OPEN LOOP EXHAUST GAS CLEANING SYSTEM (EGCS) / SCRUBBER OPERATION

Background:

1) **Sulphur limit of marine fuels**
Marpol Annex VI on Air Emissions, Reg.14 requires use or carriage of marine fuel with max sulphur content of 0.50% and with max 0.10% while operating within an Emission Control Area

2) **Equivalent Compliance**
Reg. 4 however allows for fitting, material, appliance or apparatus to be fitted in a ship or other procedures, alternative fuel oils, or compliance methods used as an alternative to that required by the above Marpol Annex VI if they are at least as effective in terms of emission restrictions. Such alternative and equivalent compliance means must be approved by the Administration (Flag/Class) in line with relevant IMO guidelines and shall be communicated to the IMO

3) **Scrubbers**
Exhaust Gas Cleaning Systems (EGCS) also known as scrubbers are such an alternative and equivalent means of compliance when built, installed and operated in compliance with the relevant IMO Guidelines and their operation allows carriage and use of marine fuel with sulphur content higher than the limits in Marpol Annex VI Reg.14 above

4) **How (open loop) scrubbers work**
The Engine exhaust gas is sprayed with (sea) water and based on a chemical reaction sulphur (Sulphur Oxide SOx) is reduced effectively in the emissions to air. To achieve equivalency the main compliance parameter is the ratio of SO_2/CO_2. In most scrubbers there is Continuous Emission Monitoring Systems (CEMS) with parameters checks (Scheme B). For the wash-water the other main compliance parameters are pH, turbidity and PAH (Polycyclic Aromatic Hydrocarbons) and nitrates.

5) **Local regulations**
Despite the number of studies justifying the environmental benefit of scrubbers including the non-adverse impact of their washwaters, some countries do not allow use of scrubbers and washwater discharges in their waters

6) **Company policy**
The IMO Guidelines do not restrict discharge of washwater within a specified distance from nearest land, despite this the Company goes beyond compliance and requires use of scrubbers and discharge of washwater when the ship is operating more than 3 (three) nm from the baselines of which terriotrial sea is measured and when underway

References:

1) IMO Marpol VI Regulations for the prevention of Air Pollution form Ships, Reg.4 “Equivalents” and Reg.14 “Sulphur Oxides (Sox) and Particulate Matter”
2) **IMO Resolution MEPC.259(68) “2015 Guidelines for Exhaust Gas Cleaning Systems” = “THE GUIDELINES”**
3) IMO Circular MEPC.1/Circ.883 “Guidance on indication of ongoing compliance in the case of the failure of a single monitoring instrument, and recommended actions to take if the EGCS fails to meet the provision of the 2015 EGCS Guidelines”
4) VMS: EMM > 1.0 Air Pollution > 1.4 Sulphur Oxide (Sox) emissions > 1.4.1 Exhaust Gas Cleaning Systems (EGCS) used as alternative compliance method

Read this Local Work Instruction in conjunction with the VMS section referenced above

5) The EGCS documentation onboard: SOx Emissions Compliance Plan (SECP), EGCS Tech Manual for Scheme B (ETM-B), Onboard Monitoring Manual (OMM), EGC Record Book, Process description, Operating and User Manual, Maintenance Manual

Voyage Appraisal procedure

The procedures below represents the Environmental Instruction required for planning of operation of open loop scrubber/EGCS

Perform the below well in advance of the Voyage planning – into the early Appraisal phase (which when possible is min two months in advance)

Bridge and Engine Teams represented by Environmental Officer and Chief Engineer:

1) Verify and plan for any No-Discharge-Zones (NDZ) along the intended route:
   a) As a Company Policy - always consider operating the EGCS/Scrubber outside 3 (three) nautical miles from the baselines of which territorial sea is measured and when underway
      OR
   b) per any other stricter local regulations (see form SAF77)
      OR
   c) outside designated marine parks, sanctuaries and protected waters

Note: Refer to all the above areas where open loop scrubber is not allowed to be operated as No-Discharge-Zone(s) **(NDZ)**

2) Investigate the seawater alkalinity of the intended route considering that:
   a) The scrubber is guaranteed to operate effectively with minimum seawater inlet alkalinity of 2300 µ based on a 130mg/L concentration of HCO_3 (bicarbonate)
   b) Alkalinity correlates strongly with Salinity of sea water for which a number of marine publications provide indications
   c) Less alkaline/less saline waters e.g. fresher water areas are likely to affect the scrubber operation adversely and might not achieve the min. required SO_2/CO_2 ratio by the CEMS (Continuous Emission Monitoring System)

Note: Seawater temperature also affects the operating parameters of the EGCS

3) Verify the number of engines required for each leg of the voyage and their max engine load (%MCR) in all possible modes as this also affects the efficiency in operation of the EGCS/Scrubber

4) Plan for any designated Emission Control Areas (ECA) along the intended route (where without EGCS/ scrubber a max of 0.10% sulphur fuel would be otherwise required) and again check the required engine numbers and their max load (as in ECAs max eng. load is limited to 85% MCR)

5) Verify the time lengths of the legs of the voyage (per the required arrival / departure SBE/FWE timings), the speeds/consumptions and the required times for hot starting of the required number of engines and then cooling times for switching over fuels from MGO (max 0.10% sulphur) to HFO (high sulphur oil >0.10% S) and stack washing when approaching port / NDZ or shutting down scrubber

Note: Consider if there will be sufficient time for starting and stopping the scrubber per the above arr/dep times and also any potential crew work-rest hours issues for the relevant scrubber operation

6) Based on the above:
   a) plan for using the open loop EGCS/Scrubber at the allowed times / locations

   The Chief Engineer in cooperation with the Master makes the decision to operate the EGCS/scrubber and discharge EGCS wash water

   b) plan for fuel stems with sufficient quantities for:
      - max 3.50% S fuel when scrubber will be used outside NDZ
      - and when the scrubber will not be used :
        - ◆ max 0.50% S fuel outside ECA and EU ports/anchorages
        - ◆ max 0.10% S fuel for ECA and in EU ports/anchorages

   Always plan for and maintain a sufficient quantity for min. 2 days of consumption operation of compliant fuel (max 0.10% sulphur) in case of EGCS breakdown

   c) mark as possible the NDZ – scrubber use or No-use areas on ECDIS and/or navigational charts
   d) mark above also on the relevant VMS forms/checklists SAF09 “Voyage Planning” and SAF52 “ Env Ops Voyage Planning”

e) discuss the use of scrubber plan at the voyage briefing before the start of each voyage

f) distribute the intended time schedule for the operation of the scrubber to the Bridge and ECR

g) if in doubt for EGCS/Scrubber operation – consult your VOTech Cell for guidance

Completed

Voyage Execution procedure

The procedures below represents the Environmental Instruction required for the operation of the open loop scrubber/EGCS during the voyage

Bridge Team represented by the Officer of the Watch OOW:

1) Follow the Voyage plan defined above and for any markings and schedules provided for scrubber operation as per the proceeding of the voyage

2) Monitor for times and areas where EGCS/scrubber operation is allowed or not allowed (scrubber starting and stopping) and provide adequate notice by clear communication to the ECR /EOOW

Absent any other local stricter regulation or protected area/park/sanctuary - always consider the Company policy for use of open loop EGCS/ scrubber outside 3nm from baselines. If in doubt check with the Environmental Officer or Chief Engineer

3) Record the notice given in the logbook

Completed

Engine Team represented by the Officer of the Watch OOW:

1) Consult at the start of the watch with any schedule provided for intended operation of the Scrubber

2) Follow the notices and instructions from the bridge for any starting/stopping of scrubber

Note: if an Engineer Officer is assigned with the operation of the EGCS/Scrubber- then the EOOW is to contact him for starting and/or stopping the scrubber.
All Engine Officers operating the scrubber shall be trained on its operation and troubleshooting including also on its Manuals during their ship familiarization process

3) In case of concerns for the time/area of starting/stopping the EGCS:
   a) contact the Chief Engineer asap
   b) consult with the Environmental Officer

4) Record the starting or stopping of the scrubber in the Engine Log Book

5) Monitor the scrubber parameters for compliance

Completed

EGCS/Scrubber Operation procedure incl. malfunctions

The procedures below represents the Instruction in case of exceedances of the EGCS/scrubber parameters during operation

Engine Officer assigned for the EGCS/Scrubber operation does the following:

Air Emission ratio exceedances

1) Monitor the recording of the SO_2/CO_2 ratio being recorded by the CEMS not the exceed the equivalent compliance limits:

Fuel Oil Sulphur Content (% m/m)	Ratio Emission SO_2(ppm)/CO_2 (% v/v)
0.10 %	4.3
0.50 %	21.7

   a) In case of exceedances of the SO2/CO2 ration for the equivalent fuel sulphur content, reduce engine load as a primary corrective action

Consult the ETM-B for possible causes and other actions.
Use the Malfunction checklist [see Appendix] to identify a malfunction and a remedial/corrective action to resolve it.

b) In case of a single sensor failure (e.g. gas analyzer) but if running on fuel with constant sulphur content and other related parameters remain in balance (such as pH sensor in conjunction with washwater flow meter) they can be used as a temporary proxy for the emission ratio monitoring and as an interim indication of ongoing compliance, in such case:

- maintain data (manual or automatic recording) which confirms all other relevant data shows values in line with values prior to the sensor failure
- record the sulphur content of the fuel used
- repair or replace the sensor that failed as soon as practicable

c) If "Short term exceedances" are experienced such as:

- short periods during which the measured emission values might indicate that the applicable Emissions Ratio limit has been exceeded due to a sudden change in the exhaust gas flow rate to the EGCS – this is a common behaviour of monitoring equipment and EGCS dynamic response
- time lags between the sensors readings and the calculation of for the emission ratio (and the unit may respond with an alarm)
- when Exhaust Gas Boiler (EGC) soot blowing is performed which is a normal ship operation with a short maintenance period and if any related exceedance of the air emission ratio

then the above are not malfunctions but transitory periods and isolated spikes and in such cases and in the recorded output the EGCS remains in compliance

d) Except in cases like b) and c) above, if the EGCS system loses a system functionality or a monitoring instrument true reading is above the applicable limits then deem the EGCS as malfunctioned, and troubleshoot the malfunction using Table 6 of the ETM-B as a checklist [*see Appendices*]

e) Record any of the issues above (*except c) "short term exceedances"*) in the EGC Record Book as malfunctions since the time/date they began, the vessel's position, with observations and the corrective actions

f) Make an additional entry in the EGC Record Book with time/date and ship's position once the malfunction is rectified and when the EGCS is brought back in compliance

Note: Once a malfunction is rectified, the one hour limit to resolve it is reset

g) If for the malfunction you:

- cannot identify a clear cause, OR
- if a resolution will require more than an hour (60 minutes) to implement, OR
- in case of repetitive malfunctions, if the same malfunction occurs more than 2 (two) times in a 24 hrs period:

then start switching to compliant / low sulphur fuel oil, shut down scrubber and make relevant entries in the Marine Sulphur Record Book and Engine Log book

h) If within one hour (60 mins) since the malfunction was detected, you:

- have not rectified it, AND
- switch over to compliant fuel has <u>not</u> been commenced

OR

- in case of such repetitive malfunctions, if the same malfunction occurs more than 2 (two) times in a 24 hrs period:

then plan for notifying the Authorities – Flag and Port State

Note: Notification is not required if the vessel has changed the operation on compliant fuel, uses an "interim indication of ongoing compliance" or is experiencing "short term exceedances"

i) For the above required notification:

- advise office / your VOTech Cell as soon as possible
- act per their instructions, where typically the office may report to the Authorities on the vessel's behalf
- make entries again for the notifications in the EGC Record Book and Engine Log Book

Wash water parameters exceedances

2) Ensure the continuous wash water monitoring and record system is in operation, except for short periods of maintenance and cleaning of equipment, and is recording pH, PAH, turbidity and temperature

3) Monitor the recording of the following wash water parameters:
   a) pH not to go below 2.7 *(as per the calculation method for the S Moon scrubber)*
   b) PAH not to exceed 34.5 µg/L, the Guidelines permit a 15 minutes deviation of up to 100% e.g. up to 69.0 µg/L, in any 12 hrs period

      Note: The wash water monitoring unit should continuously update and display the remaining PAH exceedance time on a rolling time basis

   c) Turbidity not to exceed 25 FNU (*based on all turbidity difference readings being a rolling average over a 15-minute period*), the Guidelines permit a 15 minutes deviation of up to 20% e.g. up to 30 FNU, in any 12 hrs period

      Note: The wash water monitoring unit should continuously update and display the remaining Turbidity exceedance time on a rolling time basis

      Consult the ETM-B for possible causes and other actions.
      Use the Malfunction checklist [see Appendix] to identify a malfunction and a remedial/corrective action to resolve it.

   d) In case of a single sensor failure but if other related parameters remain in balance they can be used as a temporary proxy as an interim indication of ongoing compliance, in such case:
      - maintain data (manual or automatic recording) which confirms all other relevant data shows values in line with values prior to the sensor failure
      - record the sulphur content of the fuel used
      - repair or replace the sensor that failed as soon as practicable

e) If "Short term exceedances" are experienced such as:

- Exhaust Gas Boiler (EGC) soot blowing and increase in wash water parameter for turbidity which is a normal ship operation for a short period of maintenance
- Short periods for maintenance and cleaning of equipment

then the above are not malfunctions but transitory periods and isolated spikes and in such cases and in the recorded output the EGCS remains in compliance

Record short periods of maintenance and cleaning in the EGC Record Book with explanation and the sulphur content of the fuel in use, including when soot blowing the Turbidity readings of the washwater. Ensure there are no visible traces of soot in the washwater despite high turbidity readings.

f) If the pH gets less than the value under a) above OR if the PAH and Turbidity values above under b) or c) are exceeded for more than 15 mins in any 12 hrs period as indicated by the wash water monitoring unit then switch over to compliant fuel and shut down scrubber till the time period is reset

g) Record any of the issues above (*except e) "Short term exceedances"*) with observations and the corrective action in the EGC Record Book

h) If the above limits and period (15mins in any 12 hrs) has been exceeded AND the ship has continued to operate the EGCS/scrubber and discharge washwater- then plan for notifications to the Authorities – Flag and Port State

Note: Notification is not required if the vessel has changed the operation on compliant fuel, uses an "interim indication of ongoing compliance" or is experiencing "short term exceedances"

i) For the above required notification:

- advise office / your VOTech Cell as soon as possible
- act per their instructions, where typically the office may report to the Authorities on the vessel's behalf
- make entries again for the notifications in the EGC Record Book and Engine Log Book

Completed

EGCS/Scrubber Operation Sampling and Calibration

The procedures below represents the Instructions for maintaining an ECGS/Scrubber in compliant working order

Engine Officer assigned for the EGCS/Scrubber maintenance and supervised by the Ch. Engineer:

1) Follow the manufacturer's requirements for periodical maintenance per the approved EGCS Maintenance Manual

2) Perform any required sensors calibration

3) Record all maintenance functions in the EGCS Record Book

Note: The EGCS Record book is an approved document and is subject to inspection by Flag/Class and PSC surveyors

4) Annually organize a survey the EGCS for:
   a) Availability and correctness of the documentation
   b) Complete and correct entries in the EGC Record Book
   c) Physical installation
   d) Monitoring systems in order

5) Organize sampling of washwater as follows:
   a) take during the first year of operation (after EGCS installation) two samples at least min. 14 days apart
   b) collect samples for inlet water (for background), water after the scrubber (before any treatment **s**ystem if applicable), and discharge water

      Note: One of those samples may be conducted as part a vessel's annual or other survey, and during the first year, one of those sampling events may be conducted as part of the installation of the system to ensure it is functioning properly.

   c) Analyze samples for:
      - Dissolved and Total Metals

- PAH (Polycyclic Aromatic Hydrocarbons)
- Nitrate-Nitrite
- pH

Note: For more details see the document "External Sampling Summary" in the VMS under: EMM > 6.0 Waste Water Management Practices and Procedures > 6.9 Sampling Plan

Completed

Appendices

1) ECGS/Scrubber Malfunction Checklist [per Table 6 of the ETM-B]