



**GUIDE FOR**

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**SO<sub>x</sub> SCRUBBER READY VESSELS**

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**American Bureau of Shipping  
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## Foreword

International, regional, national and local air emissions legislation is driving the development of primary machinery technologies to reduce exhaust emissions, together with the use of alternative cleaner fuels, such as LNG, and secondary exhaust emissions aftertreatment systems.

Key amongst these emissions drivers are the gaseous exhaust emissions legislated through IMO MARPOL Annex VI Regulations 13 and 14 for nitrogen oxide emissions from diesel engines and sulfur oxide emissions from all fuel burning equipment onboard.

The IMO limits SO<sub>x</sub> emissions by regulating the sulfur content of marine fuels with 0.1% for the emission control areas effective from 1 January 2015 and the anticipated global sulfur limits to 0.5% effective from 1 January 2020 (subject to review in 2018). Additionally, all ships to use fuel with a maximum sulfur content of 0.10% when ‘at berth’ (including at anchor) in EU ports since January 2010 and beginning in 2020, the EU will limit sulfur in fuel to 0.5% for operation in EU territorial seas irrespective of the outcome of any IMO determination in 2018. All these will promote increasing use of exhaust gas cleaning systems, such as SO<sub>x</sub> scrubbers as an alternative to low Sulphur fuel.

The air emissions performance testing, statutory certification, and statutory survey aspects are regulated through MARPOL Annex VI with any proposed alternative means of compliance, such as exhaust gas cleaning systems, permitted through Regulation 4 in association with any applicable IMO Guidelines. At the time of issuance of this Guide, the applicable Guidelines for SO<sub>x</sub> exhaust gas cleaning systems are IMO Resolution MEPC.259(68) – *2015 Guidelines for Exhaust Gas Cleaning Systems*, adopted on 15 May 2015. Acceptance of an exhaust emission abatement system as an alternative under MARPOL Annex VI is subject to approval by the flag Administration of the vessel.

Users of this Guide should be aware that due to changing regulations, and depending on specific geographical uses, compliance with this Guide may not necessarily reflect all requirements in all regions at the time of construction or future retrofitting.

The intent of this Guide is to provide guidance to shipowners and shipbuilders indicating the extent to which a ship design has been prepared or “ready” for the installation and operation of a scrubber for SO<sub>x</sub> emissions removal. The actual ABS requirements to be applied for a SO<sub>x</sub> scrubber are detailed in the *ABS Guide for Exhaust Emission Abatement* (herein after referred to as the *EEA Guide*).

The purpose of this Guide is to indicate the extent to which a vessel has been prepared or “ready” for compliance with the *EEA Guide*. Compliance with the applicable edition of the *EEA Guide* in force at the time the “SO<sub>x</sub> Scrubber Ready” service is provided does not guarantee compliance with the edition of the *EEA Guide* as may be applicable at the time of the SO<sub>x</sub> scrubber retrofit.

The *EEA Guide* has been developed in order to provide guidance for the design and construction of exhaust emission abatement systems, focusing on SO<sub>x</sub> scrubbers, SCR systems, and Exhaust Gas Recirculation (EGR) arrangements, and may be applied to all vessel types. An exhaust emission abatement system is considered approved upon verification of compliance with both the ABS requirements and the applicable IMO Regulations and Guidelines. Whilst compliance with the applicable IMO Regulations and Guidelines is a pre-requisite for ABS approval and notation, this Guide covers only the Classification approval aspects and statutory approval would be made by ABS as a separate parallel process in the capacity of a Recognized Organization for the vast majority of flag Administrations.

Despite the foreseen trend of using SO<sub>x</sub> scrubbers, the decision of building a new ship or retrofitting an existing one is not simple, due to the current uncertainty with the entry into force of the 0.5% global sulfur limit and the cleaner fuel alternatives such as LNG. However, considering the promise of the advantages that may be gained from use of SO<sub>x</sub> scrubber, the shipbuyers may decide to place ship orders with additional provision for using a SO<sub>x</sub> scrubber with the intention to complete installation in the future. This arrangement may be called “SO<sub>x</sub> Scrubber Ready”. In order to facilitate future modifications, the shipbuyers and shipbuilders must make a significant effort to figure out what features should be incorporated on a vessel and incorporate these in the shipbuilding contract.

This Guide has been developed considering that the following elements may be desired by owners opting for features of SO<sub>x</sub> Scrubber readiness in the Classification of their vessels.

- i)* The first is an independent and public recognition that a vessel has been designed intentionally with feasible retrofit of a SO<sub>x</sub> Scrubber in mind and that it has physical features that make it suitable for such a retrofit.
- ii)* The second addresses the need for owners to specify instructions to the builder in terms of Class guidance and requirements.
- iii)* The third provides confirmation to the owner and the shipbuilder that any vessel features agreed between the two parties have been approved by the Classification society based on their requirements that would be applied if the vessel had been built with a SO<sub>x</sub> Scrubber to the concept proposed. This Guide becomes effective on the first day of the month of publication.

This Guide becomes effective on the first day of the month of publication.

The applicable edition of the *ABS Rules for Building and Classing Steel Vessels (Steel Vessel Rules)* is to be used in association with this Guide.

Users are advised to check periodically on the ABS website [www.eagle.org](http://www.eagle.org) to verify that this version of this Guide is the most current.

*We welcome your feedback. Comments or suggestions can be sent electronically by email to [rsd@eagle.org](mailto:rsd@eagle.org).*



# GUIDE FOR SO<sub>x</sub> SCRUBBER READY VESSELS

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## SECTION 1 General

### 1 Introduction

This Guide is for optional application to ships under ABS *Rules for Building and Classing Steel Vessels*. It is applied to vessels having design features suitable to permit retrofitting at a future date to install a SO<sub>x</sub> scrubber system based on existing Class requirements.

The requirements for the arrangement and system design of all features of systems proposed are established in the *ABS Guide for Exhaust Emission Abatement (EEA Guide)*.

It is of course recognized that after the retrofitting of a vessel installed SO<sub>x</sub> scrubber system, the arrangements and installations will still be subject to approval by the flag Administrations and the flag Administration will implement the IMO requirements in effect at the time of retrofitting. The requirements for the testing, survey, certification and verification of the SO<sub>x</sub> scrubber system to ensure the equivalent compliance of regulations 14.1 and 14.4 of Annex VI of MARPOL 73/78 are specified in the *2015 Guidelines for Exhaust Gas Cleaning Systems* which adopted by International Maritime Organization (IMO) Resolution MEPC.259(68).

This Guide is to be applied to both new construction and existing vessel retrofitting, regardless of size, utilizing SO<sub>x</sub> scrubber for SO<sub>x</sub> emissions removal.

### 3 Application

The objective of this Guide is to define a three (3) leveled “SO<sub>x</sub> Scrubber Ready” scheme, to provide the details and preparations needed for each Level, and to describe the type of recognition that ABS will offer subject to compliance of the requirements at each Level.

There are three Levels considered as fundamental for defining the readiness of a vessel that is requested to be listed under the “SO<sub>x</sub> Scrubber Ready” scheme. A *Level 1 – Concept Design Review* is conducted prior to subsequent application of *Level 2* or *Level 3*. These are briefly described below:

- *Level 1 – Concept Design Review* – This is a high level evaluation of the basic suitability of a particular vessel design to be able to fit a particular SO<sub>x</sub> scrubber-installed ship concept.
- *Level 2 – General Design Review* – This Level is additional to Level 1, and it is categorized in separate design groups identifying the different parts of the complete design.
- *Level 3 – Detail Design Approval and Installation* – This is the final Level of the “SO<sub>x</sub> Scrubber Ready” scheme and incorporates both the Class Approval of the detailed drawings and the installation of parts of the system and specified equipment onboard the vessel including Survey in accordance with the related requirements of the *EEA Guide*.

## 5 Recognition

Upon satisfactory completion of each review level, ABS shall provide the following recognition of the extent to which compliance with the *EEA Guide* has been established:

- *Level 1* – An Approval in Principle (AIP) for the concept design and a Record Statement will be created.
- *Level 2* – A suitably worded Statement of Compliance with the applicable Rules at the time of review with conditional information required for actual retrofit. A Record Statement will be created.
- *Level 3* – A Class Notation **SO<sub>x</sub> Scrubber Ready** with a description note introduced in the *Record* listing the parts of the system that have been installed in accordance with approved plans and to the satisfaction of the Surveyor prior to delivery of the vessel.

*Note:* In the future once the vessel has undergone a complete retrofitting to install a SO<sub>x</sub> scrubber system that is shown to be in compliance with the *EEA Guide*, in accordance with approved plans and to the satisfaction of the Surveyor, the above “SO<sub>x</sub> Scrubber Ready” recognitions will be dropped and the **EGC-SO<sub>x</sub>** notation and other appropriate Class Notations associated with a ship featured an exhaust gas cleaning system will be assigned.

## SECTION 2 SO<sub>x</sub> Scrubber Ready Levels

### 1 Level 1 – Concept Design Review

#### 1.1 Description

This is a high level evaluation of the basic suitability of a particular vessel design to be able to feature a SO<sub>x</sub> scrubber system for emission removal. Basic suitability would mean that the geometry and structural arrangements of the vessel can physically encompass the necessary equipment and the associated systems can be functionally incorporated to the existing marine system in compliance with the *EEA Guide* at the time of the review. Upon satisfactory completion of this review level, ABS may provide an Approval in Principle (AIP) for this concept design and a Record Statement will be created.

#### 1.3 Plans and Data to be Submitted

The following plans and documentation shall be submitted for review:

- Ship general arrangement
- General description and schematic diagram of applied SO<sub>x</sub> scrubber system
- General arrangement of the SO<sub>x</sub> scrubber installation, layout, and systems
- Arrangement of the machinery space including SO<sub>x</sub> scrubber system equipment
- Arrangement and capacity of tanks for storage, chemicals, process washwater, exhaust gas cleaning residues, etc.
- Exhaust gas system arrangement
- Washwater system arrangement, if applicable
- Chemical treatment system arrangement, if applicable
- Schematic diagram for electrical, control, alarm, and monitoring system
- Preliminary study on Load Line and Stability in respect to the effect of the SO<sub>x</sub> scrubber system installations and arrangement

### 3 Level 2 – General Design Review

#### 3.1 Description

This Level is additional to Level 1 and it is categorized in separate design groups identifying the different parts of the complete design. The level of the design details to be reviewed for each system would be general. Detailed information such as particular equipment manufacturers and installations are not required except for the SO<sub>x</sub> scrubber. For new construction vessels, the drawings and supporting documentation shall be reviewed for compliance with the ABS Rules for ships having the same applicability date as the Rules applied for Classification of the vessel. Upon satisfactory completion of this review, ABS may issue a suitably-worded Statement of compliance with the applicable Rules at the time of the review with conditional information required for actual retrofitting. A Record Statement will be created. The reviewed drawings could then be used as part of the future retrofitting project pending flag State approval. The requirements for washwater chemical treatment system described in this guide are based on the use of Caustic Soda (NaOH) solution. If other chemicals to be used, the requirements should be consistent with the intent of the requirements for NaOH but would need to be assessed on a case-by-case basis.

The design groups of Level 2 are:

- i) Hull structural arrangement and reinforcement
- ii) SO<sub>x</sub> Scrubber system configuration and vessel integration
- iii) Exhaust gas system
- iv) Washwater system
- v) Chemical treatment system, if applicable
- vi) Residue system

### **3.3 Plans and Data to be Submitted**

The plans and documents to be submitted for each group of Level 2 are listed below.

#### **3.3.1 Hull Structural Arrangement and Reinforcement**

- Hull structural arrangement where the SO<sub>x</sub> scrubber unit is encompassed
- SO<sub>x</sub> scrubber unit foundation and attachments to the vessel's structure
- Hull reinforcement for accommodating the SO<sub>x</sub> scrubber unit

#### **3.3.2 SO<sub>x</sub> Scrubber System Configuration and Vessel Integration (see 2/7 of *EEA Guide*)**

- Specifications for SO<sub>x</sub> scrubber and Fuel Oil Combustion Units (FOCU)
- Compatibility analysis of the SO<sub>x</sub> scrubber with FOCU (see 2/7.3 of *EEA Guide*)
- General arrangement of the SO<sub>x</sub> scrubber installation and auxiliary equipment
- Schematic diagram for SO<sub>x</sub> scrubber system
- Electrical load analysis
- Schematic diagram and description of control and monitoring systems
- Emergency shutdown arrangement
- Description of the redundancy configuration
- Documentation detailing the effect on Load Line and Stability of the SO<sub>x</sub> scrubber system, in accordance with 2/7.15i) of the *EEA Guide*

#### **3.3.3 Exhaust Gas System (see 2/11.1 of *EEA Guide*)**

- Exhaust gas piping system including piping diagram and associated components
- Exhaust gas isolation and bypass valves arrangement
- Exhaust gas SO<sub>x</sub> scrubber and SO<sub>x</sub> scrubber piping insulation

#### **3.3.4 Washwater System (see 2/11.3 of *EEA Guide*)**

- Washwater piping system including piping diagram and associated components
- Arrangement and capacity of tanks for storage and washwater processing
- SO<sub>x</sub> Scrubber washwater supply and overboard discharge arrangement
- Sea chest arrangement and capacity

#### **3.3.5 Chemical Treatment System, if applicable (see 2/11.5 of *EEA Guide*)**

- Chemical treatment piping system including piping diagram and associated components
- Arrangement and capacity of the NaOH storage tank and NaOH overflow tank
- General arrangement of NaOH bunker station system



3.3.6 Residue System (see 2/11.7 of *EEA Guide*)

- Residue system including piping diagram and associated components
- Arrangement and capacity of EGC residue tank

## 5 Level 3 – Detail Design Approval and Installation

### 5.1 Description

This Level is the final Level of the “SO<sub>x</sub> Scrubber Ready” scheme and incorporates both the Class Approval of the detailed drawings and the installation of specified equipment onboard the ship. This Level is also categorized in separate design groups, identifying the different parts of the complete design. Level 3 includes the complete list of drawings required for approval of each part before installation, and it can be performed straight after Level 1 or in combination with Level 2. Drawings are to be in compliance with the relevant sections of the *EEA Guide*. Upon completion of the installation to the Surveyor’s satisfaction, the vessel will be eligible for the class notation **SO<sub>x</sub> Scrubber Ready**. A Record Statement will list each part of the system covered by the class notation. After delivery, the survey intervals and their requirements are covered in 2/5.5 below.

The design groups of Level 3 are the same as Level 2, above:

- i) Hull structural arrangement and reinforcement – Descriptive HS
- ii) SO<sub>x</sub> Scrubber system configuration and vessel integration – Descriptive SC
- iii) Exhaust gas system – Descriptive EG
- iv) Washwater system – Descriptive W
- v) Chemical treatment system, if applicable – Descriptive C
- vi) Residue system – Descriptive R

The above descriptive letters will be included in the vessel record when the item of equipment or system indicated has been ABS approved/surveyed as per the applicable Rule/Guide requirements and installed on board to the attending Surveyor’s satisfaction. For those instances when only part of a system is installed, the surveyor will issue a Statement of Fact which provides a brief description of the installed equipment for each partially installed design group.

### 5.3 Plans and Data to be Submitted

The plans and documents to be submitted for each group of level 3 are listed below.

#### 5.3.1 Hull Structural Arrangement and Reinforcement

- Detailed hull drawings for the space where the SO<sub>x</sub> scrubber unit is encompassed
- SO<sub>x</sub> scrubber foundation and attachments to the vessel’s structure including scantling, welding details.
- Detailed drawings for the foundation of principal components
- Strength analysis for SO<sub>x</sub> scrubber foundation and supporting structures under both static and dynamic load due to ship’s movement (if applicable)
- Details of the sea chest for suction and overboard discharge arrangements
- Material specifications for major structures, weld procedures

#### 5.3.2 SO<sub>x</sub> Scrubber System Configuration and Vessel Integration (see 2/7 of *EEA Guide*)

- Documentation detailing the SO<sub>x</sub> scrubber and Fuel Oil Combustion Units specification
- Analyses demonstrating compatibility of the SO<sub>x</sub> scrubber with FOCU (see 2/7.3 of *EEA Guide*)
- Details of all electrical equipment installed for the SO<sub>x</sub> scrubber unit and associated systems, including computer-based systems

- Material specifications for the SO<sub>x</sub> scrubber unit, pumps, valves, storage/process tanks, residue tanks, piping, distribution systems, separators, and associated components, including a corrosion assessment detailing the corrosive effect of system liquids, vapors, and gases on the materials used in the SO<sub>x</sub> scrubber system
  - 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 and washwater monitoring are to be located
  - Failure Modes and Effects Analysis (FMEA) to determine possible failures and their effects in the safe operation of the SO<sub>x</sub> scrubber [see 2/13.1ii) of the *EEA Guide*]
  - Electrical load analysis
  - Emergency shutdown arrangement
  - Documentation detailing the redundancy configuration (see 2/9.1 and 2/9.9.3 of the *EEA Guide*)
  - Operating and maintenance instruction manuals, including MSDS sheets and details for handling of hazardous and non-hazardous chemicals used in the SO<sub>x</sub> scrubber system
  - Testing procedures during installation and commissioning trials
  - Documentation detailing the effect on Load Line and Stability of the SO<sub>x</sub> scrubber system, in accordance with 2/7.15i) of the *EEA Guide*
- 5.3.3 Exhaust Gas System (see 2/11.1 of *EEA Guide*)
- Details of exhaust gas piping system and associated components, materials, design pressures, temperatures, insulation, isolation and bypass valves arrangement
- 5.3.4 Washwater System (see 2/11.3 of *EEA Guide*)
- Details of washwater piping system and associated components, materials, design pressures, temperatures, and drip trays, where applicable
  - Arrangement and capacity of tanks for storage and washwater processing
  - SO<sub>x</sub> Scrubber washwater supply and overboard discharge arrangement
  - Sea chest arrangement and capacity
- 5.3.5 Chemical Treatment System, if applicable (see 2/11.5 of *EEA Guide*)
- Details of chemical treatment piping system and associated components, design pressures, temperatures, and drip trays, where applicable
  - Arrangement and capacity of the NaOH storage tank and NaOH overflow tank
  - Tank filling, vents, sounding, and overflow arrangement
  - Ventilation arrangement for the location of NaOH storage and overflow tank
  - General arrangement of NaOH bunker station system
- 5.3.6 Residue System (see 2/11.7 of *EEA Guide*)
- Details of residue piping system and associated components, materials, design pressures, temperatures, and drip trays, where applicable
  - Arrangement and capacity of EGC residue tank
  - Tank vents and sounding arrangement

**5.5 Survey**

**5.5.1 Survey at Vendor Shops and During Installation**

ABS attendance at the shops of equipment suppliers and on board the vessel during installation is to be carried out in accordance with the *EEA Guide*.

**5.5.2 Survey after Construction**

ABS survey of the systems and equipment installed on the vessel will be included in the annual and special periodical surveys required in 6/5 of *EEA Guide*.