrical Installation, Section 3, B 1.1, 1.2.

5.6.3 Standby Pump/Fan Arrangements

i) In the event of failure of the essential exhaust emission abatement system pumps or fans, the standby pump or fan required by A 5.1 of this Guide, where provided, is to be automatically started and put into service. This failure is to be alarmed at the local and remote control station(s), as applicable.

ii) Where provided, each standby pump or fan is to be fed from separate sections of the switchboard such that in the event of failure of one section of the switchboard the standby pump or fan may be fed from the other separate section of the switchboard.

5.6.4 Circuit Protection Devices and Compatibility

Circuit breakers are to be installed for miscellaneous SCR system electrical loads and are to be compatible with the prospective short circuit current level calculated at the switchboards.

6. SCR System Piping

6.1 Exhaust Gas Piping Systems

6.1.1 Exhaust Gas Piping/Reaction Chamber Materials and Installation

i) Exhaust gas piping materials located before the reductant injection mixing sections or SCR reaction chamber may be of the same material specification as the standard exhaust gas piping.

ii) The sections of the SCR exhaust system and reaction chamber that are subjected to exhaust gas and reductant mixtures are to be constructed of suitable corrosion resistant materials.

Details of the exhaust mixers, mixing chambers, reductant nozzles, or injectors are to be submitted. Injection arrangements are to be designed to provide effective mixing of the reductant and exhaust gas.

iii) The exhaust piping systems for exhaust emission abatement systems are to meet the applicable requirements TL, Part B, Chapter 4, Machinery, Section 16.

6.1.2 Exhaust Gas Piping Valves

i) Valves used in the exhaust system of emission abatement systems are to meet the requirements of TL, Part B, Chapter 4, Machinery, Section 16 and, in general, are to comply with a recognized standard and are to be permanently marked in accordance with the requirements of that standard.

The valves are to be constructed of corrosion resistant materials.

ii) Isolation and bypass valves used in SCR system exhaust piping systems are to prevent the passage of exhaust gases to other engines or machinery spaces.

Where bypass arrangements for the SCR system are provided, the isolation and bypass valves are to be arranged in an interlocked, fail safe manner, such that free flow of exhaust gases to atmosphere at all times is possible, either through the SCR system or through the bypass. Bypass valves are to be provided with a local position indicator.

iii) Valves are to be installed in accessible locations, clear of or protected from obstructions, moving equipment, and hot surfaces, in order to permit regular inspection and/or periodic servicing.

6.1.3 Interconnections of Exhaust Gas Piping

i) Normally exhaust pipes from diesel engines are to be routed separately and not interconnected. However, interconnected exhaust piping systems to a common exhaust emission abatement unit may be accepted subject to the arrangements preventing the passage or leakage of exhaust gases to other equipment or spaces that may then pose a safety risk to that equipment or health risk to the vessel's crew or passengers. The return of exhaust gas flow from a running engine to another stopped, or in operation, engine is to be prevented.

ii) The combined SCR system is to be designed not to exceed the back pressure limits specified by the connected engines or boilers. Fans installed for this purpose are to meet the redundancy requirements of A. 5.1ii).

6.1.4 Exhaust Gas Piping and SCR Reaction Chamber Insulation

Hot surfaces of exhaust emission abatement units or their associated equipment or systems likely to come into contact with the crew during operation are to be suitably guarded or insulated. Where the surface temperatures are likely to exceed 220°C (428°F) and where any leakage, under pressure or otherwise, of fuel oil, lubricating oil, or other flammable liquid is likely to come into contact with the SCR unit or exhaust pipes, these surfaces are to be suitably insulated with non-combustible materials that are impervious to such liquids. Insulation material not impervious to oil is to be encased in sheet metal cladding or an equivalent impervious sheath.

6.2 Reductant Piping Systems – Urea Solution

The requirements for the reductant piping systems detailed in this Subsection are based on the use of ammonia as a reductant introduced in a urea/water solution at 32% or 40% concentrations.

6.2.1 Piping and Connections

i) In general, pipe fittings and joints are to meet the requirements of TL, Part B, Chapter 4, Machinery, Section 16 for certification.

ii) The reductant piping and venting systems are to be independent of other ship service piping and/or systems.

iii) Reductant piping systems are not to be located in accommodation, service, or control spaces.

iv) Supply, bunkering, and transfer lines for reductant systems, with the exception of those associated with injector equipment, are not to be located over boilers or in close proximity to steam piping, exhaust systems, hot surfaces required to be insulated, or other sources of ignition.

v) The material of the reductant related piping systems, tanks, and other components which may come into contact with the reductant solution is to be of a suitable grade of non-combustible alloyed steel, plastic, or other compatible material established to be suitable for the application.

Non-alloyed steels, copper, copper containing alloys, and zinc-coated steels are not to be used for reductant storage or piping systems.

vi) Pipes and piping components made of thermoplastic or thermosetting plastic materials, with or without reinforcement, may be used in piping systems subject to compliance with the requirements of TL, Part B, Chapter 4, Machinery, Section 16 (in particular B 2.6). For the purpose of these Rules, “plastic” means both thermoplastic and thermosetting plastic materials, with or without reinforcement, such as PVC and FRP. Plastic piping is to meet Level 3 fire endurance testing requirements (see TL, Part B, Chapter 4, Machinery, Section 16, B 2.6.9).

vii) Flexible hoses are to comply with the requirements of of TL, Part B, Chapter 4, Machinery, Section 16 (in particular D.10, and U).

6.2.2 Filters and Strainers

Filters are to be provided in reductant piping systems to minimize the entry of harmful foreign material that may affect operation and closure of regulating valves, dosing valves, or other essential system components. The filters are to be designed to withstand the maximum working pressure of the system.

6.2.3 Arrangement of the Urea Storage Tank

i) The urea storage tank is not to be situated where spillage or leakage therefrom can constitute a hazard by falling onto combustibles or heated surfaces and is to be located in a well-ventilated area away from heat sources.

The urea storage tank may be located within the engine room. If installed in a separate compartment, the area is to be served by an effective mechanical exhaust ventilation system with ventilation inlets located where any vapors would be expected to accumulate. In addition, if located in a separate compartment, the ventilation system is to be capable of being controlled from outside the compartment.

ii) The urea storage tank is to be protected from excessively high or low temperatures applicable to the particular urea concentration of the solution (e.g., above 30°C and below 0°C for a 40% solution). Depending on the operational area of the vessel, this may necessitate the fitting of heating and/or cooling systems.

iii) Every pipe emanating from a tank containing urea, which, if damaged, would allow urea to escape from the tank, is to be provided with a manual closing valve located directly on the tank.

iv) The urea storage tank is to be provided with vent pipes complying with TL, Part B, Chapter 4, Machinery, Section 16, R and the outlets are to terminate in a safe location (Vent outlets are to be situated where possibility of ignition of the gases issuing therefrom is remote) in the weather.

The vents that are open to the weather should not be subject to deterioration due to the concentrations involved and the arrangement is to be such that the potential source of moisture from the vents does not present any danger to the crew or vessel. Alternatively, the tanks are to be fitted with appropriately sized pressure/vacuum valves.

v) The urea storage tank is to be provided with temperature and level monitoring arrangements.

6.2.4 Spill Trays

Urea storage tanks with a capacity of 500 liters and above are to be located within spill trays fitted with a high level alarm.

6.2.5 Personnel Protection

For the protection of crew members, the vessel shall have on board suitable protective equipment consisting of large aprons, rubber gloves with long sleeves, rubber boots, coveralls of chemical-resistant material, dust respirator, and tight-fitting chemical safety goggles or face shields or both. An eyewash and safety shower should be nearby.

6.2.6 Safety Notices for the Compartment or at the Location of Tanks Containing Urea

Safety instructions relating to precautions and corrective response actions are to be posted in the compartment containing urea and beside the entrance to the compartment. Detailed guidelines given in the MSDS are to be followed.

7. Control, Monitoring, and Safety Systems

7.1 General

i) The control system for the SCR exhaust emission abatement system may be connected to an integrated control system or may be a standalone system. Where the SCR control system is integrated in the base engine design, the control system is to be integrated with, or in direct communication with, the engine control system.

ii) The system is to be designed such that a single fault of a component will not lead to a potentially dangerous situation for human safety and/or the vessel.

An FMEA, or equivalent, demonstrating the safety system design basis is to be submitted.

iii) Where fitted, exhaust emissions monitoring systems are to meet the requirements of Section B of this Guide.

7.2 Control and Monitoring System

i) Automatic control, alarm, and safety functions are to be provided for the SCR system so that operations remain within preset parameters for all diesel engine and exhaust emission abatement system operating conditions. For vessels with AUT or AUT-C notations, the alarm and monitoring systems are to be integrated in the vessel's centralized monitoring systems that conform to the requirements for AUT or AUT-C notations.

ii) The temperatures, pressures, and flows in the SCR system and associated systems are to be controlled and monitored as follows:

a) A local control and monitoring system for the SCR system is to be provided to enable safe operation, maintenance, and effective control in the event of an emergency or failure of any remote controls. This may be integrated with the engine control system and/or be a standalone system.

b) The design of the control system is to provide identification of faults in the equipment, as well as the process system.

c) Indications of parameters necessary for the safe and effective operation of the exhaust emission abatement process are to be provided at the local and, as applicable, remote control station(s), as per Table A.1 and are to include the following parameters:

1) SCR system pump/fan/motor operational status

2) Status of any SCR system valves

3) SCR system parameters for operational safety

4) Level indication of SCR system tanks

5) Status of any SCR system alarms, shutdowns and Emergency Stop

d) Injection of reductant solutions outside the exhaust gas temperature limits specified by the catalyst manufacturer is to be prohibited by the control system [see A5.4vi)], and control strategies are to minimize ammonia slip.

e) The computer-based control systems are to comply with the applicable requirements of TL, Part B, Chapter 5, Electrical Installation, Section 10 as a Category III.

iii) The power supply arrangements for the control and monitoring system are to meet the requirements of TL, Part B, Chapter 4-1, Automation .

7.3 Safety Shutdown System

A shutdown system is to be provided. This safety shutdown system is to be based on the following principles:

i) Means are to be provided to indicate the parameters causing shutdown.

ii) Upon activation of the safety shutdown system, alarms are to be given at the normal control position and at the local control position.

iii) In the event where shutdown by the safety shutdown system is activated, the restart should not occur automatically, unless after the system is reset.

Monitoring and safety shutdowns are to be in accordance with Table A.1.

8. FMEA Integration Test

An integration test is to be undertaken on the first SCR unit in a particular design series to verify that the operation and response of the complete SCR mechanical and electrical systems are as predicted for all operational modes. The scope of these tests is to be determined based on the FMEA required by A.7.1ii).

9. Surveys During Construction

9.1 General

This Subsection pertains to surveys during fabrication at the manufacturer's facility and installation and testing of SCR units onboard. These surveys may be incorporated with the certification, shop test, and shipboard tests required by the applicable aspects of TL, Part B, Chapter 4, Machinery, Section 02, E. For surveys at the manufacturer's facility, the scope of the survey will be confined to only those items that are supplied by the manufacturer.

9.2 Surveys at Manufacturer's Facility

See Table A.2 for certification requirements of SCR units and associated systems. Survey requirements for equipment components and packaged units at the manufacturer's facility are summarized in the relevant sections of the applicable Rules/Guides.

9.3 Surveys During Installation

The following surveys are to be carried out to the satisfaction of the attending Surveyor on the SCR unit and associated systems during installation and testing:

i) Inspection and verification that the foundations and attachments of the principal components of the SCR abatement unit and associated systems are in accordance with the approved plans and particulars.

ii) Piping systems are to be visually examined and pressure-tested. Pressure tests conducted on Class I piping systems (see TL, Part B, Machinery, Chapter 4, Section 16, Table 16.1) should preferably be recorded on test charts for the duration of their tests.

iii) Electrical wiring and connections are to be in accordance with TL, Part B, Chapter 5, Electrical Installation and checked for continuity and proper workmanship.

iv) Instrumentation is to be tested to confirm proper operation as per its predetermined set points.

v) Pressure relief and safety valves installed on the unit are to be tested.

vi) Control system and shutdowns are to be tested for proper operation.

vii) The SCR unit is to be checked for proper operation in accordance with the **TL** approved installation test procedure.

9.4 Surveys During Trials

During the initial commissioning trials, the SCR unit is to be confirmed for its satisfactory operation, including associated controls, alarms, and shutdowns. The tests are to be conducted in accordance with the **TL** approved testing procedure during sea trials.

TABLE A.1

Monitoring and Safety System Functions for SCR Systems

Monitored Parameters	*Display*	*Alarm Activated*	*Automatic SCR Shutdown and Automatic SCR Bypass (1)*
Exhaust fan motors	Running	Stop (2)	
Exhaust bypass or isolation valves, where provided	Position		
Control-actuating medium of the exhaust bypass or isolation valves, as applicable	Running	Failed	
Exhaust gas temperature before SCR chamber	X	High	X (High-High)
Exhaust gas temperature after SCR chamber	X	High	X (High-High)
Exhaust gas backpressure after the engine	X	High	X (High-High)
Differential pressure across SCR chamber	X	High	X (High-High)
Reductant dosing pumps	Running	Stop (2)	
Reductant system supply pressure	X	Low	X (Low-Low)
Reductant storage tank temperature	X	Low/High	X (High-High)
Reductant storage tank level	X	Low/High	X (Low-Low)
Reductant tank drip tray level (3)		High	X (High-High)
Pneumatic supply pressure, injector and soot blowing systems	X	Low	X (Low-Low)
Control power supply	Running	Failed	
Emergency shutdown	X	X	X

Notes:

1 Automatic bypass of the SCR unit is only applicable to those SCR units fitted with exhaust gas bypass arrangements (see A.4.1).

2 Failure of essential SCR system motors driving pumps or fans is to activate the standby units, where fitted (see A.5.6.3 of this Guide).

3 Urea storage tanks of 500 liters and above only (see A.6.2.4).

TABLE A.2
Certification of SCR Systems at the Manufacturer's Facility

This Table has been prepared for guidance only and annotated to agree with the *TL Classification and Construction Rules*. The list is not to be considered exhaustive; should additional equipment not listed be fitted onboard, same will be subject to special consideration for compliance with the *TL Classification and Construction Rules*. This list is not to be considered as substitutive or integrative of the content of the *TL Classification and Construction Rules* and/or other applicable Regulations. In case of conflict between the content of this list and the applicable *TL Classification and Construction Rules* and other applicable regulations, the latter are to be considered applicable.

Code	*Explanation*
DR	*Design Review* – Design review required.
MS	*Manufacture Survey* – Product is to be surveyed during fabrication stages by the Surveyor.
FS	*Final Survey* – Finished product is to be subject to final hydrostatic, nondestructive, operational testing, or any other required tests, and witnessed by the Surveyor at manufacturer's facility.

Equipment	*DR*	*MS*	*FS*
SCR unit	X	X	X
Exhaust piping	X		
Exhaust bypass or isolation valves	X		
Exhaust fans/motors (1)	X		X
Heat exchangers	X		X
Reductant system piping	X		
Pneumatic systems	X		
Control system	X		
Automatic shutdown and safety system	X		

Notes:

1 Applicable for motors over 100 kW (135 hp) only. For motors less than 100 kW (135 hp), certification by **TL** not required, acceptance based on manufacturers documentation and guarantee (see A 5.6.1).

B. Exhaust Emission Monitoring Systems

1. General

The requirements in this Section provide guidance on the arrangements and system design for permanently installed EEMS designed for the monitoring of gaseous exhaust emission constituents, primarily for compliance verification of the NO_x and SO_x emissions. These monitoring systems would, as a minimum, necessitate the measurement of the NO_x, SO_2, and CO_2 gaseous species.

The intent is that these requirements supplement the statutory specification, calibration, testing, and survey requirements of the applicable IMO Regulations and Guidelines. NO_x emissions monitoring systems may be installed for the purpose of monitoring exhaust emission abatement systems or for application as an alternative onboard NO_x verification procedure in accordance with the requirements for Direct Measurement and Monitoring Systems of 6.4 and Appendix 8 of the NO_x Technical Code.

Compliance with the applicable IMO Regulations is a pre-requisite for **TL** approval of the exhaust emission monitoring system in accordance with the requirements of this Guide.

2. Plans and Data to be Submitted

Plans and specifications covering the exhaust emission monitoring system arrangements are to be submitted and are, as applicable, to include:

• General arrangement of the exhaust emission monitoring system installation, layout, and systems

• Documentation detailing the exhaust emission monitoring equipment and associated system specifications

• Details of the exhaust emission sampling and piping systems, including details of probes, pre-filters, heated lines, air supply arrangements, pure and calibration gas lines, design pressures, temperatures, materials, and insulation

• Descriptions and schematic diagrams for the control and monitoring systems, including set points for abnormal conditions and details of the location and position at which exhaust emissions monitoring probes are to be located

• Details of all electrical equipment installed for the EEMS equipment and associated systems

• Schematic diagrams and operational descriptions of the exhaust emission monitoring equipment and associated systems power supply arrangements

• Electrical one line diagrams depicting type, size, and protection of electrical cables used in the EEMS control and monitoring equipment

• Operating and maintenance instruction manuals

• Testing procedures during installation and commissioning trials

3. EEMS Operation and Maintenance Manuals

In accordance with A.3 of this Guide, detailed instruction manuals are to be provided onboard, covering the operations, safety, and maintenance requirements and occupational health hazards relevant to the exhaust emission monitoring equipment and associated systems.

These manuals are to include, but not necessarily be limited to, the procedures and schedules for operation, inspection, testing, and maintenance of the EEMS together with identification of the relevant responsible parties and special instructions for the health and safety implications of handling and proximity to exhaust gases and the storage and handling of pressurized bottles of pure and calibration gases. Special attention is to be paid to maintaining the continued serviceability and accuracy of the monitoring system.

The manuals are to be submitted for review solely to verify the presence of all the information required by this Section.

4. Exhaust Emission Monitoring Systems

4.1 General

i) Exhaust emissions monitoring systems may typically be installed for the purpose of, but not limited to, verifying compliance with MARPOL Annex VI Regulations 13 and 14 for NO_x or SO_x gaseous emissions. and may also be installed in association with an EGC after treatment system.

ii) Alternative emissions monitoring system design principles are permitted provided analyzer equivalency is demonstrated [see also B 5.4i)]. Accordingly, the requirements for certain design features, such as sample handling and pneumatic systems detailed under B.5.3 and B.5.6, respectively, may not be applicable to all exhaust emissions monitoring systems.

iii) An exhaust emissions monitoring system may be assigned to a vessel fitted with, or without, an exhaust emission abatement system.

4.2 Inclinations

Exhaust emission monitoring systems are to be designed for proper operation at the inclination requirements of TL, Part B, Chapter 4, Machinery, Section 1, C, Table 1.1.

5. EEMS Equipment

5.1 General

i) Due consideration is to be given to the safety implications related to the handling and proximity of exhaust gases, the measurement equipment, and the storage and use of pressurized pure and calibration gases. Such implications are to be documented in the operation and maintenance manuals and suitable warning notices positioned at the sample points and measurement equipment.

ii) Where practicable, permanent access platforms are to be installed to enable safe operation and maintenance of the exhaust emission monitoring equipment.

5.2 Sample Probes for Gaseous Emissions

i) The gaseous sampling probes are to be positioned to enable sampling of a representative exhaust gas sample after the engine, turbocharger, or EGC system, in accordance with the location and temperature criteria of 5.9.3.1 and 5.9.3.2 of the NO_x Technical Code.

ii) A sample probe connection flange designed in accordance with Section 5 of Appendix 8 of the NO_x Technical Code and B 5.2i) is to be provided for each engine or FOCU required to be monitored.

iii) The sample probe connection flanges are preferably to be installed in accessible locations, clear of or protected from obstructions or moving equipment, in order to permit regular inspection and/or periodic servicing.

iv) In order to establish the capability of the sample probe to withstand fatigue, which is likely to occur due to vibrations under operating conditions, each sample probe design is to be vibration tested in accordance with a recognized standard, such as IEC 60068-2-6 for location on diesel engines.

5.3 Sample Handling

i) Where applicable, pre-filters and heated sample lines are preferably to be installed in accessible locations, clear of or protected from obstructions or moving equipment, in order to permit regular inspection and/or periodic servicing.

ii) In order to establish the capability of the pre-filters and sample lines to withstand fatigue, which is likely to occur due to vibrations under operating conditions, each design is to be vibration tested in accordance with a recognized standard, such as IEC 60068-2-6.

iii) Hot surfaces of pre-filters or heated lines likely to come into contact with the crew during operation are to be suitably guarded or insulated. Where the surface temperatures are likely to exceed 220°C and where any leakage, under pressure or otherwise, of fuel oil, lubricating oil or other flammable liquid is likely to come into contact with the sampling components or exhaust pipes, these surfaces are to be suitably insulated with non-combustible materials that are impervious to such liquids. Insulation material not impervious to oil is to be encased in sheet metal cladding or an equivalent impervious sheath.

5.4 Analyzer Specifications and Calibration

i) The EEMS gaseous analyzers are to be in accordance with the principles and specifications of Appendix 3 of the NO_x Technical Code or else demonstrated as equivalent in accordance with ISO 5725-1 and 5725-2, as permitted by 5.4.2 of the NO_x Technical Code and ISO 8178-1 Section 7, to the satisfaction of **TL**.

ii) Calibration of the EEMS analyzers is to be in accordance with Appendix 4 of the NO_x Technical Code or else demonstrated as equivalent to the satisfaction of **TL**.

5.5 Data Recording and Processing Device

i) The EEMS is to be capable of recording calibration and emissions monitoring data. This capability may be incorporated within the EEMS control or integrated system.

ii) The data recording device should be capable of preparing data and reports over specified time periods in a readily readable format capable of being downloaded and printed by an attending Surveyor.

5.6 Pneumatic Systems

i) Where applicable, details of the pneumatic arrangements used for exhaust emission monitoring systems are to be submitted and are to comply with the requirements of TL, Part B, Chapter 4, Machinery, Section 16.

ii) Air supply for these systems may be taken from existing vessel infrastructure provided it does not compromise the air start supply and reserve requirements of TL, Part B, Chapter 4, Machinery, Section 2, H.

6. Monitoring System

6.1 General

The control system for the exhaust emission monitoring system may be connected to an integrated control system or may be a standalone system.

6.2 Monitoring System

i) The design of the monitoring system is to provide identification of faults in the equipment, as well as the process system.

ii) The system is to be of a self-monitoring type, and means of testing the alarms are to be provided.

iii) The computer-based monitoring systems are to comply with the applicable requirements of TL, Part B, Chapter 5, Electrical Installation, Section 10 as a Category III.

iv) The electronic control equipment is to be performance tested in the presence of the Surveyor or by a recognized testing laboratory.

v) The power supply arrangements for the monitoring system are to meet the requirements of TL, Part B, Chapter 4-1, Automation.

Monitoring is to be in accordance with Table B.1.

7. Surveys During Construction

7.1 General

This section pertains to surveys during installation and testing of EEMS units onboard.

7.2 Surveys During Installation

The following surveys are to be carried out to the satisfaction of the attending Surveyor on the EEMS unit and associated systems during installation and testing:

i) Piping systems are to be visually examined and pressure-tested, as required by TL Rules. Pressure tests conducted on Class I piping systems (see TL, Part B, Machinery, Chapter 4, Section 16, Table 16.5) should preferably be recorded on test charts for the duration of their tests.

ii) Electrical wiring and connections are to be in accordance with TL, Part B, Chapter 5, Electrical Installation and checked for continuity and proper workmanship.

iii) Instrumentation is to be tested to confirm proper operation as per its predetermined set points.

iv) Pressure relief and safety valves installed on the unit are to be tested.

v) Control system and alarms are to be tested for proper operation.

vi) The EEMS unit is to be checked for proper operation in accordance with the **TL** approved installation test procedure.

7.3 Surveys During Trials

During the initial commissioning trials, the EEMS is to be confirmed for its satisfactory operation, including associated controls, alarms, and shutdowns. The tests are to be conducted in accordance with the **TL**-approved testing procedure during sea trials.

TABLE B.1

Monitoring System Functions for EEMS Systems

Monitored	*Display*	*Alarm Activated*
Analyzer/EEMS power supply	X	Failed
Pneumatic air supply, as applicable		Failed
Exhaust gas sample temperature	X	Low/High
Pre-filter and heated line temperature, as applicable	X	Low/High
Sampling flow rate, as applicable	X	Low
Data logging	X	Failed

C. Surveys After Construction and Maintenance of Class

1. General

This Section pertains to periodical surveys after construction for the systems described in Section A, B of this Guide.

1.1 Definitions

For definitions related to the surveys of equipment covered refer to TL Classification and Surveys Rules.

1.2 Modifications

When it is intended to carry out any modifications to the exhaust emission abatement system, associated components, or monitoring equipment, which may affect classification, including substitutions of material differing

from that originally installed, the details of such modifications are to be submitted for review. If **TL** determines that the modification will affect classification, the affected system or component to be modified will be subject to the review, testing, and survey requirements in accordance with this Guide.

2. Survey Intervals

2.1 Annual Survey

An Annual Survey of a vessel fitted with exhaust emission abatement equipment, monitoring equipment, and installed classed systems covered by this Guide is to be carried out within three (3) months before or after each annual anniversary date of the crediting of the previous Class Renewal Survey or original construction date. For vessels on Continuous Survey, all Continuous Survey requirements for those parts (items) due are generally to be completed each year. The Annual Survey will not be credited and the Certificate of Classification will not be endorsed unless Continuous Survey items that are due or overdue at the time of the Annual Survey are either completed or granted an extension.

2.2 Class Renewal Survey

A Class Renewal Survey of exhaust emission abatement equipment, associated systems, and monitoring equipment is to be completed within five years after the date of build or after the crediting date of the previous Class Renewal Survey. The fifth Annual Survey must be credited as a requirement of the Class Renewal Survey.

The Class Renewal Survey may be commenced at the fourth Annual Survey and be continued with completion by the fifth anniversary date. Where the Class Renewal Survey is commenced prior to the fourth Annual Survey, the entire survey is to be completed within fifteen (15) months if such work is to be credited to the Class Renewal Survey.

A Class Renewal Survey will be credited as of the completion date of the survey but not later than five years from date of build or from the date recorded for the previous Class Renewal Survey. If the Class Renewal Survey is completed within three (3) months prior to the due date, the Class Renewal will be credited to agree with the effective due date. Special consideration may be given to Class Renewal Survey requirements in unusual cases. Consideration may be given for extensions of Rule-required Class Renewal Surveys under exceptional circumstances.

2.3 Continuous Class Renewal Surveys

At the request of the Owner, and upon approval of the proposed arrangements, a system of Continuous Surveys may be undertaken, whereby the Class Renewal Survey requirements are carried out in regular rotation to complete all of the requirements of the particular Class Renewal Survey within a five-year period. The proposed arrangements are to provide for survey of approximately 20% of the total number of survey items during each year of the five-year period. Reasonable alternate arrangements may be considered as recommended by the manufacturer.

Generally, each part (item) surveyed becomes due again for survey approximately five (5) years from the date of the survey, and the due parts (items) are generally to be completed each year.

TL may withdraw its approval for Continuous Survey if the Surveyor's recommendations are not complied with.

2.4 Survey Based upon Preventive Maintenance Systems

A properly conducted approved program of preventive-maintenance/condition-monitoring plan may be credited as satisfying the requirements of Class Renewal Survey. This plan must be in accordance with TL, Classification and Surveys, Section 3, A 4.5 and A 4.6.

3. Surveys

3.1 Annual Surveys

3.1.1 General

The following should be carried out during each Annual Survey of the exhaust emission abatement equipment, associated systems, and monitoring equipment:

i) General. The logbooks are to be examined with regard to correct functioning of the exhaust emission abatement systems, emissions monitoring, and washwater monitoring systems, etc. The hours per day of the prime movers, SCR systems, exhaust emission monitoring systems, as applicable, are to be considered together with historical records.

ii) Operating and Maintenance Instruction Manual. The approved instructions and manuals covering the operations, safety, and maintenance requirements and occupational health hazards relevant to exhaust emission abatement units and associated systems are to be confirmed as being aboard the vessel.

iii) Instrumentation, Control, Monitoring, and Safety Systems. The instrumentation, control, monitoring, and safety equipment applicable to each particular type of installed exhaust emission abatement unit and associated systems, including indicators and alarms, is to be confirmed in satisfactory operating conditions. The examination is to be made with one or more ship's service generator(s) in operation and the control system energized to permit random checking of function indicators, alarms, and such control actuators as may be operational. Installed interlocks, where applicable, are to be verified in working condition.

iv) Exhaust Gas Handling Piping and Machinery. All piping, hoses, bellows, blowers/fans, heaters, dry scrubbing equipment, soot blowing equipment, emergency shutdown or bypass valves, remote operating valves, and machinery and equipment associated with processing or distribution of exhaust gases is to be examined, as far as possible. Stopping of pumps, fans, and blowers upon emergency shutdown of the system is to be confirmed.

Where applicable, exhaust system bypass, isolation, or mixing valve sealing arrangements are to be examined.

The integrity and effectiveness of insulation arrangements is to be confirmed.

v) Water Treatment, Reductant, and Residue Systems. All tanks, piping, hoses, pumps, strainers, separators, filtration units, dosing systems, and equipment associated with processing of washwater, injection of reductant or collection of exhaust residues are to be examined and verified to be in operational condition.

vi) Drip Trays, Overflow Arrangements, and Insulation. Drip trays, overflow arrangements, shielding, or insulation installed for the protection of personnel or the vessel from the effects of hazardous or corrosive chemicals used in exhaust emission abatement systems or system temperatures are to be examined for continued suitability for their intended service.

vii) Electrical Equipment. Electrical equipment associated with the operation or monitoring of exhaust emission abatement systems is to be examined for continued suitability for its intended service and installation area.

viii) Personal Protective Equipment. The required PPE equipment and facilities are to be confirmed as being onboard and in an operational condition.

ix) Warning Notices. The location of the applicable warning notices is to be confirmed.

x) Spare Parts. Spare parts are to be verified as available onboard in consideration of the equipment redundancy arrangements.

3.1.2 EGC – SCR Systems

The following are to be examined, so far as applicable, during each Annual Survey. Insulation need not be removed, but any deterioration or evidence of leakage is to be investigated:

i) External Examination. External examination of all components, including SCR reaction chamber, injectors, dosing units, soot blowing equipment, piping, tanks, insulation, valves, pumps, drip trays, etc., including foundations and attachments.

ii) Equipment Operation. Confirmation of correct operation of all rotating and reciprocating components, such as dosing pumps, ventilation fans, etc.

iii) Control Valves. Verify the correct operation of all remotely operated or automatically controlled valves in the exhaust, reductant dosing, or soot blowing systems.

iv) System Operation. Examination of the exhaust emission abatement system during working condition.

3.1.3 Exhaust Emissions Monitoring Systems

The following are to be examined, so far as applicable, during each Annual Survey. Insulation need not be removed, but any deterioration or evidence of leakage is to be investigated:

i) External Examination. External examination of all components including exhaust gas sample probes, pre-filters, heated lines, analyzer units, pneumatic systems, span and calibration gases, etc.

ii) System Operation. Examination of the EEMS during calibration and exhaust gas sampling conditions; verification of the emissions monitoring and data logging functions is to be undertaken.

3.2 Class Renewal Survey

In addition to the items covered by the Annual Survey listed in C. 3.1, the Class Renewal of the exhaust emission abatement equipment, associated systems, and monitoring equipment is also to include the following:

i) Washwater, Water Treatment, and Dosing Pumps. All washwater, water treatment pumps, and reductant dosing pumps are to be examined including opening for examination, as deemed necessary.

ii) Exhaust Fans and Blowers. All exhaust fans, blowers and associated prime movers are to be examined including opening for examination, as deemed necessary.

iii) Control Valves. All bypass, mixing, isolating, shut-down, or control valves in the exhaust, water treatment, and dosing systems are to be inspected and proven operable. Pressure relief valves are to be function-tested. A random selection of valves is to be opened for examination and adjusted as necessary.

iv) Control Actuators. All mechanical, hydraulic, and pneumatic control actuators and their power systems are to be examined and tested as considered necessary.

v) Electrical Equipment. The electrical equipment is to be examined to include the physical condition of electrical cables and supports, together with insulation resistance testing of the windings of electrical control motors and actuators. Where a proper record of testing is maintained, consideration may be given to accepting recent readings.

vi) Automatic Controls. Automatic controls for components associated with the exhaust emission abatement equipment and associated systems, including auto-changeover for system pumps/fans and electrical power supply, are to be examined for functionality and for continued system serviceability.

vii) Instrumentation, Control, Monitoring, and Safety Systems. Control systems are to be subjected to dock trials to verify correct operation of the following automatic functions, alarms, and safety systems:

• Function test of the monitoring and alarm systems

• Function test of safety systems, including override of system functions, if provided

• Manual control of the EGC equipment and systems

• Automatic changeover of designated machinery associated with the exhaust emission abatement equipment.