SOx and Scrubbers

Requirements and DNV involvement from a Class perspective

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Regulations
Global SO$_X$ regulations

- MARPOL Annex VI regulating SOx emission globally and regionally (ECA) through a limit on the sulphur content of the fuel
- Exhaust gas cleaning is considered an equivalent measure and can be used as an alternative (regulation 4)
MARPOL Annex VI - SOx requirements

- The following options for compliance apply:
  - Sulphur content of the fuel shall not exceed the set limit
  - An exhaust gas cleaning system approved by or on behalf of the national maritime administration in accordance with guidelines developed by IMO – MEPC.184(59). The system shall reduce the total emission of sulphur oxidises from vessels including both auxiliary and main propulsion engines, to x g SOx/kWh or less calculated as total weight emission of sulphur dioxide (see table below for value of x)
  - Any other technological method that is verifiable and enforceable to limit SOx emissions to a level (described in legislation). These methods shall be approved by the national maritime administration in accordance with IMO guidelines

<table>
<thead>
<tr>
<th>Fuel Oil Sulphur Content (% m/m)</th>
<th>Ratio Emission SO$_2$(ppm)/CO$_2$(% v/v)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.50</td>
<td>195.0</td>
</tr>
<tr>
<td>3.50</td>
<td>151.7</td>
</tr>
<tr>
<td>1.50</td>
<td>65.0</td>
</tr>
<tr>
<td>1.00</td>
<td>43.3</td>
</tr>
<tr>
<td>0.50</td>
<td>21.7</td>
</tr>
<tr>
<td>0.10</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Existing and possible new ECAs
California regulations - CARB

- Regulations requiring operators to use the following low sulfur marine distillate fuels in auxiliary diesel and diesel-electric engines, main propulsion diesel engines, and auxiliary boilers on ocean-going vessels within 24 n-miles;

<table>
<thead>
<tr>
<th>Effective date</th>
<th>Fuel*</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 1, 2009</td>
<td>Phase I Fuel requirement</td>
</tr>
<tr>
<td></td>
<td>Marine gas oil (DMA) at or below 1.5% sulfur;</td>
</tr>
<tr>
<td></td>
<td>Marine diesel oil (DMB) at or below 0.5% sulfur</td>
</tr>
<tr>
<td>January 1, 2014 (updated)</td>
<td>Phase II Fuel requirement</td>
</tr>
<tr>
<td></td>
<td>Marine gas oil (DMA) or marine diesel oil (DMB) at or below 0.1% sulfur</td>
</tr>
</tbody>
</table>

*DMA and DMB are marine grades of fuel as defined in Table I of International Standard ISO 8217:2005

Scrubbers will not be allowed in order to comply with CARB. State of California has no jurisdiction for emissions to air, only sulphur limits in fuel. Only federal government can regulate emissions to air.
Current EU legislation

**EU Directive EC 2005/33:**
- **1.50%** sulphur limit for passenger vessels in the EU (1.00% in SECA)
- **0.1%** sulphur limit for any fuel used onboard ships in EU ports as of **1. January 2010.**
- Boiler safety concerns raised by industry
- Not clear how strict enforcement will be, EC passing responsibility on to individual member states
Technologies and solutions
Difficult choices ahead
Three options for SO\textsubscript{X} removal

<table>
<thead>
<tr>
<th>Option</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrubber</td>
<td>Can use cheaper, high sulphur fuel. Fuel available</td>
<td>Takes up space. Significant investment cost No significant reduction of NO\textsubscript{x} Requires additional energy during operation Discharge of water</td>
</tr>
<tr>
<td>LNG</td>
<td>Currently cheaper fuel, but future price development is uncertain Reduces NO\textsubscript{x} and CO\textsubscript{2}</td>
<td>Retrofit difficult Requires larger fuel tanks Fuel availability uncertain Infrastructure currently limited</td>
</tr>
<tr>
<td>Distillate fuel</td>
<td>No or little modifications and investment needed. Well known and tested.</td>
<td>Higher fuel cost. Prices likely to increase. Fuel availability uncertain Wear and tear.</td>
</tr>
</tbody>
</table>

![Diagram showing 1850-1900, 2011, 2015 ECA, 2020-2025 Global with options for SO\textsubscript{X} removal: LNG fuel, Low sulphur fuel, Scrubber.](image)
Scrubber installation - example

Technical data:
- Year built: 2006
- Length: 199.8 meters
- Width: 26.50 meters
- Speed: 22.5 knots
- Cargo capacity: 3,831 lane meters
- MAN B&W type 9L60 MC-C (21MW)
- Classification: LRS

Technical data:
- In operation since: May 2010
- Height: 10.5 meters
- Length: 8.2 meters
- Diameter: 4.6 meters
- Weight empty: 24T
- Weight with water: 32T
- Exhaust gas: 192,000 Kg/h
- Material: SS alloys
- PM Scrubbing
- Sea water pump: 300kW/1000m³/h

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DNV Exhaust gas cleaning systems for SOx
1) Class and Statutory Approval

Class

The approval of scrubber systems can be divided in three parts;

1. Approval in Principal of systems to DNV Class rules (not obligatory);
   - The principles of the system is reviewed (not technical details)
   - Gives reinsurance to owners/ manufacturers that DNV will accept solution before an installation is done/ planned

2. Approval according to DNV Class rules;
   - Covers system documentation, safety of ship main concern.
   - Main Relevant Chapter: Piping Systems, DNV Rules for Classification of Ships, Pt.4 Ch.6
   - Installation also covered by other class rules as applicable.
     - Important to note requirements for class notation E0, RP DYNPOS etc. if applicable
SOx - DNV Approvals, Rules and Status

Statutory

3. Approval according to Revised MARPOL Annex VI, Regulation 14
   - Approval according to the Guidelines for Exhaust Gas Cleaning System (Resolution MEPC.184(59))
   - This covers the emission from the vessel
   - Vessel receive a MED B* Certificate when approved.

*It is on going discussions to remove the MEPC 184(59) from the MED list, but the approval according to MEPC 184(59) will still be applicable/ obligatory for compliance with MARPOL ANNEX VI
DNV Rule for Classification Status and Principles

Status DNV Rules;

- Proposed to add a new section for EGC-systems, status: Proposal No. 2011-203
  - Internal and external hearing during spring 2012 (finished pr 16/4): Planned release date 1/7-2012

DNV Rules Principles

- DNV focus on Safety: Main requirements is one exhaust pipe pr. source, but to avoid one scrubber pr. unit multistream solutions will be accepted with safety features.
  - Major risk factors
    - Clogging
    - Rise in back-pressure
    - Ingress of water from scrubber in to idle machinery
    - Ingress of exhaust gases in to idle machinery
  - Fire in engine room and casing

By pass/ damper arrangement/ drainage system

Requirement for material class for scrubber and associated piping. (dependent of location)
MARPOL ANNEX VI: Guidelines for Exhaust Gas Cleaning System (Resolution MEPC.184(59))

- Scheme A: Unit certification with parameter and emission checks
  - Vessel is given a SOx Emission Compliance Certificate (SECC).
  - Continues monitoring of some operating parameters to verify normal operations.
  - Spot checks of SO2/CO2 in exhaust gas to verify compliance.

- Scheme B: Continues emission monitoring with parameter checks
  - Continues monitoring of SO2/CO2 in exhaust gas to verify compliance.
  - Spot check of operating parameters to verify normal operations

- Washwater discharge criterias.

- Approval of manuals and test procedures
  - The following are the compulsory documents for approval according to MEPC 184(59)
    - SECP (SOx Emission Compliance Plan)
    - ETM (Exhaust Gas Cleaning System Technical Manual)
    - OMM (Onboard Monitoring Manual)
    - EGC Record book

- Verification of onboard emission measurements.
Approval of EGCS-SO\textsubscript{x} unit subject to periodic parameters and emission checks

**ETM (EGCS-SO\textsubscript{x} Technical manual)**
- Identification and description of the unit description
- Operating limits (exhaust and washwater parameters, engine power)
- Corrective actions when non compliance with exhaust/washwater limits
- Design of washwater system and variations of washwater characteristics through range
- Maintenance and survey methods to verify compliance
- The SECC (SOx Emission Compliance Certificate)

**On board Monitoring manual (OMM)**
- Sensors, position and maintenance
- Analysers & calibration and how monitoring is to be surveyed

**SOx Emissions Compliance Plan (SECP)**
- Equipment description of cleaned and non-cleaned units
- Demonstration on how continuous monitoring of key data (water pressure/flow rate, exhaust pressure(drop)/temperature, equipment load) will demonstrate that the parameters are within the manufacturer’s recommended specifications (Daily exhaust gas emission recording)

**EGCS – SOx Record book**
- Record of the EG unit in service operating parameters
IMO Guidelines on SOx Exhaust gas Cleaning systems – Scheme B

System equipped with continuous monitoring system in service and approved by the Administration.

ETM (EGCS-SO\textsubscript{x} Technical manual)
- Identification and description of the unit description
- Operating limits (exhaust and washwater parameters, engine power)
- Corrective actions when non compliance with exhaust/washwater limits
- Design of washwater system and variations of washwater characteristics through range

On board Monitoring manual (OMM)
- Sensors, position and maintenance
- Analysers & calibration and how monitoring is to be surveyed

SOx Emissions Compliance Plan (SECP)
- Equipment description of cleaned and non-cleaned units
- Demonstration on how continuous monitoring of the exhaust gas (SO2/CO2) will ensure compliance. Daily recording of key parameters (water pressure/flow rate, exhaust pressure(drop)/temperature, equipment load)

EGCS – SOx Record book
- Record of the EG unit in service operating parameters
Certification: IMO Guidelines on SOx Exhaust gas Cleaning systems – Scheme A and B

Survey and Certification

1. Prior (or after) installation on board each EGC unit for **scheme A** should be certified as meeting the Certified value as declared by the manufacturer.
2. Monitoring System of the EGC system subject to survey on installation and Initial / Intermediate and Renewal survey (**scheme B**)
3. Each ECG Unit meeting the requirements provided with a SECC by the Administration for **Scheme A**
4. Supplement of the IAPP duly completed (scheme A and B)
### Approval Process

#### Documents to be submitted to DNV for approval (Class and Statutory)

- Arrangement of exhaust gas system including exhaust gas cleaning units.
- Arrangement of exhaust gas treatment fluid systems.
- Arrangement of systems for prevention of overheating of exhaust gas cleaning system components.
- Arrangement of seawater systems for exhaust gas cleaning units.
- Arrangement of freshwater systems for exhaust gas cleaning units.
- Arrangement of waste and discharge systems from exhaust gas cleaning units.
- Arrangement and details of By-pass valve/dampers.
- Exhaust gas cleaning system technical manual (ETM) (Scheme A or B).
- On board monitoring manual (OMM)
- SOx emission compliance plan (SECP)
- Certificates for exhaust gas cleaning units as required by MARPOL Regulation 13 / NOx Technical Code or IMO Res. MEPC 184(59).
- Onboard test programme to include tests addressing failure impact on main functions.
- Statutory documentation as required by Ref. MARPOL Regulation 13 / NOx Technical Code or IMO Res. MEPC 184(59), when DNV is authorised to issue the IAPP certificate.

#### In addition: Stability documentation, steel/structure etc. dwgs. as applicable
Status Approved systems by DNV

Statutory Approvals

- MED Certificate (MEPC 184(59)) for Scheme B have been issued to Hamworthy/Krystallon for the vessel Jolly Diamante

Approval in principle

- Wärtsila: Principle approval of system
- Clean Marine: Principle approval of system

Test installations:

- MT Suula (Wärtsila)
- Baru (Clean Marine)

No full installation (Class + Statutory) have been approved by DNV as pr. Date (16/04-2012)
Some items to be considered

- Availability of space in casing and engine room.
  - Scrubber in casing
  - New piping for water to scrubber
  - Sludge tank
  - Possible NAOH tank (closed loop or hybrid solutions)

- Stability, weights are added high up on the vessel.

- Change of lightweight (possible new inclining test and stability calculation)

- Engines possibility to handle increased back pressure

- Power requirement: Owner should consider the required power/ load the scrubber must be able to handle.

- Availability and redundancy of components. Fines etc. if non compliance not clear.

- Trading area
Safeguarding life, property and the environment

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