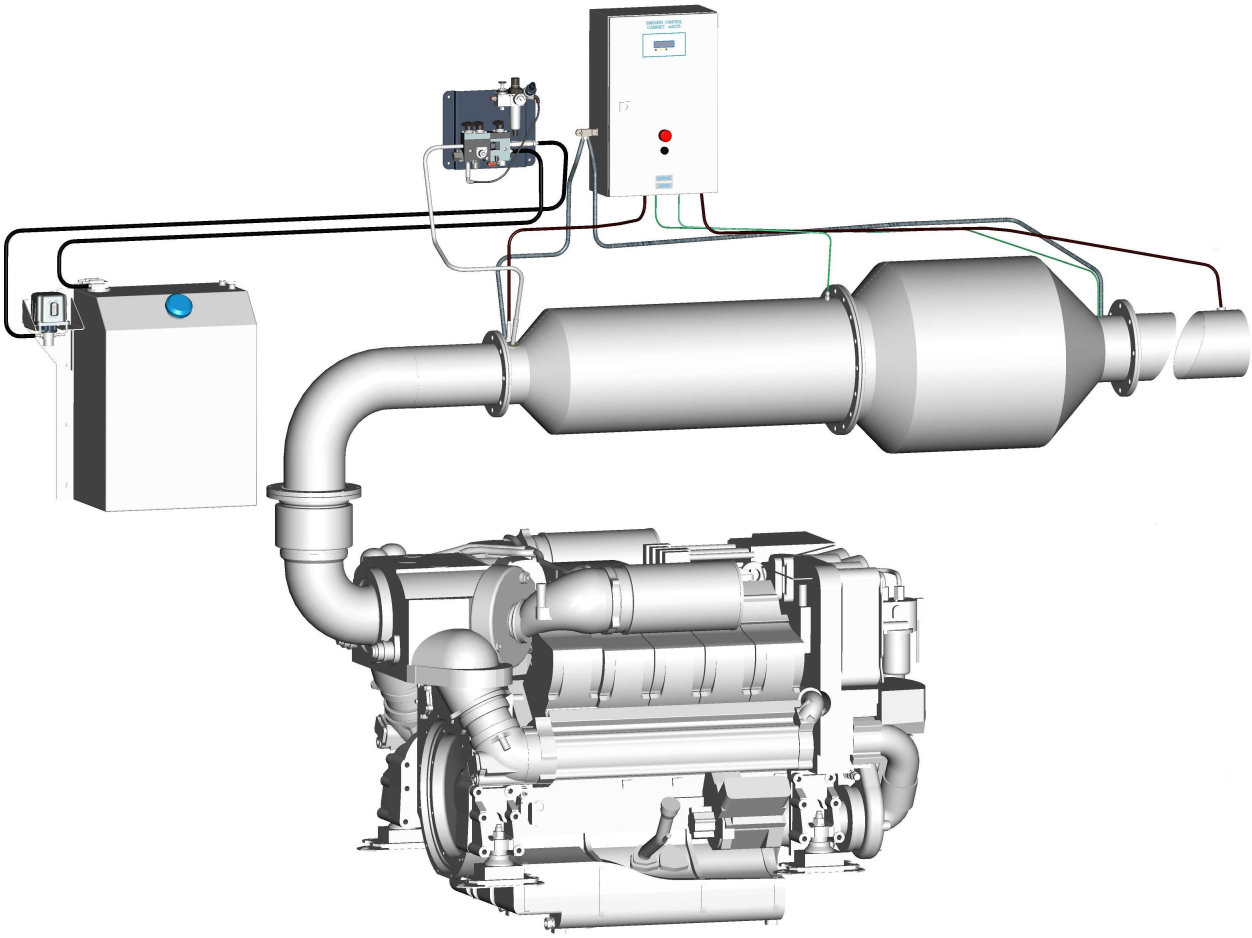
SCR *marine*

NO_x reduction technology by STT Emtec AB

Installation Guideline



This guideline describes the installation procedure and maintenance for the STT SCR*marine* system
Latest version available at www.sttemtec.com

STT Emtec AB (pbl)
Box 46, Njurundavägen 16A
SE-862 02 NJURUNDA
SWEDEN

Tel: +46 (0)60-64 10 40
Fax: +46 (0)60 64 10 45
e-mail: info@sttemtec.com
Internet: www.sttemtec.com

Head office: Njurunda
Org.nr: 55 62 05 – 2927
VAT ID: SE556205292701
ISO-cetrifikat nr: 15627-02,

Table of content

1 Purpose

The purpose of this document is to give sufficient information on how to install and operate the key components of the SCR*marine* system. The installation guideline also describes the post adjustments and inspection processes and gives general information on service and maintenance. The first section gives an overview of the system and presents key points to enable commissioning.

This guideline describes a general installation and presupposes that the installation work is carried out professionally by people with experience and knowledge of this type of work. If the installation at hand requires additional actions or adjustments outside the scoop of this guideline or if anything is unclear, contact STT Emtec for advice.

1.1 The SCR technology

NOx, nitrogen oxides, produced during the combustion process in diesel engines is a contributing factor to air pollution. In an SCR system (Selective Catalytic Reduction) the injected urea solution reacts over the catalyst with the harmful NOx gases in the exhaust and converts it to water and nitrogen.

$$4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6H_2O$$

Urea is a clear, non-toxic chemical. It is in normal conditions safe to handle and is not harmful to the environment. To be able to inject the urea into the exhaust, a mixture of urea diluted in distilled water, called Diesel Exhaust Fluid (DEF) is used. Another technical name is Aqueous Urea Solution (AUS). Urea can cause corrosion to metal parts; therefore the handling equipment must be designed to withstand urea. This applies to tanks, pumps, lines, etc.

In this document the common names *DEF* and *Reductant* are used instead of trade names.

It is important to only use DEF with the quality, cleanliness and handling in accordance to the ISO 22241 standards.

Note! The fuel quality for the SCR system *must fulfill EN 590:2004*. The engine lubrication oil must be suitable for low sulfur fuel and compatible with exhaust after treatment systems.

For other fuel qualities please contact STT Emtec AB for consultation.

1.2 System overview

The schematic diagram in *Figure 1* shows the layout of the SCR*marine* system. It is a fully automated after-treatment NOx reduction system with low maintenance requirements.

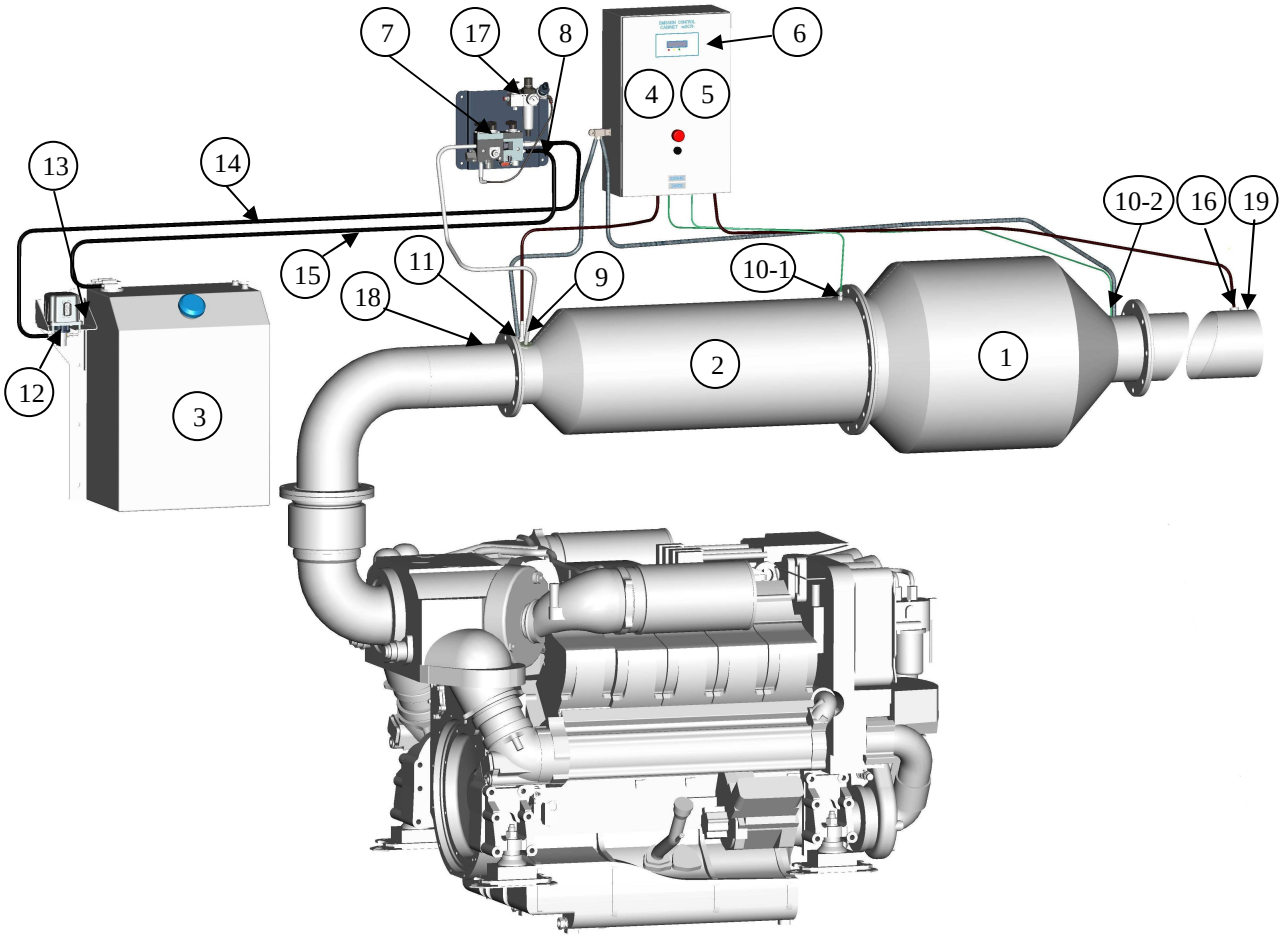
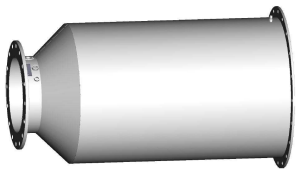


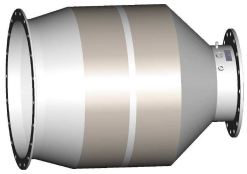
Figure 1.
SCR marine system, arrangement and layout
1. SCR chamber, 2. Exhaust mixer, 3. DEF service tank, 4. Control cabinet, 5. Electronic Control Unit (ECU),
6. Diagnostic display, 7. DEF Dosing Unit (DDU)), 8. Exhaust pressure sensor, 9. Injection Nozzle,
10-1. SCR temperature sensor 1, 10-2. SCR temperature sensor 2, 11. NOx Sensor 1, 12. DEF supply pump,
13. DEF line; from service tank to supply pump, 14. DEF line; from supply pump to DDU,
15. DEF line; from DDU to service tank. 16. NOx sensor 2, 17. FR unit (compressed air supply)
18. Boss for NOx measurement probe pre SCR chamber (refer to section 4.2.3 for proper placement)
19. Boss for NOx measurement probe post SCR chamber (refer to section 4.2.3 for proper placement)

1.3 Components overview

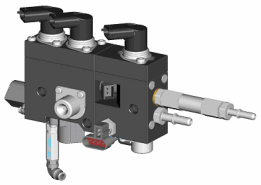
The following are the key components of the SCR*marine* system.



Exhaust Mixer

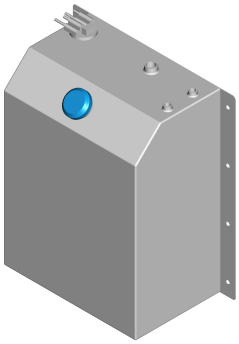


SCR Chamber

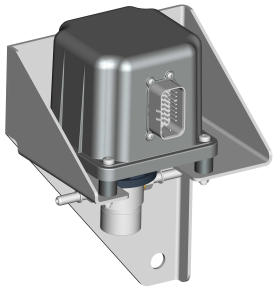


DEF Dosing Unit

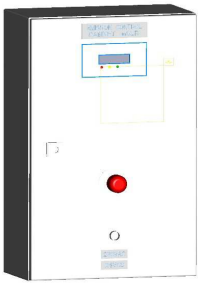
Injection Nozzle



DEF service tank



DEF Supply Pump



Control Cabinet

Hose Kit

Cable Kit

FR Unit

Temp. sensors

NOx Sensors

Figure 2.
SCR marine system, key components

1.4 System requirements

The SCR*marine* is an automatic NOx reduction system and requires little or no calibration during commissioning. A SCR catalyst assembly (exhaust mixer and SCR chamber) is installed in the exhaust line as close to the engine as possible to preserve exhaust temperature. Besides from the sensors relating to the SCR assembly the SCR*marine* system requires the following from the vessel installation:

- **Power supply**
  24VDC or 230VAC @ 150W nominal power
  Power supply shall always be active to the control system. The control system requires a 24VDC or 230 VAC back up power which must be arranged by the installer/yard
- **Compressed air supply**
  The air consumption is continuously 40 l/min FAD nominal per system while the engine is running
  Min supply pressure 5 bar
  For compressor dimensioning refer to section 3.5.5 *Air compressor considerations*
- **Access to engine runtime data**
  The following signals need to be available in runtime:
  - Engine speed
  - Engine load
  - Engine boost air pressure
  - Engine boost air temperature
  - Engine running (ON/OFF) signal

  The runtime signals can be obtained from the engines CAN (J1939) databus or Modbus RS422. For engines without databus it is possible to use discrete sensors.
- **DEF**
  The reductant fluid for the SCR catalyst must always be available in the service tank. As a rule of thumb the DEF consumption is ~ 5% of engine fuel consumption

1.5 Commissioning requirements

A checklist to enable system commissioning and to make sure that no vital details have been overlooked is available in *Appendix 02 - Commissioning prerequisites*

In order to complete system commissioning an installation report must be completed and returned to STT Emtec AB. The report document can be found in *Appendix 04 – Post installation inspection.*

2 Exhaust components installation

This section provides general and specific information on installing the mechanical components in the exhaust system.
The exhaust system is stressed both by high temperature variations and vibrations. It is therefore important to observe both the application notes in this document as well as applying regulation according to the vessel requirements to ensure trouble free operation of the SCR*marine* system.

2.1 Flanges and gaskets

The exhaust mixer and the SCR chamber are produced of stainless steel with flanges on the in- and outlet ports. The inlet port of the exhaust mixer and the outlet port of the SCR chamber use standard DN350-PN10 or DN200-PN10 flanges and gaskets.
The flanges at the exhaust mixer outlet and the SCR chamber inlet is purpose made. This flange pairs are mounted together with a 1.5mm stainless steel reinforced graphite gasket. For attachment, zinc plated screws M16x50 8.8 with nuts and washers are used. The number of screws is 16 or 20 depending on flange size. Tightening torque is 197 Nm

Table 1 Flange dimension

Flange	Gasket part no
650 mm (Inside diameter)	108717-00
416 mm (inside diameter)	108162-00

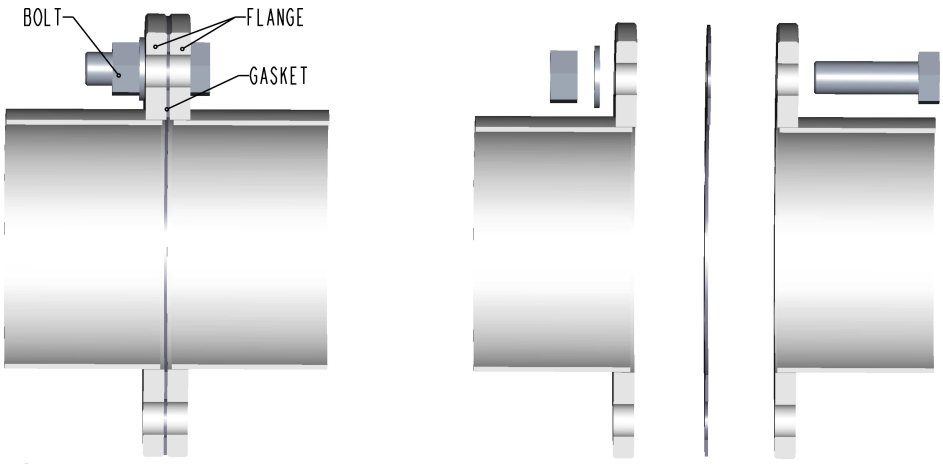


Figure 3.
Flange pair, installed and exploded view

2.2 Thermal expansion and vibrations

Relative movements, vibrations and heat extension must always be considered when routing and installing exhaust pipes. Use gastight flexible parts and compensators to handle these parameters. In general a heat expansion of 1-2 mm /meter piping for every 100°C can be used as a rule of thumb.

2.3 Exhaust mixer and SCR chamber (SCR assembly)

Figure 4.
SCR assembly

2.3.1 Function

In the SCR chamber a chemical reaction that converts NOx and DEF into Nitrogen and Water takes place. The first part of the SCR assembly is the exhaust mixer which ensures that the injected mixture of DEF and air gets thoroughly and homogenously atomized before entering the catalyst chamber. The catalyst is only active in temperatures above 220°C and it is therefore important that the whole SCR assembly, and the pipes leading to it, are well insulated to preserve as much of the exhaust temperature as possible, especially in low load and low ambient temperature conditions.

2.3.2 Installation

The SCR assembly can be installed in a vertical or horizontal position. **Some large diameter SCR chambers can only be installed in a horizontal position**, please consult STT Emtec AB for consultation. The exhaust mixer shall face the engine. The flange pairs are mounted with a 1.5mm stainless steel reinforced graphite gasket, see section Flanges. It is important to leave space for the insulation at the installation, see section Insulation.

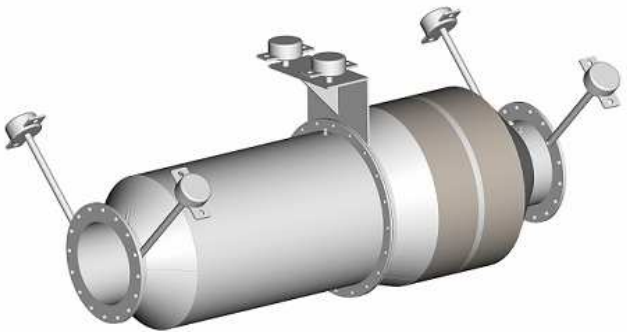


Figure 5.
Example of support brackets with resilient elements on a horizontal mounted unit

Brackets to support the catalyst assembly are required. Support brackets should be mounted to the exhaust pipe connecting flanges together with the flange bolts. Brackets should be designed in such way that also axial movement is limited. Use also additional support brackets at the flange connecting the exhaust mixer with the SCR chamber to reduce stress on the exhaust pipe connections.

The design of the support may be depending on the surroundings and support of other parts. STT Emtec recommends the use of metal resilient elements type Vibratec® or similar. Always use gastight flexible parts/compensators at the inlet and outlet of the SCR assembly in order to remove stress from relative movements between exhaust pipes and the SCR assembly. Welding is not allowed on the exhaust mixer or the SCR chamber.

2.3.3 Maintenance

The SCR catalyst is designed not to trap soot and therefore normally maintenance free. Engines with high oil consumption and or high PM (Soot) emissions can cause catalyst fouling over time and therefore might need regular maintenance. It is recommended to regularly check flanges for tightness and to verify the NOx converting function of the catalyst.
If necessary, verification of the NOx conversion shall be performed. NOx conversion verification must be performed by trained personnel only; please contact the system distributor for more information. See also *Appendix 03 – Maintenance* for further information

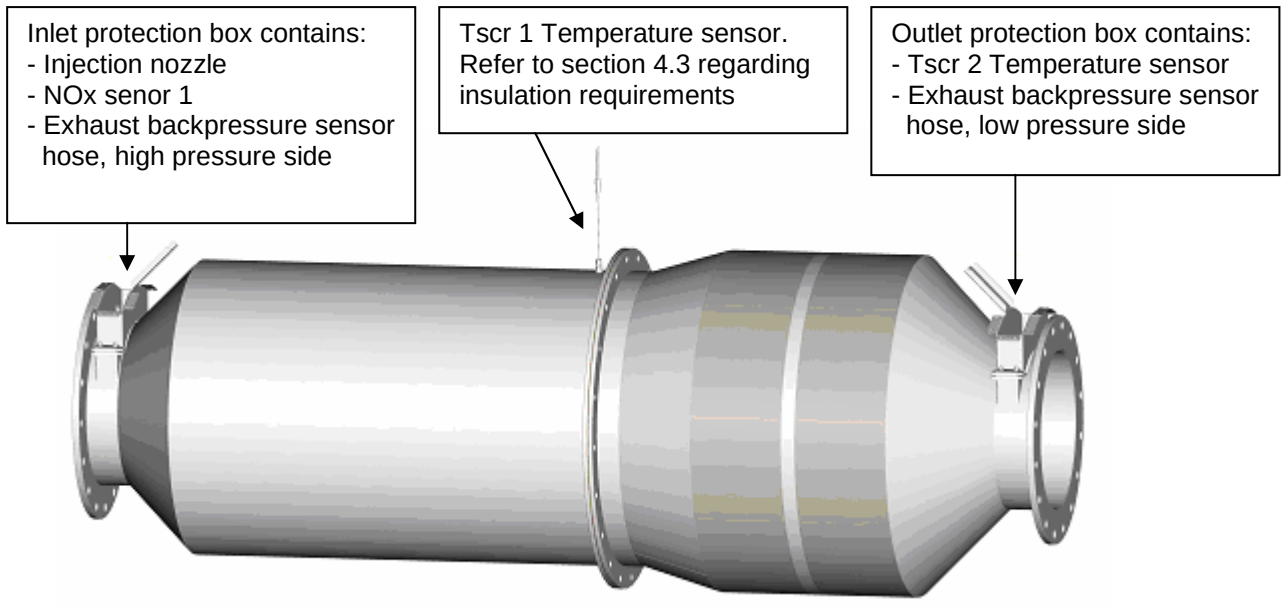
2.4 Insulation

All exhaust components and the pipes leading from the engine must be insulated. The purpose of the insulation is to retain required operating exhaust temperature for the SCR catalysts at low load conditions and cold ambient temperatures. It is also necessary to keep the surface temperature of the pipes and SCR mixer at a level where condense is avoided. Insulation is also required by SOLAS regulations to ensure the engine crew safety and protection of the surrounding areas.

It is important to leave space for the insulation at the installation. In a typical installation the insulation is minimum 50 mm thick. Additional insulation may be required according to regulations and/or customer demands.

Extra care must be taken when insulation are performed where electrical sensors and the injection nozzle are placed. Under no circumstances should sensor cable be covered by insulation and the same is valid for the stainless steel braided hose part of the injection nozzle and the press sleeve connecting the braided hose to the injection nozzle.

The SCR assembly have protection boxes at the exhaust inlet flange and the exhaust outlet flange. These boxes are designed to protect the sensors and connections mounted inside the boxes from being covered with insulation and at the same time keep the surface temperature on the top of the boxes low and provide easy access to the sensors and fittings.



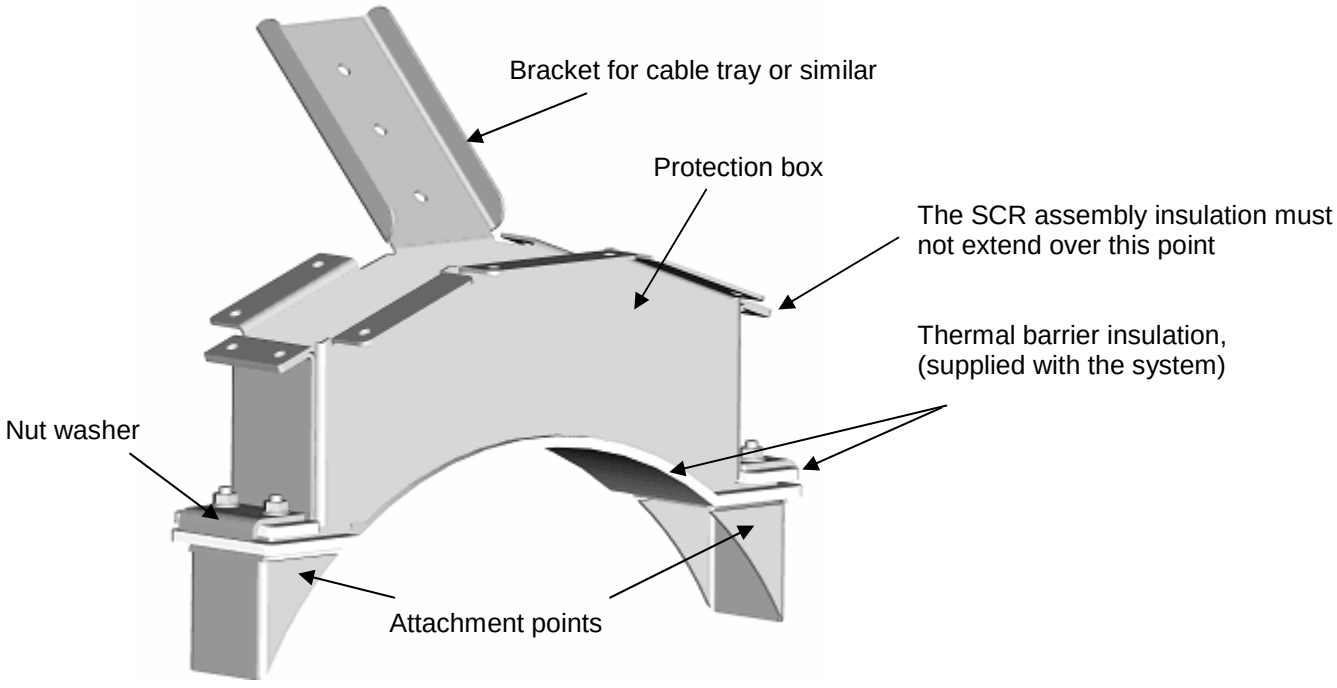


Figure 6
Protection box at the inlet and outlet of the SCR

The protection boxes have brackets for a cable tray or similar support for sensor cables and sensor hoses. The SCR assembly insulation must not extend beyond the lid of the boxes (se figure 6, 7). The protection boxes are mounted on the attachment points at the SCR assembly inlet and outlet flanges. Thermal barrier insulation is placed between the protection box and the attachment points as well as between the protection box and the nut washer. The thermal barrier prevents heat transfer between the SCR assembly and the protection box. Refer to figure 6 and 7 for more details. A detailed description on how to disassemble and assemble the protection box for easy access to sensors and injection nozzle are found in *Appendix 3 Maintenance*

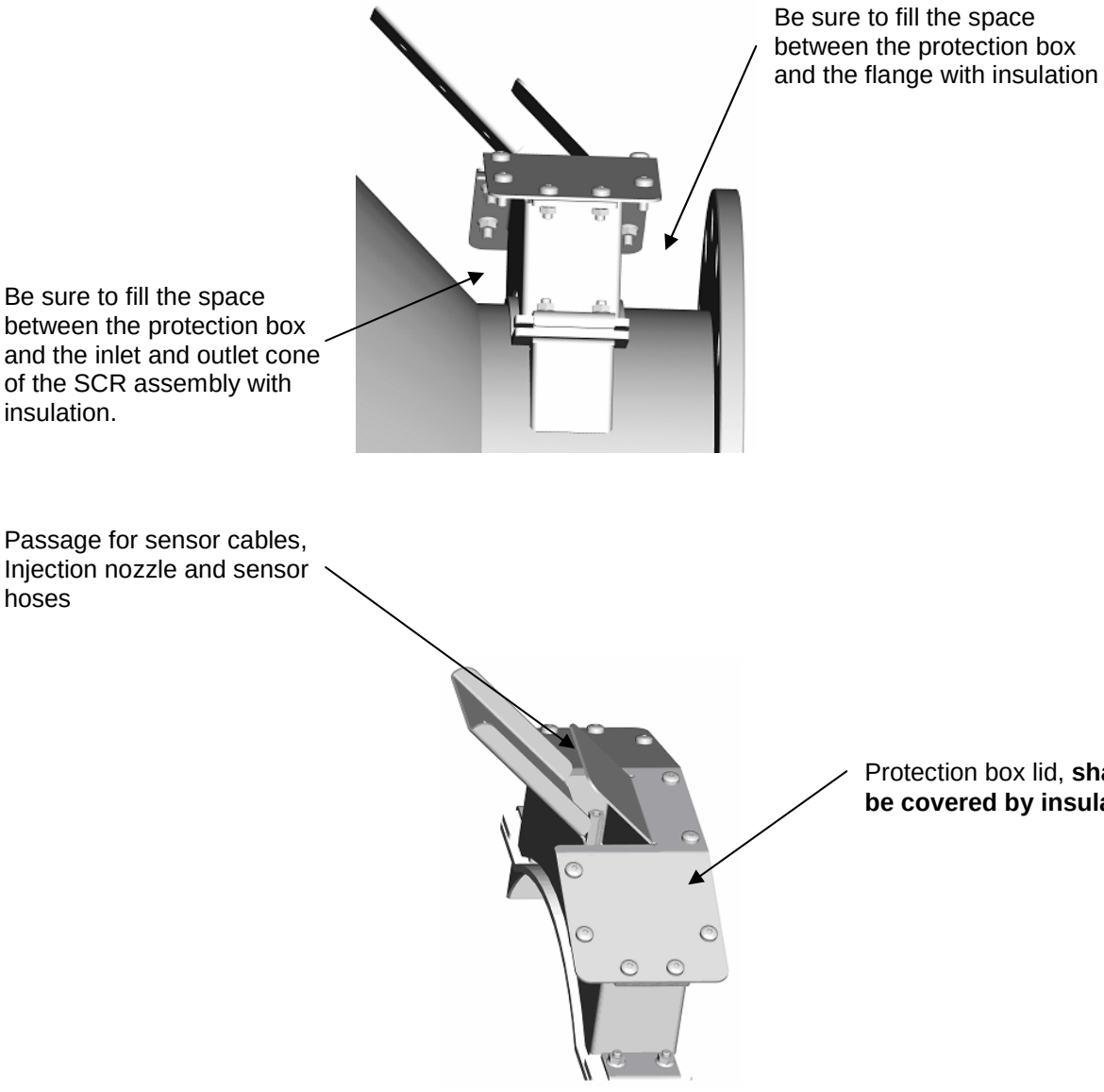


Figure 7
Protection box with lid

3 DEF dosing components installation

This section provides information on installing and maintaining the DEF dosing components of the SCR*marine* system. The DEF dosing system together with its control system is referred to as the DDS system in this document.

3.1 General

The dosing components are designed to carry liquid DEF from the service tank to the exhaust stream. When dehydrated the DEF solution will form salt deposits from its urea content. This salt is prone to block the supply lines and the dosing components. The following guidelines are intended to ensure that the system can evacuate DEF thoroughly when injection is not required, i.e. when the engine is stopped, in order to avoid forming deposits.

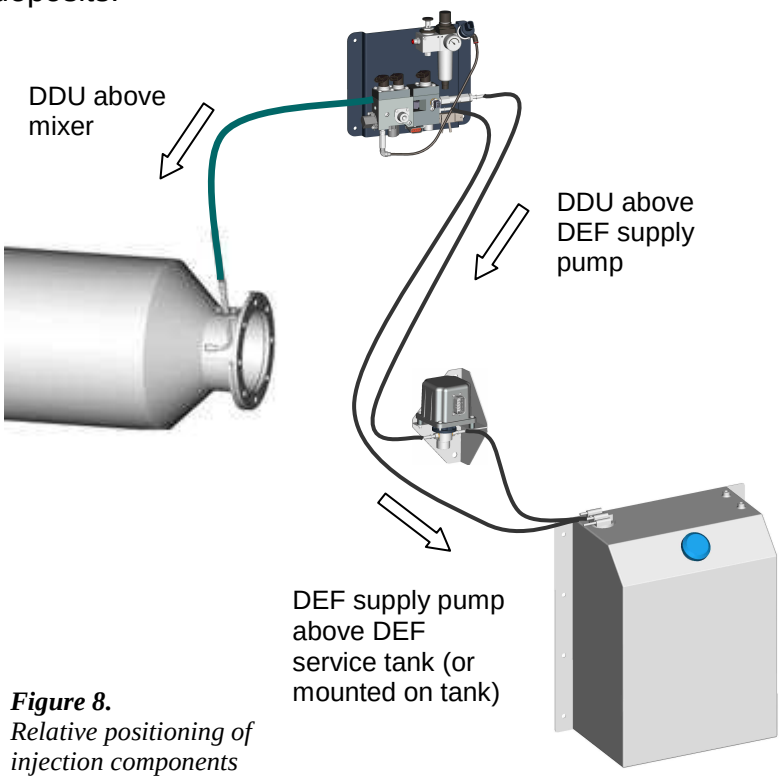


Figure 8.
Relative positioning of injection components

3.2 Components placement

When positioning the injection components it is important to consider their relative positions in altitude. It is also important to maintain a constant slope of the pipes or hoses carrying DEF and to avoid any air pockets.
These rules serve to accomplish a good evacuation of DEF from the injection components.

3.3 DEF supply lines

3.3.1 Function

The DEF lines (Service tank - - Supply pump, Supply pump - - Dosing unit, Dosing unit - - service tank) carry the DEF from the tank to the DEF dosing unit. The lines supplied in the kit are 600 mm long hoses made of stainless steel with fittings matching those of the service tank, supply pump and DEF dosing unit. The hoses should be connected to each other with stainless steel pipes supplied by installer and/or yard. This excludes one hose which should be connected directly between the Service tank and the Supply pump.

3.3.2 Installation

All DEF lines, suction- as well as pressure lines, have to be routed as straight as possible to prevent air pockets which may have a negative impact on post injection drainage and lead to freezing and other blockage. The inner diameter of hoses or pipes must be minimum 4 mm and they must comply with class rules requirements.
Due to the volatility of the DEF; make sure that all fittings are tight. Stainless steel compression fittings might be difficult to get tight when carrying DEF.
Pay close attention to the cleanliness of the DEF lines during assembly to avoid any kind of debris or dirt entering the system.

Note! DEF is very volatile and will slip thru the slightest gap! Make sure all connections are tight! Pay close attention to the cleanliness of the DEF lines.

3.3.3 Maintenance

The supplied stainless steel hoses are maintenance free.

3.4 DEF service tank

3.4.1 Function

The service tank provides the DEF dosing unit with DEF.
The liquid is pumped from the tank by using the DEF supply pump, normally mounted on the side of the tank. A built-in level sensor is used by the control system to indicate refill on the system display. The service tank has a filling cap for manual filling and the cap is ventilated.

3.4.2 Installation

The DEF service tank can be mounted on additional brackets and has to be attached firmly. The service tank connects to the DEF supply pump (suction line) and to the DEF dosing unit (return line) thru nipples at the tank top.

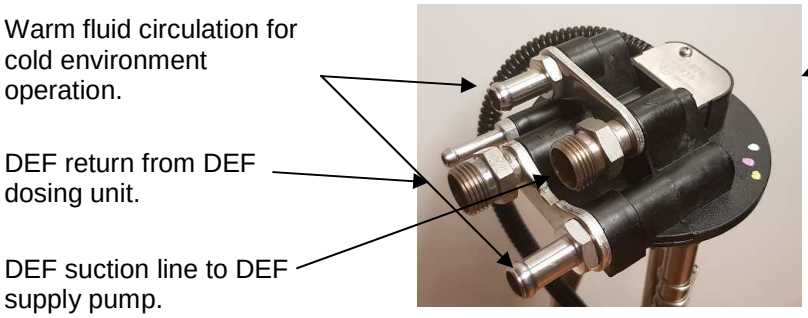


Figure 11.
Fittings for DEF supply and coolant

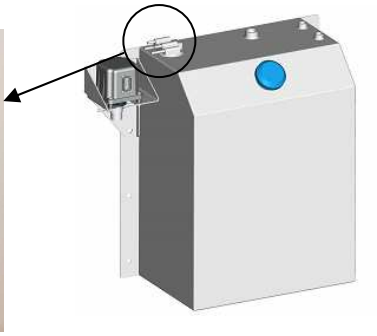


Figure 10.
DEF service tank.

3.4.3 Bulk tank

The DEF service tank also has two spare bosses (ISO G1/2") to the right at the top of the tank suitable for automatic refill from a bulk tank. One of the connections should be used to vent the service tank to atmosphere during filling. If a bulk DEF tank is located in the vessel and the service tank is permanently connected by a line or hose, there must be a mechanical shut-off valve before the service tank. This is in order to prevent hydraulic lock of the engine, in case of a DEF pump breakdown.

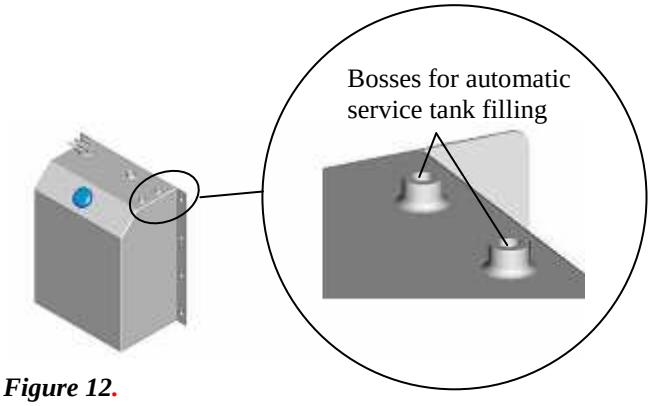


Figure 12.
Bosses for automatic filling

An ISO G1" boss is also available at the top of the tank to facilitate an additional level sensor that might be needed if an automatic filling system is installed.

The bulk tank and service tank refill system is not within STT Emtecs scope of supply. An automated service tank refill system should implement a high level alarm.

Make sure that the material selected for a bulk tank and its filling system is fully compatible with the DEF. Note that no forms of copper alloy are allowed.

3.4.4 Heating systems

If a heating system for the DEF carrying components in the system is required for a cold environment application an autonomous heating system and temperature control circuit must be implemented. Note that circulating high temperatures, such as 80+°C engine coolant, water thru the tank will degrade the DEF solution. Please refer to ISO standard 22241 for handling, transportation and storage of DEF.

Heating systems are not within STT Emtecs scope of supply.

3.4.5 Maintenance

The mesh filter under the filling cap should be observed during filling, and cleaned if necessary. The mesh filter in the bottom of the tank (fitted on the armature suction device) should be checked, and cleaned if necessary. (Refer to appendix 3, maintenance for more details)

No filtration device is present in the DEF supply lines to the DEF dosing unit except for the emergency filter in the inlet port of the DEF dosing unit (refer to section 3.7.4). The DEF used for the SCR*marine* system shall have quality and cleanliness according to the standard ISO 22241.

If a bulk tank system is installed it is recommended to also install a DEF filtration device between the bulk tank and the DEF service tank if the is a risk of contaminated DEF to enter the service tank. If such filter exists it shall be a part of the maintenance schedule

Note! Prevent DEF from getting in contact with the air line or its connections. Any air equipment that has been polluted with DEF has to be replaced. DEF liquid or crystals in the air inlet can cause blockage and damage to the DEF dosing unit!

3.5 FR unit

3.5.1 Function

The FR unit consists out of a shut-off valve, a pressure regulator with gauge, an electronic pressure switch and a condensate trap. The purpose of the unit is to supply regulated air pressure of 4.5 bar to the DEF dosing unit. The pressure switch fitted on the air outlet side is used by the control system to indicate air supply failure. The shut-off valve on the FR unit should always be open unless for safety or maintenance purposes. **If the air supply needs to be shut off always first shutdown the DDS control cabinet. The DDS need to be shut down in a safe manner, please refer to section 5.2 for the correct procedure.**

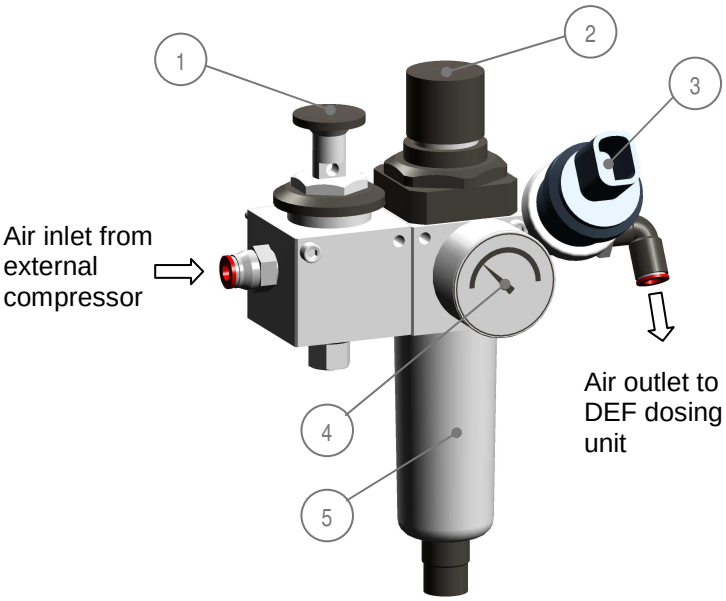


Figure 13. FR unit
1. Shut-off valve, 2. Pressure regulator, 3. Pressure switch, 4. Pressure gauge, 5. Condensate trap

3.5.2 Installation

The FR unit is connected to the vessel pressurized air system or an additional air compressor and to the DEF dosing unit. Connections are typically made using Ø6mm PA hose but other materials, such as stainless steel, may be required due to regulations. The FR unit is normally located on the same mounting bracket as the DEF dosing unit but may be relocated for space reasons. The unit comes assembled with Ø6 mm pneu-fit quick release fittings on both inlet and outlet ports. The thread of the fittings is G1/4" internal.

3.5.3 Maintenance

Check the condensate trap

Note! Do not attempt to disable the DDS by shutting off the air supply!
Blockage or damage to the injection components may occur!
See section System Operation for correct procedures.

Table 2 FR unit, spare parts

Pos	Detail
1	Air regulator
2	Gauge/manometer
3	Pressure switch

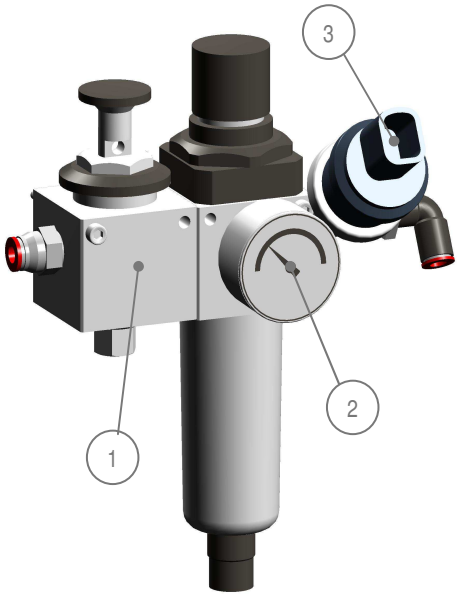


Figure 14.
FR unit Spare parts

3.5.4 Adjusting the air pressure

The air pressure regulator is located on the right hand side of the FR-unit. Max allowed inlet pressure is 16 bar and has to be adjusted to 4.5±0.2 bar. Use the manometer on the FR-unit when adjusting the air pressure.

Use the Diagnostic display, see section 5.4, to verify the main air pressure;

1. Stop the engine
2. Go to the Actuator test page (Main page ↓ Key down)
3. Step to the AIR test (→Key right)
4. Activate the Atomization air valve (↓ Key down)
5. 'Nozzle prs' shall read 1600±200 mbar when correct air pressure is adjusted

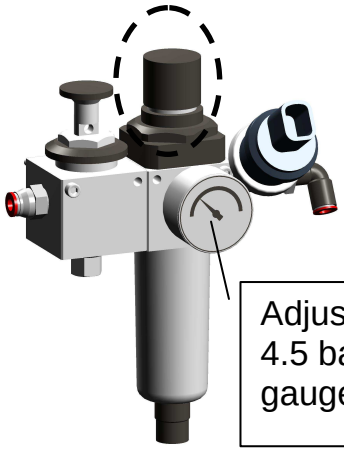


Figure 15
FR unit

Note: The 'Nozzle prs' indicates the backpressure in the injection nozzle resulting from the air flow thru the DEF dosing unit. This pressure level should not be confused with the gauge reading of the pressure on the FR unit!

3.5.5 Air compressor considerations

Compressed air should be provided from the vessel air supply with installed oil separator. If the compressed air supply includes an air dryer, then if possible, take the air supply to the FR-unit before the air dryer. If a compressed air system is not available a separate air compressor has to be installed. The table below contains recommendations for the air compressor.

Table: Compressor data recommendations **per system**

Air consumption per system	40 l/min FAD 80 l/min peak (at flush) Regulated pressure 4,5±0,2 Bar (gauge pressure)
Recommended compressor capacity	290 l/min FAD 8-10 bar capacity Screw compressors are recommended
Tank volume	Min 90 l to reduce the compressor load time

Note! Piston type compressors are typically not designed for continuous operation and power capacity and tank size must be selected with this in mind.

When using a compressor driven by the engine, either by direct (e.g. belt-) drive or when the engine supplies electrical power to the compressor, the same capacity requirements as above regarding the compressor are recommended. However when the engine stops so does the compressor and in this case the tank volume must be sufficient to handle post-operation component cleaning.
Minimum tank volume depends on the pressure according to the following calculation:

Tank volume= 180/(pressure-4.5) liters (pressure expressed in bar)

3.6 DEF supply pump

3.6.1 Function

The DEF supply pump delivers pressurized DEF liquid to the DEF dosing unit. Liquid that is not metered by the DDU is returned to the service tank. The supply pump is speed- and direction controlled by the ECU in the control cabinet. During post injection the pump is reversed to assist in the evacuation of the DEF injection nozzle and the DEF supply lines.

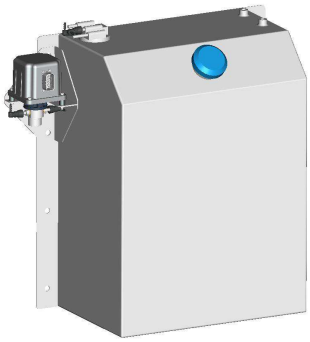


Figure 17
Default (and lowest) DEF supply pump mounting position

3.6.2 Installation

The preferred mounting position of the DEF supply pump is on the left side of the DEF service tank near the tank fittings. The pump bracket is designed to match the mounting holes of the service tank. Should this location not be suitable the DEF supply pump can be positioned within 0.2 metres below (equals max DEF filling level) to 1.0 metres above the service tank top, see figures 17-19.. The low position restriction is to prevent drainage of the tank and the high position limit is to ensure priming of the supply pump under all conditions, Maximum length of the suction line from the service tank to the supply pump is 2 metres.
Note that the length of the suction hose supplied with the system will limit the possibilities to relocate the DEF supply pump.
The supply pump connects to the service tank and to the dosing unit according to Figure 16.

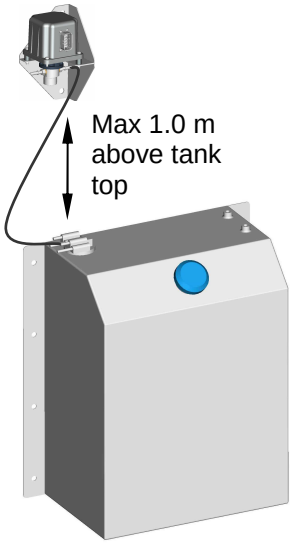


Figure 18
Max elevation of DEF supply pump

Figure 16
DEF supply pump interface

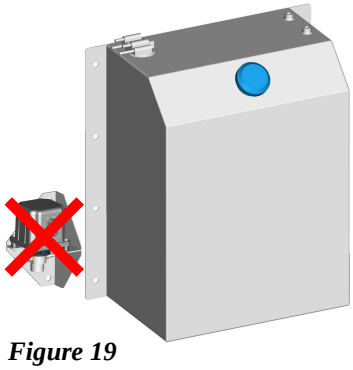


Figure 19
*Mounting the DEF supply pump below default position is **not** ok!*

3.6.3 Maintenance

The DEF supply pump is maintenance free

3.7 DEF dosing unit

3.7.1 Function

The DEF dosing unit (DDU) is a metering device controlled by the ECU in the control cabinet. DEF is circulated thru a fixed pressure regulator and metering is controlled by a DEF dosing valve. In order to obtain a high accuracy metering the DEF temperature is measured as well as the pressure up- and downstream the dosing valve. A separate pressure sensor monitors air flow thru the injection nozzle. Air flow and post-injection flush is controlled by two solenoid valves. The urea dosing unit is equipped with an in-line DEF filter to prevent particulates from entering the dosing system and interrupting the dosing function.

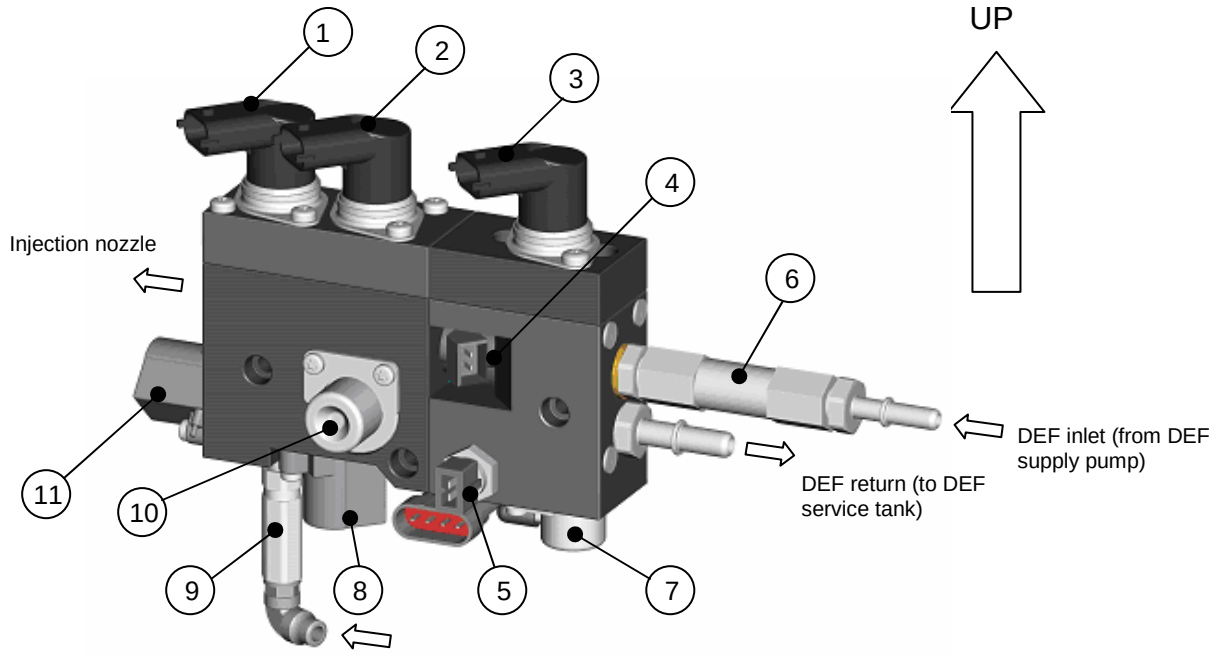


Figure 20. DEF dosing unit (DDU)
1. Nozzle pressure sensor, 2. DEF pressure sensor, 3. DEF supply pump pressure sensor, 4. DEF dosing valve, 5. DEF temperature sensor, 6. DEF filter, 7. DEF pressure regulator, 8. Flush air valve, 9. Check valve, 10. Hydraulic (DEF) damper, 11. Atomization air valve

3.7.2 Installation

For proper function, the DEF dosing unit should be oriented, as shown in figure 20 above. The DDU is mounted with shock absorbers on an additional bracket. This bracket has to be attached to a firm point in the engine room. Avoid a mounting location that may have an elevated ambient temperature.
The DDU, FR unit and Exhaust backpressure sensor may be mounted separately due to space restrictions. When doing so it is important to observe any mounting instructions regarding elevation and tilt depicted in this document.
The DDU should be mounted above the level of the Injection nozzle flange on the mixer unit and above the DEF supply pump in order to maintain a downward slope towards those components.

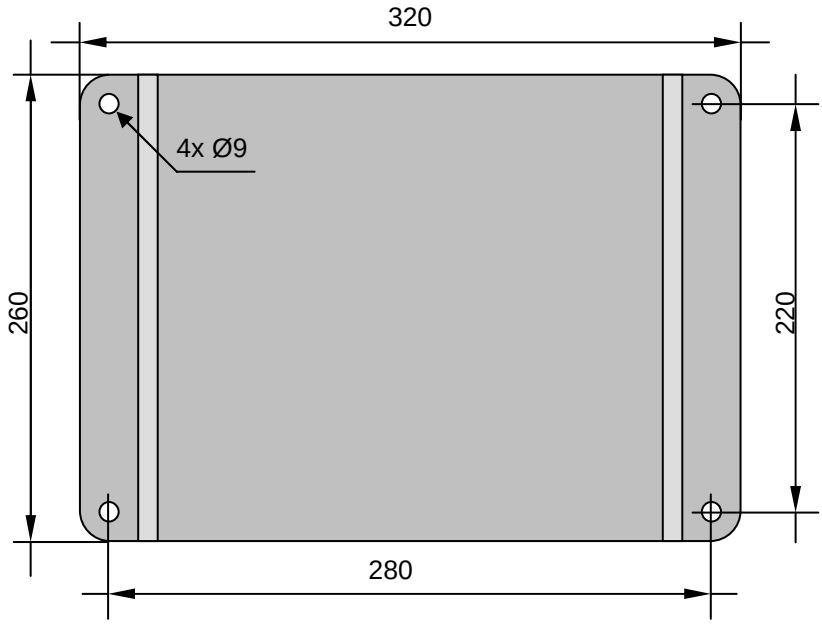


Figure 21.
Support bracket for DDS, FR unit and backpressure sensor

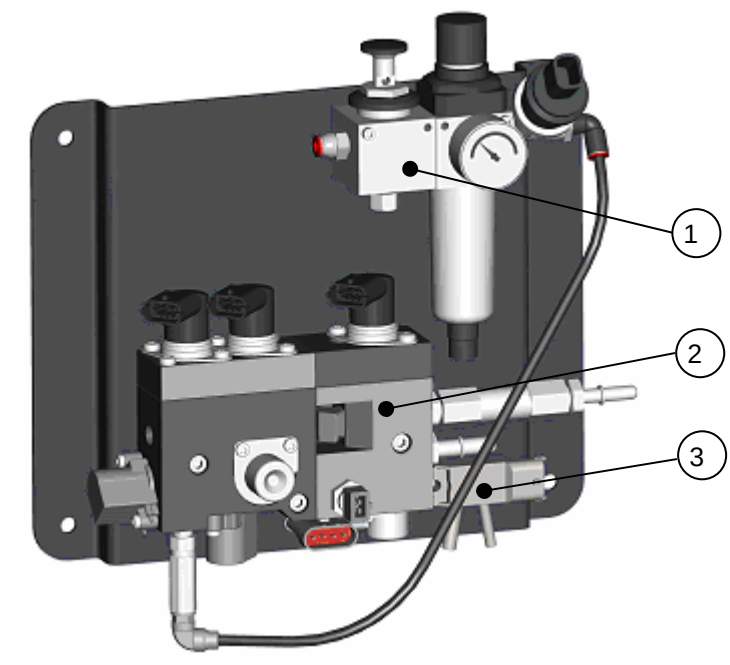


Figure 22.
1. FR unit, 2. DEF dosing and 3.Exhaust backpressure sensor mounted on support bracket

The DEF dosing unit can be mounted anywhere above the level of the DEF supply pump. The maximum length of the hose or tube connection is 10 m but it is preferable to keep it as short as possible. Max elevation is also 10m above the DEF supply pump.

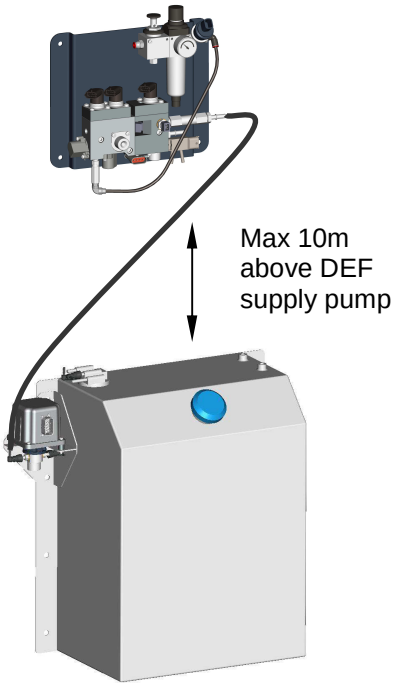


Figure 23.
Default (and lowest) DEF supply pump mounting position

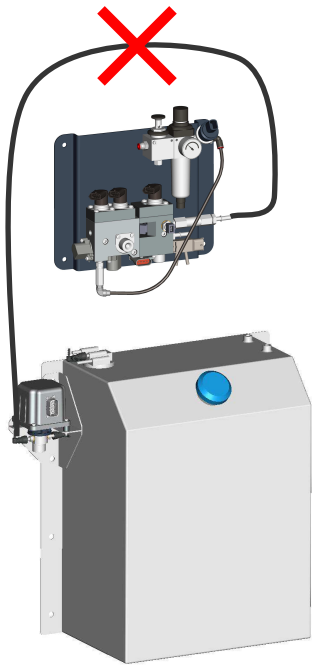


Figure 24.
Air pockets not allowed

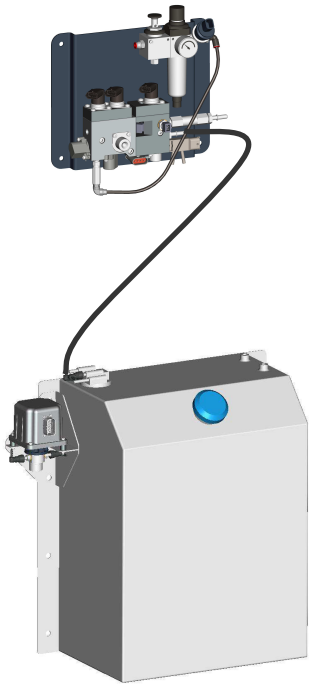


Figure 25.
DEF dosing unit to DEF service tank

The return line from the DEF dosing unit to the service tank is normally not pressurized but can in frozen, or otherwise blocked, conditions observe the same pressure as any other DEF line. The same restrictions regarding air pockets, lengths and elevation as in the pressure line applies here also.

Note! DEF is very volatile and will slip thru the slightest gap! Make sure all connections are tight! And pay close attention to the cleanliness of the DEF lines.

Note! Do not use copper or brass in compression fittings!

Note! Avoid air pockets when routing DEF lines or blockage may occur!

3.7.3 Maintenance

The DEF filter should be replaced every 12 months, see *Appendix 03 – Maintenance*.

3.7.4 Replacing the DEF filter

The DEF filter element is mounted inside the DEF filter unit and can be replaced as a separate part. This filter is to be regarded as an emergency filter and is not intended to be the main filter for the DEF supply system. To replace the DEF filter unit first disable the DDS. **The DDS need to be shut down in a safe manner, please refer to section 5.2 for the correct procedure.**

Disconnect the DEF pressure hose from the fitting on the filter unit. Unscrew the entire filter unit from the DDU manifold. Separate the filter unit by unscrewing the top half from the bottom half. Replace the filter element and the sealing ring. Assemble the filter unit and reassemble the unit on the DDU manifold. Reconnect the urea hose before turning power back on. Refer to appendix 3, maintenance for details

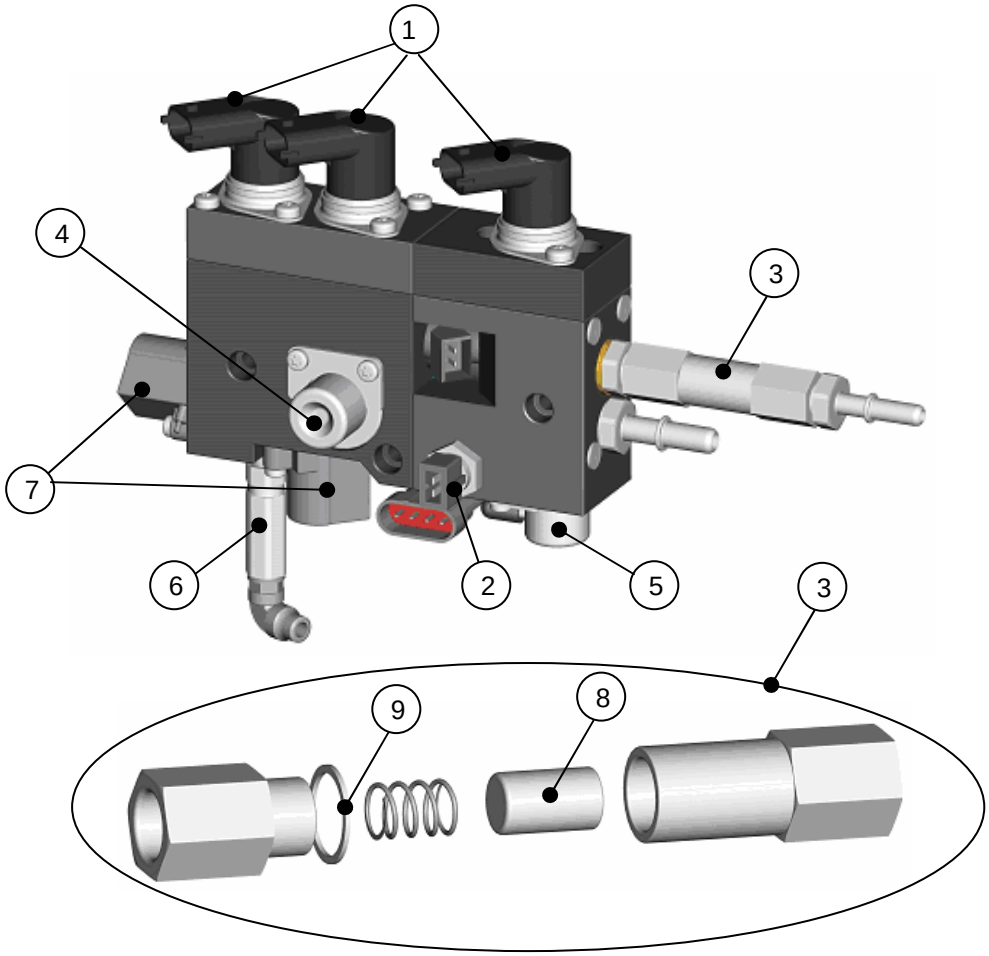


Figure 27. *DEF dosing unit, spare parts*
1. DEF pressure sensors, 2. DEF temperature sensor, 3. DEF filter unit, 4. DEF pressure damper, 5. DEF pressure regulator,6. Air check valve, 7. Air solenoid valves, 8 DEF filter element, 9.Sealing ring

3.7.5 Replacing the DEF dosing unit

Consult the bill-of-materials for your specific system when ordering spare parts.

Note! Start by disabling the DDS and then release the air pressure. If the nozzle is blocked /clogged, note that pressurized air can be trapped in the urea line from the pump to the nozzle!

Note! When releasing the DEF- and the electric connections, make sure no DEF gets in contact with the connector receptacles!

3.8 Injection nozzle

3.8.1 Function

The injection nozzle transports DEF and air into the exhaust mixer chamber of the SCR assembly. It creates a mist of air and DEF when air and DEF is released from the nozzle tip into the mixer.

3.8.2 Installation

The nozzle is installed at the inlet of the exhaust mixer with the tip in the exhaust flow direction (towards the SCR chamber), see Figure 28.
The nozzle steel braided hose can be bent to make a proper route from the manifold to the mixer unit but the bending radius must not be less than 125mm. The nozzle is bolted to the flange on the mixer chamber using a graphite gasket; see section Replacing the injection nozzle

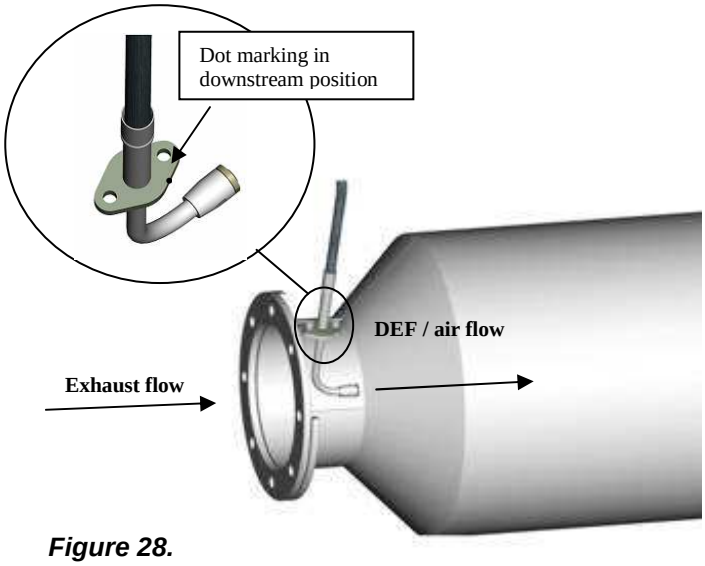
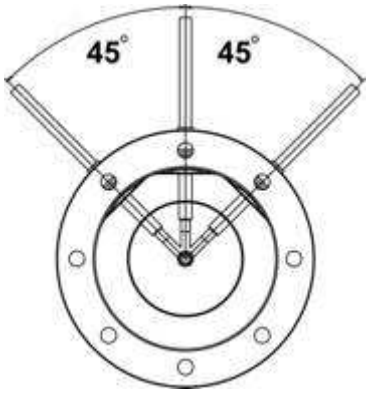


Figure 28.
Injection nozzle orientation



The orientation of the nozzle must be on the topside of the mixer and not more than ± 45° from the vertical plane. See figure 29 below. This is to ensure proper DEF evacuation when the engine is stopped

Figure 29.
Nozzle installation, allowed angle

Note! The inside radius of the hose must not be bent narrower than 125mm and be installed with a slack to prevent pulling forces on the nozzle assembly.

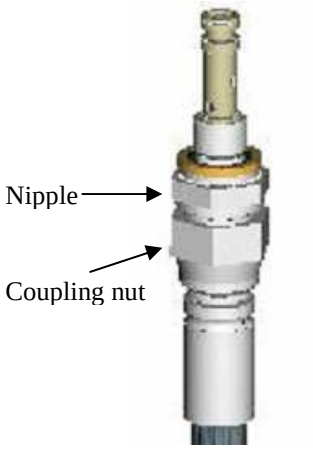
Under no circumstances can the stainless steel braided hose part of the injection nozzle and the press sleeve connecting the braided hose to the injection nozzle be over covered by insulation.

3.8.3 Maintenance

The injection nozzle should be inspected or replaced every 12 month or 3000 operating hours, see *Appendix 03 - Maintenance*

3.8.4 Replacing the injection nozzle

To replace the injection nozzle first disable the DDS
The DDS need to be shut down in a safe manner, please refer to section 5.2 for the correct procedure.
Release the coupling nut securing the nozzle to the DEF dosing unit before loosening the nipple. Retract the nipple straight out of the DDU – note that it is easy to damage the o-ring of the nipple (Table 11, pos 5) if the nipple is not carefully inserted or retracted.



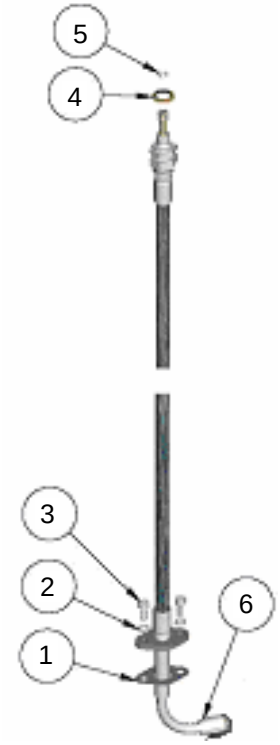


Figure 31. *Injection nozzle*

The washers, screws and o-ring in table 5 can be reused if the conditions of the components are acceptable. The gasket (position 1) shall always be replaced. When installing the new nozzle, make sure that that the nozzle tip is oriented in the same direction as the exhaust flow, see figure 28.

Table 3 Injection nozzle, spare parts

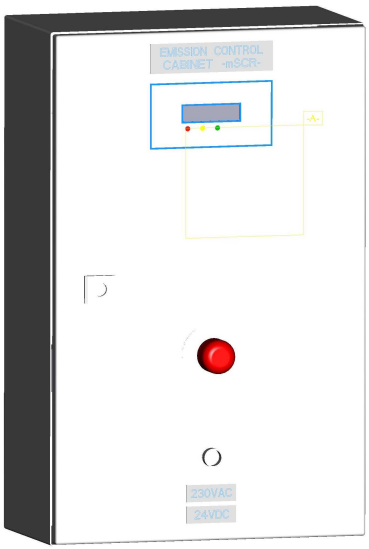
Pos	Description	Qty
1	Gasket	1
2	Washer spring	2
3	Screw	2
4	Washer tredo	1
5	O-ring	1
6	Injection nozzle	1

Note! Start by disabling the DDS and then release the air pressure. If the nozzle is blocked /clogged, note that pressurized air can be trapped in the urea line from the pump to the nozzle!

4 Electrical components installation

This section describes the mechanical installation of the discrete electrical sensors in the exhaust system. For electrical installation notes see section Cables. If the engine interface is not CAN (J1939) or Modbus RS422 based, discrete engine sensors can be used. For further information regarding selection and installation of discrete engine sensors, consult the system supplier.

4.1 Control cabinet



4.1.1 Function

The control cabinet contains the electronic control units (ECU), main switch, relays and a terminal rail where all the wires from the sensors and power supply are installed. A 230/24V converter may also be included depending on system configuration. The control unit reads sensor data from the engine and exhaust system, monitors the SCR assembly and sensors operation and controls the DEF dosing unit.

4.1.2 Installation

The control cabinet is wall mounted. M8-M12 bolts may be used. To ensure a safe installation make sure that the cabinet is well grounded.
The control system requires a 24VDC or 230VAC back up power which must be arranged by the installer/yard.

Figure 32. *Control cabinet*

Diagnose connector

In case of severe vibrations, the cabinet can be mounted on 6 pcs of rubber bobbins (optional). If required, additional brackets (optional) may also be used.

4.1.3 Maintenance

Check tightening of the terminal screws every 24 mon or 6000h, see *Appendix 03 - Maintenance*

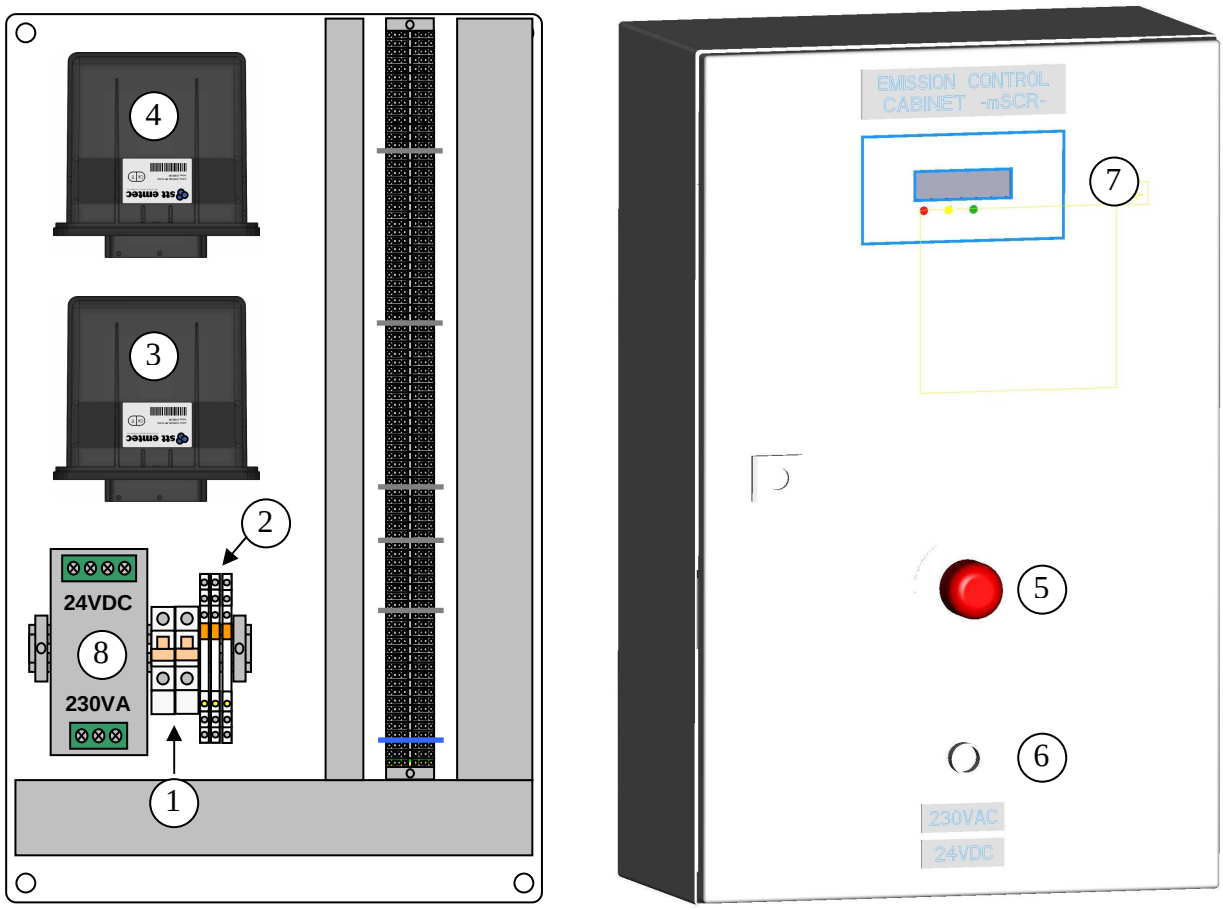


Figure 33. *DDS control cabinet.*
1. Automatic fuses, 2. Control relays, 3. Electronic control unit,
4. Electronic control unit for emergency stop, 5. Emergency stop switch,
6. Start switch (emergency stop reset), 7. LCD display unit, 8 Power supply unit (optional)

Table 4 Control cabinet, spare parts

Pos	Detail
1	Automatic fuse, 10A
2	Control relays, 6A
3	Electronic control unit
4	Electronic control unit, emergency stop
5	Emergency stop switch
6	Start switch (Em.Stop reset)
7	LCD display unit
8	Power supply unit (option)

4.2 NOx concentration sensors

4.2.1 Function

The NOx sensors measure the NOx concentration in the exhaust gas. The NOx sensor number 1 (pre SCR chamber) is used for calculation of necessary DEF injection rate to each demand NOx reduction rate. The NOx sensor number 2 (post SCR chamber) is used for system diagnostics.

Figure 34.
NOx concentration sensor with control unit

4.2.2 Installation

The NOx sensor number 1 shall be installed at the inlet of the exhaust mixer. A mounting boss for the sensor number 1 is located inside of the protection box at the inlet of the exhaust mixer.
The NOx sensor number 2 shall be installed downstream of the SCR chamber. A second mounting boss is supplied for this purpose and it shall be installed on the exhaust pipe as far as possible downstream of the SCR chamber outlet.
If water injection is installed in the exhaust system the NOx sensor number 2 must be placed upstream of the water injectors. It should also be avoided to install the NOx sensor close to a bend. The orientation of the NOx sensors must be on the topside of the mixer or exhaust pipe and not more than ± 45° from the vertical plane. The orientation should always be 90º relative to the exhaust pipe center line. See figure 38 below.

To install the mounting boss, make a 19 mm hole in the exhaust pipe and weld the M20 mounting boss onto the exhaust pipe on top of the hole.. Apply anti-seize (high temperature graphite paste) to the mounting boss and the sensor thread before assembly. Max torque 50 Nm.

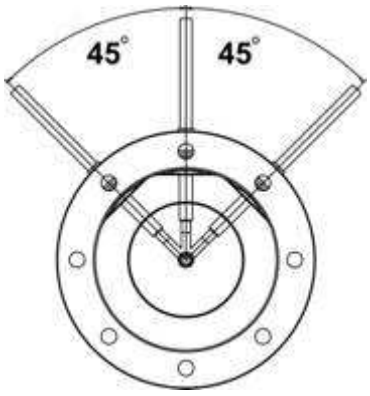


Figure 38.
Angle of the NOx sensor element

Figure 35.
NOx sensor, mounting boss

The NOx sensor has to be mounted in such way that no condensed water is collected inside the protection tube of the sensing element.
The NOx sensor is sensitive to moist and has a built-in heater to keep the sensor element dry at all times. If moist gets in contact with the sensor element the sensor deteriorates. Once the sensors are installed in the exhaust stream the power supply must always be enabled to the DDS control cabinet as long as the engine is running otherwise the sensor risk being damaged.

Note! The NOx sensors require permanent power supply once installed in the exhaust pipe!

If the supply power for the control system is not available and the engine needs to operate, the sensor element should not be inserted in the exhaust stream.

The electronic control unit of the NOx sensor should be kept away from the exhaust heat radiation. The wiring harness between the sensor element and the sensor control unit is 600 mm. Make sure that the sensor control unit is attached securely with screws (use flanged M6 screws) and within the allowed mounting positions.

Figure 36 shows the allowed NOx sensor mounting positions.

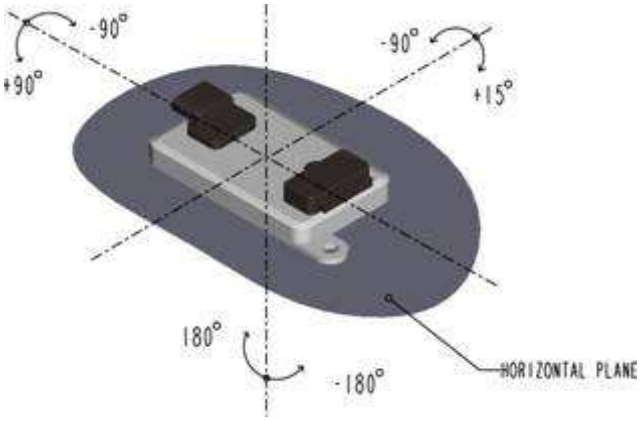


Figure 36.
Orientation of the NOx sensor control unit

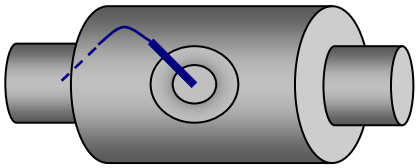


Figure 39. *Insulation cutaway*

A cutaway must be made in the exhaust pipe insulation where the NOx sensor number 2 is inserted. If the cable above the sensor is covered by insulation, it will be damaged by heat from the exhaust system. The insulation cutaway also provides service access to the sensor.

Under no circumstances can the sensor cable be covered by insulation.

4.2.3 Additional bosses for NOx measurement device

Depending on requirements the engine and its SCR*marine* system can be subject to periodical spot checks to assess the NOx reduction performance. These spot checks are performed by using a NOx measurement device complying with the requirements in IMO NOx technical code.

The NOx measurement device is typically an exhaust gas analyser that uses a sample probe to sample exhaust gas from the exhaust pipe pre and post the SCR assembly.

Bosses to facilitate the NOx measurement device sampling probe should be installed on the exhaust pipe pre and post the SCR assembly. The bosses are of the same design as the NOx sensor mounting boss as shown in figure 35. The bosses together with sealing plugs are supplied with the system.

The recommended location of the boss pre-SCR assembly is at least 10 exhaust pipe diameters downstream of the turbocharger outlet. If the minimum recommended length cannot be achieved, the boss should be mounted close to the exhaust mixer inlet flange.

The recommended location of the boss post the SCR assembly, is at least 10 exhaust pipe diameters downstream of the SCR chamber outlet flange, but at least 0,5 meter upstream of the exit of the exhaust gas. If the minimum recommended length cannot be achieved, the boss should be mounted as far as possible from the SCR chamber outlet.

It should be avoided, if possible, to mount the bosses pre and post the SCR assembly close to a bend or on the outside or inside of a bend.

If water injection is installed, the boss must be installed in the exhaust pipe, upstream of the water injectors.

To install the mounting boss, make a 19 mm hole in the exhaust pipe and weld the M20 mounting boss onto the exhaust pipe on top of the hole. Apply anti-seize (high temperature graphite paste) to the mounting boss and the plug thread before assembly. Max torque 50 Nm.

Make sure that the bosses for the NOx measurement device are easy to access and have a demountable section of insulation on top.

4.3 Exhaust temperature sensors (thermocouple type)

4.3.1 Function

The SCR catalyst is only active above ~220°C. Injecting DEF at lower temperatures will not cause NOx reduction and can lead to salt deposits in the SCR assembly. The SCR temperature sensors, one upstream and one downstream of the catalyst, makes sure that DEF metering is only enabled when the catalyst is active. The temperature sensors are also used for monitoring purpose and for the emergency stop system.

4.3.2 Installation

The fitting for temperature sensor number 1 is located at the outlet of the exhaust mixer and the fitting for temperature sensor number 2 is located at the outlet of the SCR chamber.

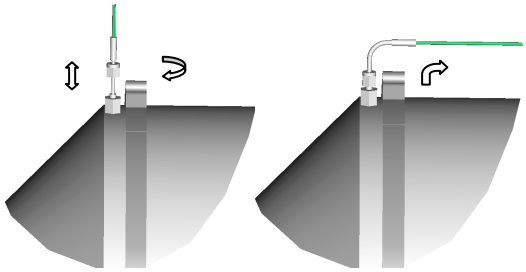


Figure 40. *Installation of thermocouple*

Install the sensors the following way;

1. Tighten the lock nut finger tight and then with a key ¾ of a turn, only.
2. The sensor can be bent up to 90º in any direction.

The cable above the sensor is protected by a steel braided hose and under no circumstances can this part of the sensor be covered by insulation.
The temperature sensors have a wire length of 1 meter, see figure 42 below.

Figure 42. *Temperature sensor*

Note! Do not try to straighten the thermocouple after it has been bent once.

Note! Do not tight the nut past ¾ of a turn, the thermocouple will break or wear out prematurely

Note! The inside radius of the thermocouple must not be bent narrower than 15mm

Under no circumstances can the steel braided hose part of the temperature sensor and the press sleeve connecting the braided hose to the temperature sensor be covered by insulation.

4.4 Exhaust back pressure sensor

4.4.1 Function

The exhaust backpressure sensor is used for monitoring the pressure drop across the Exaust mixer/SCR chamber unit and provides alarms for high pressure drop. The same sensor is also used for the emergency stop system.

4.4.2 Installation

Mounting bosses for the pressure sensor hose fittings are installed in the protection boxes at the inlet of the exhaust mixer and at the outlet of the SCR chamber.

Exhaust Pressure sensor,

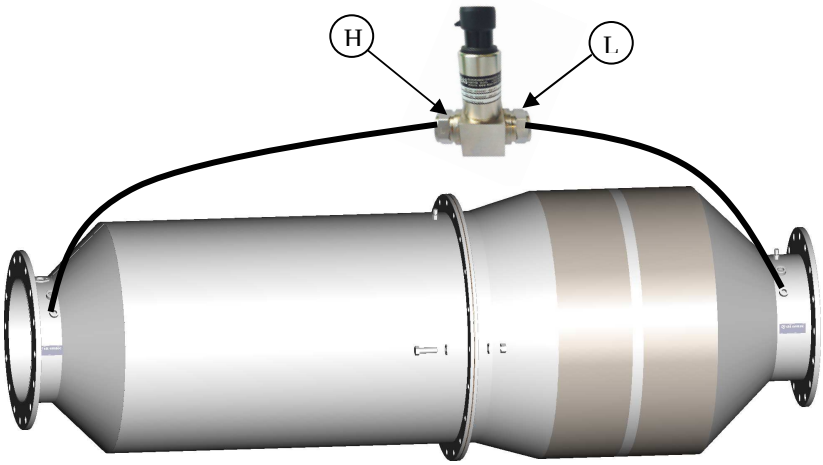


Figure 44.
Example of installed pressure sensor on a horizontal mounted SCR unit

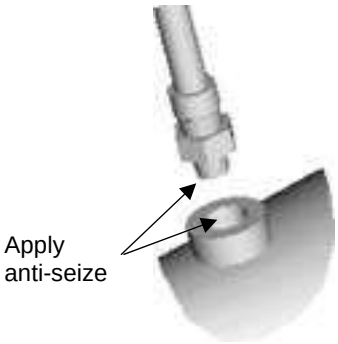


Figure 45.
Pressure sensor, installation

The exhaust pressure sensor is mounted by means of two rubber p-clamps around the high- and low pressure port of the sensor (the p-clamps are supplied with the system). The exhaust backpressure sensors must be located so that the pressure hoses can maintain a downward slope towards the connecting bosses on the exhaust mixer and the SCR chamber. This is valid for both horizontal and vertical mounting position of the exhaust mixer and catalyst chamber unit.
Humidity from the exhaust stream will otherwise disturb the pressure measurement or damage the pressure sensor element.

Apply anti-seize (high temperature graphite paste) on the thread of the mounting bosses and on the hose ends. Install the threaded end of the metal hose into the mounting boss. The other end should be connected with the hose routed to the sensor. The length of the metal hose is 1 m. The pressure hose pre exhaust mixer should be connected to the pressure sensor port marked H. and the pressure hose post SCR chamber should be connected to the pressure port marked L.

Note! Ensure that the exhaust back pressure hoses are routed uphill from the exhaust pipe to the pressure sensor to enable drainage of condensed water.

4.5 Cables

This section describes the electrical installation of the SCR*marine* control system.

4.5.1 Cable restrictions

The standard cable length is 10 m. Maximum wiring routing length between the control cabinet and the system components is 15 m, with an exception for the following cables where the range is extended to 30 m:

- SUPPLY Dosing system power supply
- OBD LCD slave panel (up to 60 meters possible)
- ALA Sum alarm signal vessel diagnose interface
- RUN Engine running signal

Note! Use only cables delivered, or specified, by STT Emtec AB to ensure proper system operation!

The electrical installation kit includes a full set of installation cables. All cables are connected from the side terminal rail of the SCRmarine control cabinet (Figure 49) to each of the respective DDS system component. When required the cables are equipped with a mating connector at the sensor/actuator end.

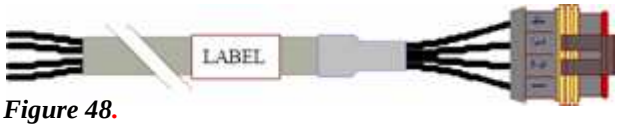


Figure 48.
Cable marking

Each cable is tagged with a label at the component End and a separate chart of label stickers is included for tagging the control cabinet side after the cable is cut to the appropriate length. (Figure 48)

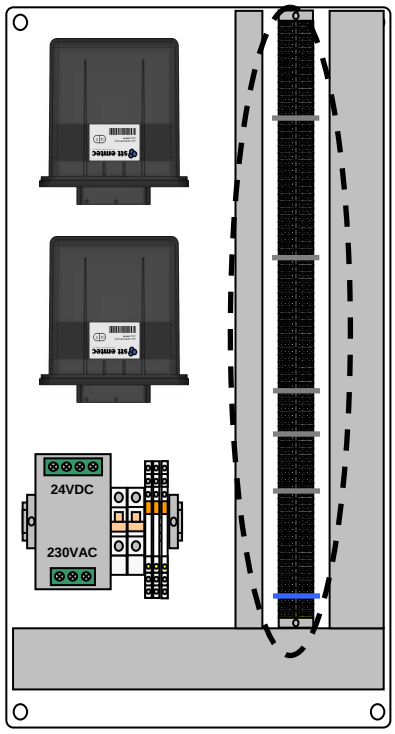


Figure 49.
Terminal rail, control cabinet

4.5.2 Wire connection

The wires in the cables are numbered and the wires shall be connected to the terminal rail in the control cabinet according to the following tables:

- 24VDC system use Table 18 – Wire installation chart 24VDC system
- 230VAC system use Table 19 – Wire installation chart 230VAC system

The terminal rail is labelled A-M with an adjoining consecutive nr, e.g. “C2”, and each wire corresponds to a unique terminal nr according to the column Wire connections in the Wire installation chart.

- Note that not all wires in all cables shall be connected in the control cabinet. Non connected wires are marked with a ‘-‘ in the installation chart.
- Note also that not all terminals in the control cabinet are occupied This depends on your actual system configuration.
- Note that not all cables in the Wire installation chart may be included in your cable kit. Cables not included should not be installed unless pointed out in specific installation instructions.
- Note that Nx2x0.75 type cables have number prints and the 3G1.5 and 2x0.22/K type cables are colour coded

The difference between 24VDC systems and 230VAC systems lies in connecting the supply power and CAN (J1939) or Modbus RS422 databus to the DEF dosing system. See further notes in section Electrical installation considerations.

4.5.3 Component layout

Use Figure 50 - Component location and Table 18/19 – Wire installation chart to match each individual cable marking to the corresponding installation point (sensor, actuator, power supply etc). The position numbers in the figure corresponds to the cable No in the wire installation chart.

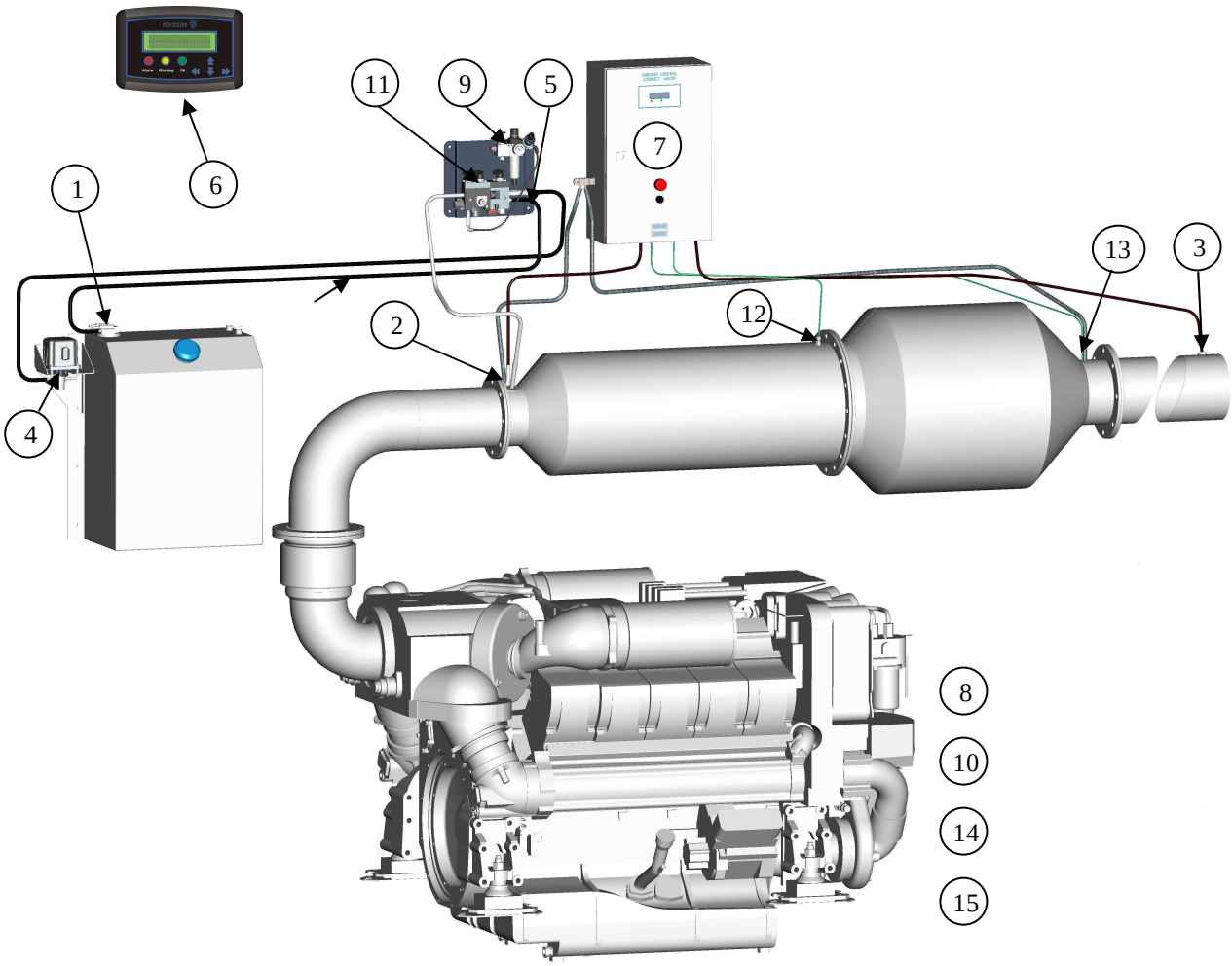


Figure 50.
Cable to component location

1. TANK, 2. NOx1, 3. NOx2 4. PUMP, 5. EBP, 6. OBD 7. COM 8. RUN, 9. AIR, 10. ALA, 11. DDU, 12. Tscr1, 13. Tscr2, 14. Supply 15. CAN/Modbus

Table 18. *Wire installation chart 24VDC*

Cable type	No	Label	Wire connections												Route cable to
			1	2	3	4	5	6	7	8	9	10	11	12	
1x2x0.75	1	AIR	C5 24V	I6 On											Air pressure switch on FR unit
	2	RUN	G10 0V	G9 24V											Engine running signal
	3	ALA	G8 COM	G7/6 NC/NO											Vessel sum alarm from DDS
	4	MIT	D5 0V	H4 Temp											Engine boost air temp (using discrete sensor on engine)
	5	EBP	C6 24V	H8 Tmp											Pressure drop sensor over SCR schamber
2x2x0.75	6	TANK	D1 0V	E1 5V	H1 Level	-									DEF service tank level sensor
	7	NOX	B1 0V	C1 24V	F3 Data Lo	F6 Data Hi									Engine out NOx concentration sensor before SCR chamber
	8	NOX2	B2 0V	C2 24V	F4 CAN2 LO	F7 CAN2 HI									NOx concentration sensor after SCR chamber
	9	PUMP	B4 0V	J2 24V-STOP	G2 Speed	G5 On/Off									DEF supply pump
	10	CAN	-	-	F1 Data Lo	F2 Data Hi									Engine CAN bus (J1939) connection
	11	MAP	D4 0V	E4 5V	H2 Pressure	-									Engine boost prs (using discrete sensor on engine)
	12	OBD	B3 0V	C3 24V	M1 Data	-									External slave LCD panel
	13	COM	B6 0V	-	M3 Data Rx	M2 Data Tx									Connection to remote modem
	14	RPM	D6 0V	E3 5V	I5 Fq										Engine speed (using discrete sensor on engine)

Table 18. *Continued. Wire installation chart 24VDC*

Cable type	No	Label	Wire connections												Route cable to
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
3x2x0.75	15	MODBUS	L4 TX+	L5 TX-	L6 RX+	L7 RX-	L8 SGND	-							Engine databus (Modbus RS-422 in slave mode)
6x2x0.75 (alt 7x2x0.75)	16	DDU	D2 0V	E2 5V	H7 Temp	H3 Pressure	H5 Pressure	H6 Pressure	G1 On/Off	G4 On/Off	G3 On/Off	J1 24V- STOP	C4 24V	-	DEF dosing unit
2x0.22/K			**White**	**Green**											
	17	TSCR1	I1 Temp -	I2 Temp +											SCR inlet temperature sensor on SCR chamber
	18	TSCR2	I3 Temp -	I4 Temp +											SCR outlet temperature sensor on SCR chamber
3G1.5			**Gn/Yw**	**Blue**	**Brown**										
	19	SUPPLY	A1 GND	A2 0VDC	A3 24VDC										DDS supply voltage

Table 19. *Wire installation chart 230VAC*

Cable type	No	Label	Wire connections												Route cable to
			1	2	3	4	5	6	7	8	9	10	11	12	
1x2x0.75	1	AIR	C5 24V	I6 On											Air pressure switch on FR unit
	2	RUN	G10 0V	G9 24V											Engine running signal
	3	ALA	G8 COM	G7/6 NC/NO											Vessel sum alarm from DDS
	4	MIT	D5 0V	H4 Temp											Engine boost air temp (using discrete sensor on engine)
	5	EBP	C6 24V	H8 Tmp											Pressure drop sensor over SCR schamber
2x2x0.75	6	TANK	D1 0V	E1 5V	H1 Level	-									DEF service tank level sensor
	7	NOX	B1 0V	C1 24V	F3 Data Lo	F6 Data Hi									Engine out NOx concentration sensor before SCR chamber
	8	NOX2	B2 0V	C2 24V	F4 CAN2 LO	F7 CAN2 HI									NOx concentration sensor after SCR chamber
	9	PUMP	B4 0V	J2 24V-STOP	G2 Speed	G5 On/Off									DEF supply pump
	10	CAN	B5 0V	-	F1 Data Lo	F2 Data Hi									Engine CAN bus (J1939) connection
	11	MAP	D4 0V	E4 5V	H2 Pressure	-									Engine boost prs (using discrete sensor on engine)
	12	OBD	B3 0V	C3 24V	M1 Data	-									External slave LCD panel
	13	COM	B6 0V	-	M3 Data Rx	M2 Data Tx									Connection to remote modem
	14	RPM	D6 0V	E3 5V	I5 Fq										Engine speed (using discrete sensor on engine)

Table 19. *Continued. Wire installation chart 230VAC*

Cable type	No	Label	Wire connections												Route cable to
			1	2	3	4	5	6	7	8	9	10	11	12	
3x2x0.75	15	MODBUS	L4 TX+	L5 TX-	L6 RX+	L7 RX-	L8 SGND	-							Engine databus (Modbus RS-422 in slave mode)
6x2x0.75 (alt 7x2x0.75)	16	DDU	D2 0V	E2 5V	H7 Temp	H3 Pressure	H5 Pressure	H6 Pressure	G1 On/Off	G4 On/Off	G3 On/Off	J1 24V- STOP	C4 24V	-	DEF dosing unit
2x0.22/K			**White**	**Green**											
	17	TSCR1	I1 Temp -	I2 Temp +											SCR inlet temperature sensor on SCR chamber
	18	TSCR2	I3 Temp -	I4 Temp +											SCR outlet temperature sensor on SCR chamber
3G1.5			**Gn/Yw**	**Blue**	**Brown**										
	19	SUPPLY	A1 GND	A2 N- 230VAC	A3 L- 230VAC										DDS supply voltage

4.5.4 Databus

CAN databus in (J1939) 24VDC vs 230VAC installation
The DDS normally derives runtime data for Engine speed, Engine load, Engine boost air pressure and Engine boost air temperature from the CAN databus (SAE-J1939 format) of the engine.

In a 24VDC installation care must be taken to derive supply power to the DDS from a power source with the same electrical 0V potential as the engine. Otherwise engine malfunction or component damage may occur. When making a 'CAN' connection in a 24VDC application only the CAN_HI and CAN_LO signals, and not the 0V, shall be made with this cable, see Table 18 , since there already exists a 0V reference in the power supply cable and dual 0V connection will create an undesired ground loop.

In a 230VAC installation it is equally important that the 0V connection must be made in the 'CAN' cable along with the CAN_HI and CAN_LO signals to the node supplying the engines databus, see Table 19 . Improper CAN databus grounding can also lead to engine malfunction or component damage.
Operation of the CAN bus can be monitored using the runtime meters: Engine speed, Engine load, Boost prs, Boost air temp, CAN status (See section LCD diagnose)

Modbus
For installations where the DDS derives runtime data from a Modbus RS244 the following connections should be made to the engine (data supplier):

- Rx+
- Rx-
- Tx+
- Tx-
- SGND (0V reference)

The Modbus interface is galvanically isolated from the DDS control system hence the SGND should always be connected, regardless if the supply voltage is 24VDC or 230VAC.
The Modbus RS422 of the DDS operates in Master mode and the Modbus RS422 of the engine (data supplier) should operate in Slave mode.

Note! Improper databus connections may lead to engine malfunction and/or component damage!

4.5.5 Activation relay input (RUN cable)

Besides from the Engine speed data from the databus, or a discrete sensor, the DDS requires a redundant activation signal indicating that the engine is running. This signal connects to the 'RUN' cable and drives a potential free relay coil (6-24VDC/100mA) in the DDS, see Table 18. Please note that the activation signal must be ON even during idling and not only at high engine load.

Operation of the activation signal can be monitored using the runtime meter: Activation (See section LCD diagnose)

4.5.6 Alarm relay output (ALA cable)

The alarm output is activated whenever the DDS is in state Alarm or Warning and DEF dosing (and NOx reduction) is disabled. In this state the red (Alarm) or yellow (Warning) lamp on the LCD is also lit and the display reads "Service required"

Alarm interface
The alarm connects to the ALA cable and is a potential-free relay contact capable of driving 24VDC or 230VAC at 6A. It is intended to connect to the sum-alarm of the vessel monitoring system. Both the Normally Open and Normally Closed contacts are available, see Table 18/19.
Horn reset and alarm acknowledge shall be implemented in the vessels overall alarm system and is not a part of STT Emtecs scope of supply.
If new trouble codes appears while the relay is already actuated the relay will briefly disengage to indicate the presence of a new alarm or warning.

4.5.7 Fuses and system disable

The control cabinet carries a fuse pair for the power supply. The fuse pair carries the power supply to the DDS and shall always be active when the engine is operating or the NOx sensor risk being damaged. Also without power supply the post-running cleaning process will not take place and the injection components risk being clogged by salt deposits from the remaining DEF.
The emergency stop switch outside the cabinet door also acts as a disabling switch. Activating the emergency switch can be used as a means of safely stopping the DDS when service is required.
To enable the system after activation of the emergency switch is done by releasing the emergency switch and push the start button. Emergency switch and start button is shown in figure 51. I.e. never interrupt supply power to the DDS unless for safety reasons. See also section System operation.

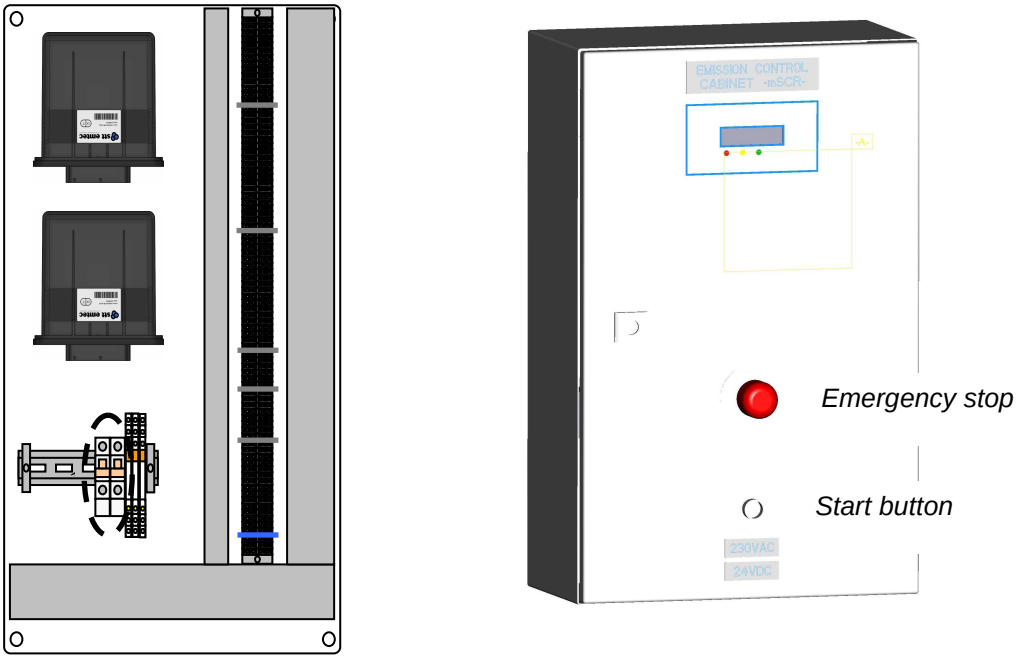


Figure 51.
Fuses, control cabinet

Note! Always keep supply power enabled to the DDS in order to avoid damage to NOx sensors and injection components!

4.5.8 Emergency stop system

The emergency stop system is activated by any of the reason listed below. When the emergency stop is activated the system stop DEF dosing and after a short delay the DEF supply pump and the DEF metering valve is deactivated by switching of the 24 VDC supply. The delay allows for a controlled evacuation of remaining DEF in the injection nozzle to avoid solid urea deposits. When the emergency stop is active the display shows “System stopped”.

Emergency stop is activated by	Activation limit
Emergency stop switch	Switch manually activated.
Exhaust back pressure	Maximum allowed exhaust backpressure has been reached
Exhaust temperature sensors	Temperature 1 (Tscr1): Exhaust temperature > 550°C Temperature 2 (Tscr2): Exhaust temperature > 550°C
Loss of power supply	24 vdc supply not within the 13 vdc – 32 vdc range.

To enable the system after an emergency stop event is done by pushing the start button on the cabinet door.

4.5.9 Cable shield connection

Some cables (Nx2x0.75 types) carry a metallic sheath (shield) beneath their jacket. The shield needs not to be connected and may be cut away. It is acceptable to connect the sheath to GND (not to 0V) in the control cabinet but in this case the sheath must not be connected in the component end.

4.5.10 Power consumption and fuse dimensioning

The DDS has an average power consumption of 100W and peak power is 150W.
In 24VDC installation a 10A fuse type B is recommended.
In a 230VAC installation a 1A fuse is theoretically acceptable but the 3G1.5 ‘SUPPLY’ cable allows for a fuse in the practical range of up to 10A.

5 System operations

This section provides information on how to operate the SCR*marine* control system, i.e. safe enabling/disabling and troubleshooting using the built-in diagnostic functions.

5.1 Routine operation

The DDS control system does not require any day-to-day handling to operate normally. Power- and air supply shall always be active and the control system automatically operates the necessary actuators when the engine starts and stops etc. (See also sections 4.2 NOx-sensor and 3.7 DEF dosing unit regarding the importance of always keeping power- and air supply active)
The LCD diagnose display will provide information on operator actions required besides normal service and maintenance, such as refilling the DEF service tank or if any components should fail.

5.2 Enabling and disabling DEF dosing

The DDS need to be shut down in a safe manner if electrical power or compressed air must be interrupted e.g. for maintenance purposes.
The shutdown procedure looks like this:

1. Activate/push the emergency switch on the control cabinet door.
2. Wait for the LCD display to read “System Stopped”
3. Disengage supply power and/or compressed air supply.

By following this procedure it is ensured that the post-operating component cleaning process was completed in order to avoid salt blockage in the injection components.

The start-up procedure is equally simple:

1. Engage air supply.
2. Engage power supply and release the emergency stop.
3. Press the start switch on the cabinet door.

Note! Do not operate the engine without power supply to the DDS or the NOx sensors risk being damaged!

When the emergency stop is activated (and the LCD show “System Stopped”) the DDS is deactivated in the sense that all actuators are disabled and no air or DEF is consumed (or injected into the exhaust stream). The sum alarm relay will be permanently activated while the emergency stop is activated. The relay will also activate when power supply to the DDS control system is interrupted.

5.3 Operating mode switching

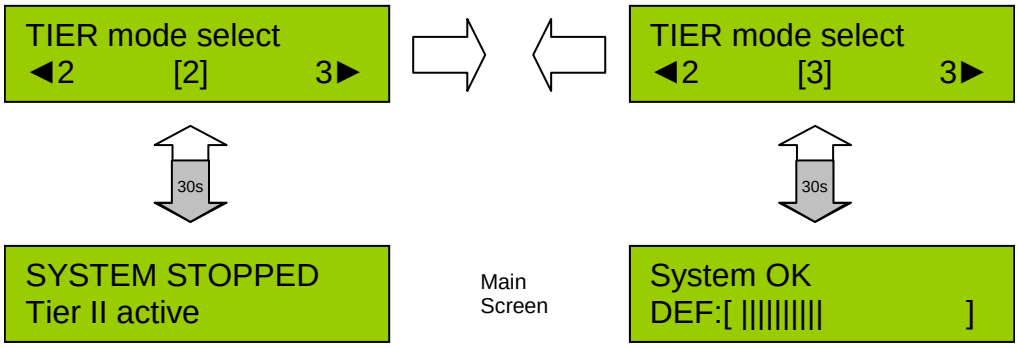
The engine can be operated without the influence of the SCR system through a controlled deactivation of the DEF dosing system. The mode can be switched from normal system operation i.e. SCR system active mode to SCR system deactivated mode by using the functions on the system display. For engines that is certified IMO Tier II and uses the SCR marine system to comply with IMO Tier III the modes is named IMO Tier II respective IMO Tier III mode.

The display is placed on the control systems cabinet door. A separate display panel with the same functions can be, depending on classification rules, installed at a permanently manned location (intended for the bridge)

The DEF dosing system will always automatically start up in IMO Tier III mode at engine start even if IMO tier II mode is activated prior to engine shut down.
When IMO Tier II mode is activated the diagnostic trouble code nr. 40 “Tier II active” will appear on the system display and stored in the diagnostic trouble code log until cleared by the operator.

IMO Tier II mode is activated according to the following procedure:

From the main screen press the arrow up button and the screen TIER mode select will appear. Use the left arrow button to activate IMO Tier II mode. After selecting Tier II mode the main screen will display System stopped and Tier II active.
In order to select IMO Tier III mode from the main screen use the arrow up button and the screen TIER mode select will appear. Use the right arrow button to activate IMO Tier III mode. After selecting Tier III mode the main screen will display System OK and the DEF level indication for the DEF service tank.



If required, the Tier operating mode shall be recorded in a logbook as prescribed by the administration at entry into and exit from an emission control area, or when the Tier mode status changes within such area, together with the date, time and position of the ship.

5.4 Troubleshooting

A log of diagnostic trouble codes (DTC's) is available in the LCD menu system, see section 5.5 Monitoring system.
Table 23 – List of trouble codes serves as a guide for troubleshooting.

Note! Some DTC's are latched and need to be cleared before DEF dosing is re-enabled. (Latched DTC's are marked 'L' in DTC list)

5.5 Monitoring system

A diagnostic display (see figure 52 below) is mounted at the front of the SCR control cabinet. This display shows the current state of the system. The display has three lamps indicating the operating state:

- Green System OK – Normal operation
- Yellow Warning – Limited NOx reduction, service required
- Red Alarm – No NOx reduction, service required

When the engine is stopped, and after the post-running cleaning process is complete, the DDS shuts down with all lamps off, unless a severe Alarm condition exists.

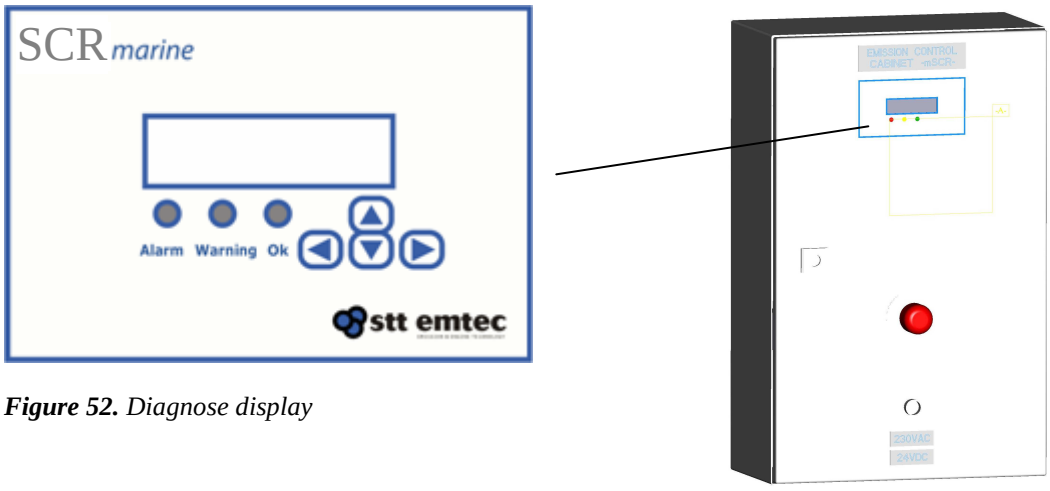


Figure 52. *Diagnose display*

5.5.1 DDS operating states

The normal startup procedure for the DDS means going from *System OFF*, where DEF dosing is disabled, via *Starting*, where the DEF pump is primed and the nozzle cooled by atomization air, into *System OK*.
In *system OK,* DEF dosing is enabled according to requested ANR (ammonia to NOx ratio) and actual exhaust prerequisites. When the required dosing amount equals zero the control system enters state stopping where the nozzle is evacuated from DEF.
If the engine is stopped the state *Stopping* will perform additional system evacuation by means of reversing the pump and flushing air thru the injection system, before returning to *System OFF*. The current state is reflected on the Main menu screen.
The system operating state is always displayed in the Main menu unless there are active trouble codes.

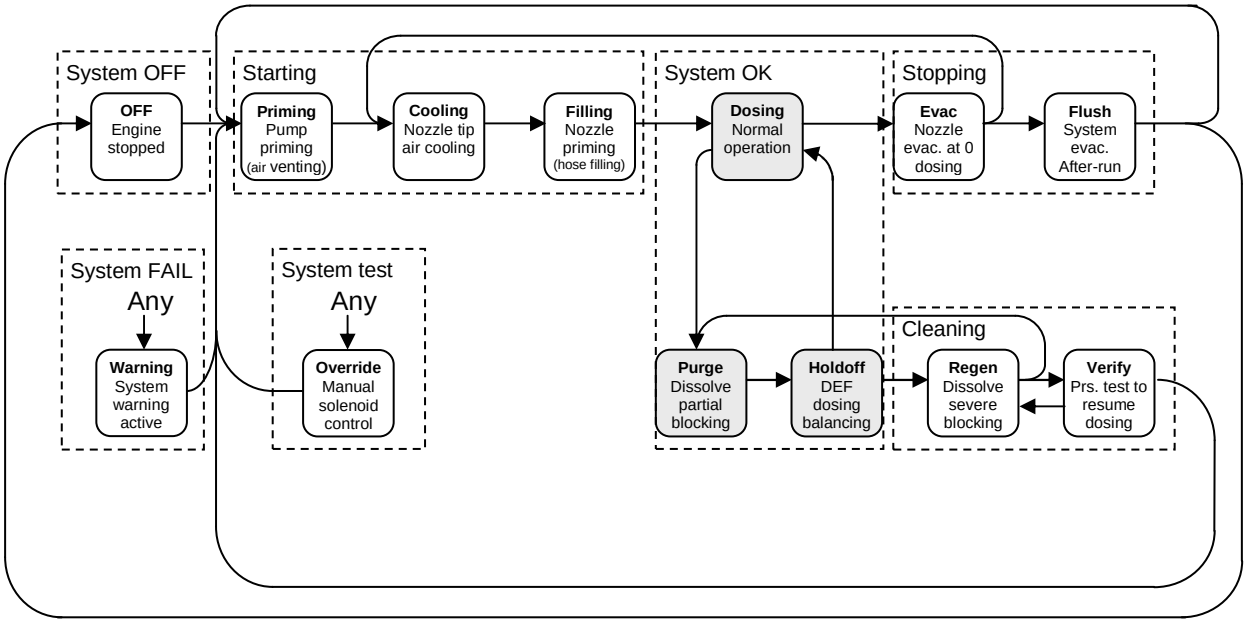


Figure 53.
System operating states

Table 20 – System states as reflected on the LCD

LCD display	Definition
System OFF	DEF dosing disabled. All solenoid valves closed. DEF supply pump stopped.
Starting	Priming the DEF supply pump, filling the pressurized part of the DDU with DEF, filling the injection nozzle with DEF, cooling the injection nozzle before commencing DEF metering. This is the waiting point before SCR temperatures allows DEF injection.
System OK	DEF dosing is active according to the programmed calibration. Dissolving of minor blockage in the injection nozzle may take place.
Stopping	When DEF dosing is not required (but engine is running) the DEF in the injection nozzle is returned to the service tank to prevent salt blockage. If the engine is stopped a post-injection cleaning process will attempt to evacuate all DEF lines including the DDU and supply pump.
Cleaning	This mode is entered only in case of a severe blockage in the injection nozzle in an attempt to dissolve the blockage using the heat from the exhaust stream.
System test	In this state the operation of solenoid valves and the pump is controlled by the LCD operator and normal DEF dosing is inhibited
Service required	Diagnostic Trouble Code(-s) active. DEF dosing disabled.
System stopped	Emergency stop activated. DEF dosing disabled. After a power failure the system will wake up in this state.

5.5.2 LCD diagnose operation

The LCD can be used interactively to perform system diagnose functions using the 4 arrow buttons under the display. The buttons let you navigate thru a menu structure where you can monitor and test system behaviour. Pressing and holding down a button will cause a 1 sec automatic repetition of that key. The full menu is outlined in Figure 55. The menu is based around a Main screen to which the system always reverts after a limited time if the operator is not actively using the arrow buttons.

The Main screen will always display either of the two following:

1. The operating state plus DEF service tank filling, or
2. Any active Warning or Alarm level trouble code(-s) if such exists
   (If several DTC's are active at the same time the display will scroll the list of active codes every 3 sec)

Figure 54.
Main screen, normal view *Main screen, DTC active*

When the DEF dosing system is powered up the LCD will show a Boot splash screen with firmware and dataset information. You can exit the Boot screen by pressing the ↓ Down button or simply wait 30s before the system reverts to Main screen.

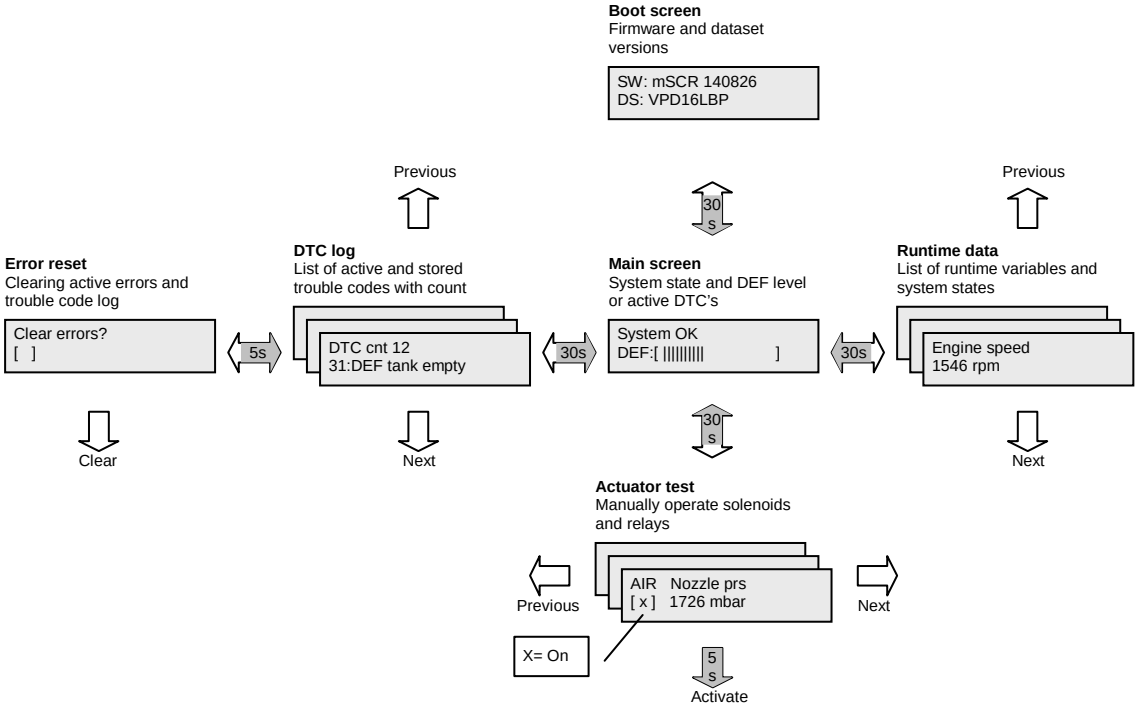


Figure 55.
LCD diagnose menu structure

5.5.3 Available diagnose screens

- **Boot screen**
  Displays firmware and dataset versions
  Reverts automatically to Main screen after 30s or upon key ↓
  Only active at power-up
  The display shows on row 1: System firmware
  The display shows on row 2: Data set
- **Main screen**
  Normally active menu
  Displays either system state plus service tank filling or active trouble codes
  The display shows on row 1: The system state
  The display shows on row 2: DEF level or active DTC
- **DTC log**
  Activate by key ← from Main menu
  List of currently and previously active trouble codes
  Show nr of occurrences since last reset plus a blinking ‘F’ if the DTC is currently active
  Scroll the list using keys ↓ or ↑
  Reverts to main menu after 30s if no key is pressed or by pressing key →
  The display shows on row 1: Number of occurrences for current DTC
  The display shows on row 2: Current DTC
- **Error reset**
  Activate by key ← from DTC log
  Scroll DTC log by pressing key ↓
  Clear DTC one by one by pressing key ← and acknowledge by pressing key ↓
  Reverts to main menu after 30s if no key is pressed or by pressing key →
  The display shows on row 1: Clear errors?
  The display shows on row 2: Shows clearing… if activated
- **Runtime data**
  Activate by key → from Main menu
  Show list of runtime data from the control system, see Table 21
  Scroll the list using keys ↓ or ↑
  Reverts to main menu after 30s if no key is pressed or by pressing key ←
  The display shows on row 1: Selected run time data meter
  The display shows on row 2: Current value
- **Actuator test**
  Activate by key ↓ from Main menu
  Show list of actuator test modes from the control system, see Table 22
  Scroll the list using keys → or ←
  Reverts to main menu after 30s if no key is pressed or by pressing key ←
  Note: in actuator test mode normal system operation (NOx reduction) is inhibited!
  The display shows on row 1: Actuator under test
  The display shows on row 2: Corresponding meter value when test is active

5.5.4 Runtime data

The following meters are available in the list of runtime data. They are useful during post-installation inspection and during troubleshooting.

Table 21 – list of runtime data

Runtime data	Description
Engine load [%]	From engine J1939
Engine speed [rpm]	From engine J1939 (or optional discrete sensor)
Boost air temp [°C]	From engine J1939 (or optional discrete sensor)
Boost prs [mbar]	From engine J1939 (or optional discrete sensor)
Engine NOx [ppm]	NOx concentration at SCR chamber inlet
T_SCR1 [°C]	Temperature at SCR chamber inlet
DEF level [l]	Filling rate of DEF service tank
Activation	State of Engine running signal/relay
T_SCR2 [°C]	Temperature at SCR chamber outlet
Supply voltage [mV]	Internal supply voltage in DDS cabinet
Exhaust prs [mbar]	Pressure drop over SCR
CAN status	Composite state signal for J1939 and NOx
Nozzle prs [mbar]	Backpressure in injection nozzle resulting from atomization air
Tail NOx [ppm]	NOx concentration at SCR chamber outlet
DEF1 prs [mbar]	Pressure at DEF dosing valve inlet (prs regulator)
DEF2 prs [mbar]	Pressure at DEF dosing valve outlet
Engine time [h]	Total engine running time
Dosing time [h]	Total engine running with SCR dosing active
DEF temp [°C]	DEF temperature in DDU
Air offset prs [%]	Deviation from baseline nozzle pressure
Inj offset prs [%]	Deviation from baseline DEF pressure
Air pressure	State of pressure switch on FR unit

5.5.5 Actuator test

The following actuators can be activated in this test mode. Note that while in actuator test mode DEF dosing (NOx reduction) will be disabled.

Table 22 – List of actuator test

Actuator	Action	Display
Air valve	Operate atomization air valve	Nozzle prs [mbar]
Flush valve	Operate flush air valve	Nozzle prs [mbar]
DEF pump	Operate DEF pump (full rpm fwd)	DEF1 prs [mbar]
DEF injector	Override DEF dosing valve (25% duty)	DEF2 prs [mbar]
Alarm relay	Override alarm relay	N/A
Pump priming	Initiate the pump priming sequence	DEF1 prs [mbar]

5.5.6 Diagnostic trouble codes

The following trouble codes can appear in the DTC log. These tables are also useful as a troubleshooting guide.

Self-deactivating trouble codes and latched trouble codes

The trouble codes in table 23 stops DEF dosing (i.e. no NOx reduction) and activates the sum alarm relay. Codes that are **not** marked with `**L**´ will automatically become inactive when the fault condition is no longer active and they do **not** require clearing to resume DEF dosing.

Codes market with `**L**´ are latched and need to be cleared before DEF dosing is re-enabled. All codes will remain in the log until cleared.

Table 23 – List of trouble codes

Nr	DTC	Definition	Action(-s)
1	Load sensor	Databus communication with engine interrupted. Normally these codes appear in group. Databus connections typically located in engine control cabinet or on the actual engine	1. Check engine databus status 2. Check databus termination 3. Check databus wiring 4. Check/replace ECU Note: These signals may be discrete (analogue), in this case see sensor datasheet for guidance
2	Speed sensor		
3	Boost air temp sensor		
5	Boost prs sensor		
6	NOx conc sensor	Sensor reports measurement fault or CAN communication interrupted. Sensors located on exhaust system	1. Check sensor wiring 2. Check/replace NOx sensor 3. Check/replace ECU
14	Tail NOx sensor		
7	T_SCR1 sensor	Sensor reading out-of-range (-50C > T > 2000C). Sensors located on exhaust mixer and SCR chamber	1. Check sensor 2. Check sensor wiring The sensor element is a thermocouple type K and shall measure < 10 Ω between sensor terminals when unplugged.
8	T_SCR2 sensor		
9	Exhaust prs sensor	Sensor reading out-of-range (0mbar > P > 350mbar).	1. Check sensor 2. Check sensor wiring The sensor shall read ≈ 960mV at atmosphere pressure at terminal H8 on the terminal rail in the control cabinet.
10	Nozzle prs sensor	Sensor reading out-of-range (0mbar > P > 10.000mbar). Sensors located on DDU.	1. Check sensor 2. Check sensor wiring The sensors shall read ≈740mV at atmosphere pressure at terminal H6 (Nozzle), H3 (DEF1), and H5 (DEF2), on the terminal rail in the control cabinet.
12	DEF1 prs sensor		
13	DEF2 prs sensor		

Table 23 continued – List of trouble codes

Nr	DTC	Definition	Action(-s)
11	DEF level sensor	Sensor reading out-of-range (0L > P > 100L). Sensor located on service tank.	1. Check sensor 2. Check sensor wiring The sensor shall read ≈4500mV at full tank at terminal H1 on the terminal rail in the control cabinet.
15	DEF temp sensor	Sensor reading out-of-range (-40C > T > 130C). Sensor located on DDU	1. Check sensor 2. Check sensor wiring The sensor shall read ≈ 2600mV at 20°C at terminal H7 on the terminal rail in the control cabinet.
17	CAN comm	CAN communication interrupted. Normally occurs with engine and NOx sensors.	1. Check CAN / Modbus wiring 2. Check CAN / Modbus termination
18	Supply voltage	Supply voltage out-of-range (13V > V > 32.0V). As measured by the ECU.	1. Check power fuses 2. Check power supply 3. Check power wiring
19	Internal temp	Temperature out-of-range (-50C > T > 200C). Internal measurement in ECU	1. Replace ECU
20	Program failure	Internal ECU fault	1. Reboot ECU (switch pwr supply) 2. Replace ECU
21	Mapdata failure	Internal ECU fault	1. Reboot ECU (switch pwr supply) 2. Replace ECU
22	Exhaust prs warning	Exhaust pressure above warning limit. Indicate blockage (soot/deposits) in the SCR catalyst but can also be the result of plugged sensor hoses or moist-damaged sensor element	1. Check sensor hoses for water/soot 2. Check/replace sensor 3. Check exhaust mixer and SCR chamber for deposits
23 L	Exhaust prs alarm	Exhaust pressure above alarm limit. DTC latched, DEF dosing disabled!	Same as DTC 22. This code is latched and must be cleared by the operator before DEF dosing is re-enabled.
24	DEF flow control	Relative injector pressure drop (Inj offset prs) out-of-range. Indicates a blocked injection nozzle or a blocked DEF dosing valve. DEF2 prs sensor and DEF dosing valve located on DDU.	1. Replace injection nozzle 2. Check/replace DEF2 prs sensor 3. Check/replace DEF dosing valve Meter Inj offset prs [%] must be within ± 50%

Table 23 continued – List of trouble codes

Nr	DTC	Definition	Action(-s)
25	Air flow control	Relative nozzle backpressure (Air offset prs) out-of-range. Nozzle prs sensor located on DDU	1. Check air supply pressure 2. Replace injection nozzle 3. Test AIR and FLS valves 4. Check/replace Nozzle prs sensor 5. Check DDU for internal blockage Meter Air offset prs [%] must be within ± 50%
26	System frozen	DDU below DEF freezing point (< -11C). DEF temp sensor located on DDU.	1. Thaw DEF dosing system 2. Check DEF temperature sensor 3. Check sensor wiring The sensor is a PTC element and should measure ≈ 2500Ω at 20°C between sensor terminals when unplugged.
27	Nozzle blocked	Both wet cleaning and heat cleaning failed. Indicates a blocked injection nozzle.	1. Replace injection nozzle 2. Check DDU for internal blockage
28	DEF tank empty	DEF service tank level below reserve limit (<15L)	1. Refill service tank 2. Check tank level armature 3. Check DEF level sensor
29 **L**	Exhaust temp alarm	Exhaust temperature above alarm limit (>550C). DTC latched, DEF dosing disabled!	Indicates engine malfunction. Check all exhaust components for heat damage: SCR catalyst, SCR temp sensors, NOx sensors. Verify NOx reduction. This code is latched and must be cleared by the operator before DEF dosing is re-enabled.
30 **L**	NOx reduction	Low NOx reduction. Comparison of Engine- and Tail NOx does not match ANR setting.	Indicates a DEF dosing problem, a damaged SCR catalyst or a deteriorated NOx sensor. This DTC typically occurs with other error codes that can help with troubleshooting. Verify NOx reduction.

Table 23 continued – List of trouble codes

Nr	DTC	Definition	Action(-s)
31	DEF pressure control	DEF1 prs. does not equal DEF regulator pressure. DEF 1 pressure must be within 4000 ± 500 mbar.	Indicates a DEF supply problem to the DDU or a DEF pressure regulator failure. 1. Check suction and pressure lines 2. Check or replace DEF filter 3. Check/replace DEF regulator 4. Check/replace DEF supply pump
32	Air supply	Pressure switch on FR unit not active. Indicates lack of air supply.	1. Verify air pressure on FR unit gauge 2. Test AIR and FLS valves
38 L	System disabled	Emergency stop evoked LCD reads 'System STOPPED'	Check and rectify the reason why emergency stop has been activated. Refer to section 4.5.8 Emergency stop system for details. This code is latched and must be cleared by the operator before DEF dosing is re-enabled. Press START switch on control cabinet to release the latch Note that functions 1-4 below must be ok before the STOP can be released. 1. Release STOP switch on control cabinet 2. Check T_SCR1 temperature and sensor 3. Check T_SCR2 temperature and sensor 4. Check EBP pressure and sensor
39	DEF temperature	DEF temp > 60C DEF pump stopped	1. Check actual DEF temperature 2. Check DEF temp sensor on DDU
40	Tier II active	Tier II mode activated	

Self-deactivating trouble codes without disabling reductant dosing

The trouble codes in table 24 activate the sum alarm relay but do ***not*** stop the DEF dosing. These codes will automatically become inactive when the fault condition is no longer active. The codes will remain in the log until cleared.

Table 24 – List of trouble codes

Nr	DTC	Definition	Action(-s)
33	DEF consumption	Comparison of service tank consumption does not match accumulated DEF dosing.	Indicates DEF dosing error in DDU or a fault in the DEF level sensor 1. Check/replace DDU 2. Check/replace DEF level armature/sensor Verify NOx reduction.

Information trouble codes

The following trouble codes (table 25) are for information and extended troubleshooting only. They have no impact on the DEF dosing and they will not activate the sum alarm relay. These codes will remain in the log until cleared by the operator.

Table 25 – List of trouble codes

Nr	DTC	Definition	Action(-s)
34	Flush failed	The previous Flush sequence did not successfully complete	These DTC's are for monitoring engine operating cycle and may be disregarded.
35	Priming failed	The previous Priming sequence did not successfully complete	
36	Evacuation failed	The previous Evacuation sequence did not successfully complete	
37	Alarm reset	Indicates how many times the DTC's were reset	

External trouble codes (provided by the yard / installer)

The following trouble code covers automatic bulk-to-service tank refilling and is not covered by the system alarm handling. The following codes should be implemented by the system installer (yard) if an automatic tank refill system is required.

Nr	DTC	Definition
	Tank high level	DEF service tank filled above max level

5.5.7 Normal trouble codes

Some trouble codes are a result of normal system operation or wear and may appear more frequent than others. They indicate a need for regular system maintenance.

Below is a short form table of the most frequent codes and suggestions on how to act.

Table 26 – Frequent trouble codes

Nr	DTC	Action
28	DEF tank empty	Refill DEF service tank
32	Air supply	Check gauge on FR unit and external compressor, see section 3.5
25	Air flow control	Replace injection nozzle, see section 3.8
24	DEF flow control	Replace injection nozzle, see section 3.8 Replace DEF filter, see section 3.7.4
38	System disabled	Release STOP switch on control cabinet Press START switch on control cabinet

5.6 External monitoring

5.6.1 Slave display panel

A separate display panel can or must be, depending on classification rules, installed at a permanently manned location (intended for the bridge)
The slave panel will show the same information and have access to the same features as the cabinet display. The maximum cable length for this display is 60m (to the control cabinet). Refer to section 5.3 and 5.5 for more information regarding functionality.

- Dimensions: 117mm x 79mm x 24mm
- IP classification: IP20
- Temperature range: -20ºC-+70ºC

Figure 56. *Discrete display*

5.6.2 PC diagnose software

In addition to the LCD based diagnostics a PC based software called EmtecDiag is also available. EmtecDiag enables access to extensive trouble code history and recorded logger data.

See *Appendix 7 – PC diagnostic tool manual* for further information

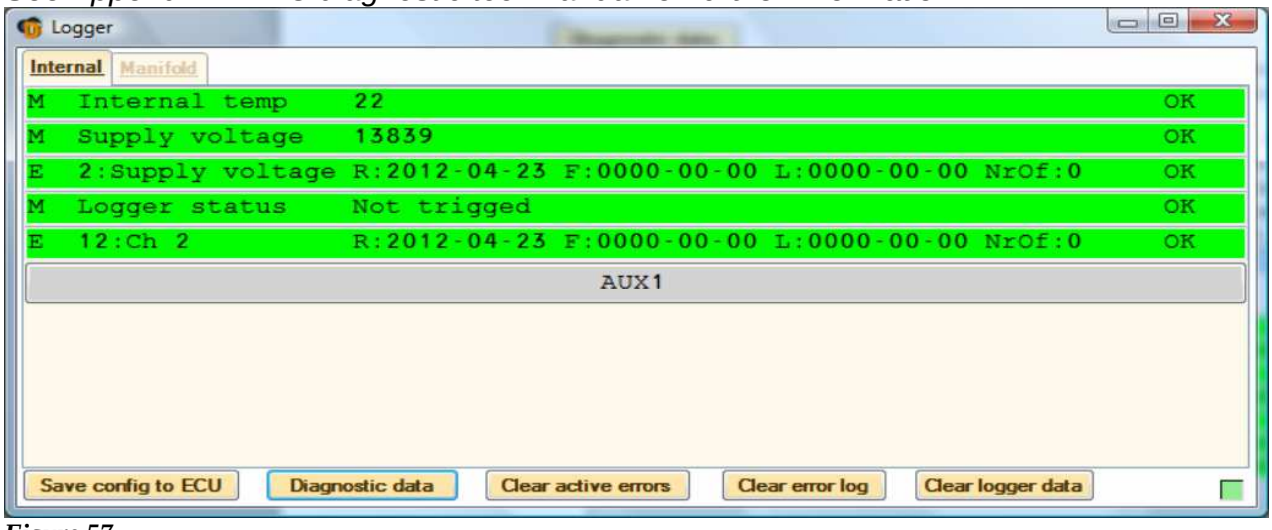


Figure 57.
Example of monitoring software desktop

Appendix 01 Technical specifications

1.1 DDS Control Cabinet

Material:	Powder coated steel
Dimensions:	600x380x210 mm
Weight:	20 kg
Ambient temperature:	-20 to +60 °C
Supply voltage:	176 to 264 VAC alt 24-32 VDC
Power consumption:	100 W nom, 150 W peak (entire DDS system)
Degree of protection:	IP 56
Communication protocol:	CANbus SAE J1939 / Modbus RS-422

1.2 DEF Dosing Unit (DDU)

Material:	Anodized aluminum
Dimension:	W=144mm, H=184mm, L=247mm
Weight:	1,7 kg
Ambient temperature:	-40 to +50°C (+85°C peak)
DEF temperature range:	-5 to +50°C. Maximum +30°C storage temperature is recommended.
DEF flow range:	0 to 20 kg/h
Medium:	DEF/AUS 32 (ISO 22241) Urea conc. 32,5% in water
Air pressure:	4,5±0,2 bar
Air consumption:	40 l/min nom FAD, 80 l/min peak FAD (+20°C)
Cleanliness requirements:	According to ISO 22241 standards.
Supply voltage:	5 VDC, 12 VDC
Power consumption:	20 W nom, 25 W peak
Degree of protection:	IP 65

1.3 DEF supply pump

Material:	Aluminum, cupper, stainless steel, ABS plastics
Dimension (mounted on bracket):	W=124mm, H=240mm, D=158mm
Weight:	2.9 kg
Medium:	DEF/AUS 32 (ISO 22241) Urea conc. 32,5% in water
Max DEF pressure:	10 bar
Max DEF flow:	75 l/h
Supply voltage:	10 to 32 VCD (full flow available ≥ 24 VDC)
Power consumption:	50 W nom, 75 W peak
Degree of protection:	IP 65

1.4 Injection Nozzle

Material:	Stainless steel, Teflon
Medium:	DEF/AUS 32 (ISO 22241) Urea conc. 32,5% in water Compressed air

1.5 DEF line, service tank - - supply pump

Medium:	DEF/AUS 32 (ISO 22241) Urea conc. 32,5% in water
Dimension:	Inner diameter 10 mm, length 600 mm
Material:	Stainless steel hose and pipe
Pressure:	1 bar operating pressure, 200 bar maximum

1.6 DEF lines, supply pump - - dosing unit

Medium:	DEF/AUS 32 (ISO 22241) Urea conc. 32,5% in water
Dimension:	Inner diameter 10 mm, length 600 mm
Material:	Stainless steel hose and pipe
Pressure:	4 bar operating pressure, 200 bar maximum

1.7 DEF lines, dosing unit - - service tank

Medium:	DEF/AUS 32 (ISO 22241) Urea conc. 32,5% in water
Dimension:	Inner diameter 10 mm, length 600 mm
Material:	Stainless steel hose and pipe
Pressure:	1 bar operating pressure, 200 bar maximum

1.8 FR unit (air regulator)

Material:	Brass, NBR, technopolymer
Temperature:	Operating temperature ±0 to +50°C
Mounting:	Attached to bracket for urea dosing unit
Medium:	Compressed air
Inlet supply pressure:	Max 16 bar
Outlet pressure range:	0,5 to 10 bar
Filter pore size:	5 µm
Drain:	Automatic drain
Connection:	Ø6 mm teflon alt. polyamide tube (PA) or stainless steel pipe

1.9 DEF Service Tank

Material:	LDX2101 Stainless steel, EN 1.4162
Ambient temperature:	-40 to +85°C
Volume:	50 - - 125 l
Weight:	32 kg (100 l empty)

1.11 Exhaust mixer and SCR chamber

Material, mixer and SCR chamber:	Stainless steel AISI 316/316L, AISI 304/304L
Dimensions:	Application specific
Weight:	Application specific

Appendix 02 Commissioning prerequisites

In order to achieve a successful commissioning of the SCRmarine system the system installation must be finished **according to installation guideline** and the checklist below must be completed.

2.1 Exhaust system

2.1.1 SCR catalyst/mixer assembly installed
2.1.2 Exhaust system without leakage
2.1.3 Insulation of exhaust system, exhaust mixer and SCR chamber completed
2.1.4 Accessible bosses for the NOx measurement device sampling probe installed in exhaust system.

2.2 DEF dosing system

2.2.1 DEF service tank installed
2.2.2 DEF dosing pump installed
2.2.3 DEF dosing unit installed
2.2.4 Injection nozzle installed
2.2.5 DEF hoses and pipes between tank, pump and DEF dosing unit installed and tight
2.2.6 Hoses for exhaust backpressure pressure sensor assembly installed and air tight with a continuous downward slope
2.2.7 Pipes or hoses for compressed air installed

2.3 Electrical system

2.3.1 DDS control cabinet installed
2.3.2 Slave display panel installed
2.3.3 Required cables and sensors installed
2.3.4 Supply voltage installed
2.3.5 CAN (J1939) or Modbus RS-422 cable connected to engine control system.
Or discrete sensors mounted on engine and cables connected.
The following signals must be available:
- Engine load
- Engine speed
- Boost pressure
- Boost temperature

2.3.6 RUN (engine running) cable connected to engine control system providing a 6-24VDC/100mA signal when the engine is running
2.3.7 Alarm interface, ALA cable connected to the vessel overall alarm system

2.4 Urea day tanks filled up

- Min 25 litres per system tank

1.5 Compressed air available

- Compressed air system installed, connected and adjusted according to installation guidelines

2.7 Supply voltage available at control cabinet

- 24VDC/10A or 230VAC depending on system configuration

2.8 Engine able to run under normal load conditions

- 20 min 25% continuous load
- 20 min 50% continuous load
- 20 min 75% continuous load
- 20 min 100% continuous load

NOTE: Engine operation with SCR system deactivated

If engine operation is required before commissioning of the SCR system, the NOx sensor should not be installed in the exhaust system. The sensor contains an electrical heater which is imperative to the sensors lifespan.

Appendix 03 Maintenance

1 System deactivation and activation

The DEF dosing system (DDS) need to be shut down in a safe manner before electrical power and compressed air is interrupted for maintenance purposes.

1.1 Shutdown procedure:

4. Activate/push the emergency stop switch (1) on the control cabinet door
5. Wait for the LCD display (2) to read “System Stopped”
6. Disengage supply power (3) and compressed air supply (4) on filter-regulator unit

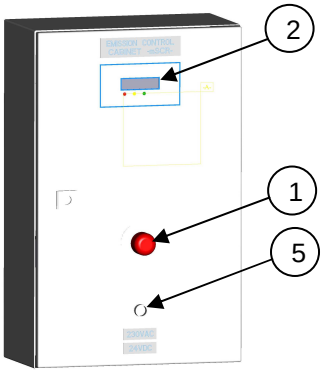
Following this procedure makes sure that the post-operating component cleaning process was completed in order to avoid salt blockage in the injection components.

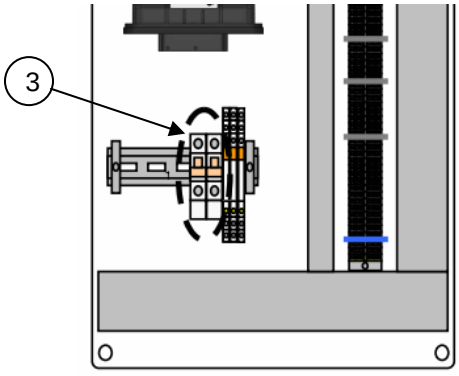
When the emergency stop is activated (and the LCD show “System Stopped”) the DDS is deactivated in the sense that all actuators are disabled, and no air or DEF is consumed (or injected into the exhaust stream). The sum alarm relay will be permanently activated while the emergency stop is activated. The relay will also activate when power supply to the DDS control system is interrupted.

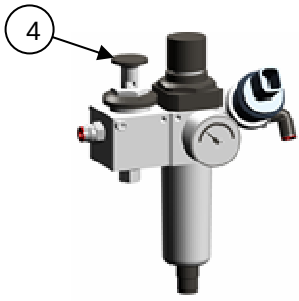
Note! Do not operate the engine without power supply to the DDS or the NOx sensors risk being damaged!

1.2 Start-up procedure:

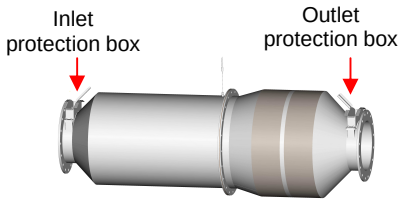
4. Engage air supply (4) on filter regulator unit
5. Engage power supply (3) and release the emergency stop switch (1)
6. Press the start switch (5) on the cabinet door



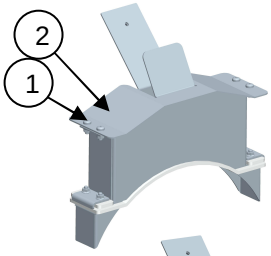




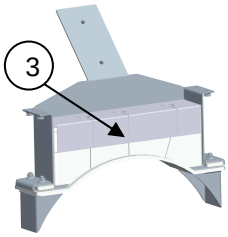
2 Protection boxes



Scope:
In order to perform maintenance operations (noted for the respective components in chapter 3), the protection boxes mounted on the mixer inlet and catalytic converter outlet must be disassembled. For the protection boxes to function correctly the disassembly and assembly of them may be carried out as described below



Tools needed:
- [T30] Torx
- [10mm] socket

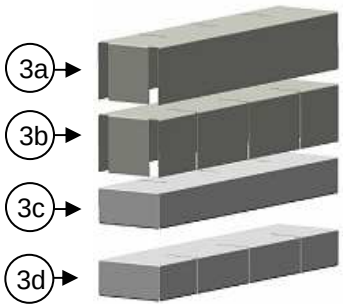


2.1 Disassembly of protection box

1. Locate protection box for the component intended for inspection/replacement

2. Remove 4 x bolts (1) [T30]
   protection box lid (2) and front piece (5a)

3. Carefully remove heat insulation (3) inside protection box

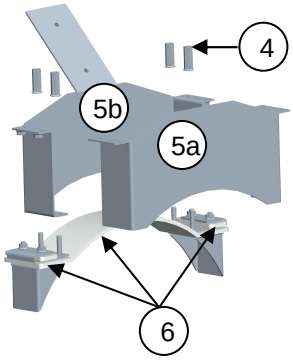


4. If necessary remove 4 x extension nuts (4) [10mm]
   and remove the back piece (5b)

2.2 Assembly of protection box

1. Replace insulation pads (6) if necessary

2. Reinstall back piece (5b) and fasten
   with 4 x extension nuts (4) [10mm]



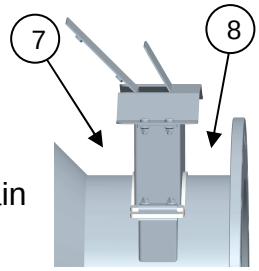
3. Reinstall heat insulation in order (3d → 3a) inside protection box. Make sure that the direction of the slits is alternating between each layer.

Identification of the insulation

Nr.	Type of insulation	Comments
3a, 3b	Alu foil blankets	
3c, 3d	Insulfrax LTX blankets	Low density
6	Insulfrax LTX blankets	High density

Specification on the insulation material can be given by the SCR-system supplier.

4. Reinstall front piece (5a) and protection box lid (2) fasten them with 4 x bolts + washers (1) [T30]



5. Be sure to fill the spaces (6, 7) between protection box and SCR-assembly with heat insulation before reinstalling the main heat insulation on the SCR-assembly.
   Protection box lid (2) must not be covered by insulation

3 Maintenance schedule

Components	Ch 1	Ch 2	See section	6 mon. 1500h	12 mon. 3000h	- 6000h	12 mon. -
Control cabinet	X		3.1			I	
DEF Line/connection	X		3.2	I			
Flange connections			3.3	I			
Injection nozzle	X	X	3.4		I (R)		
DDU DEF filter	X		3.5		R		
Tank DEF filters	X		3.6			I	
NOx sensors	X	X	3.7			R	
SCR catalyst	X	X	3.8				I
Mixer unit	X	X	3.9				I

I= Inspect, If necessary, clean, adjust or replace. R = Replace.

Ch1: System Deactivation/Activation procedures (Chapter 1) needed
Ch2: Protection box Disassembly/Reassembly (Chapter 2) needed

Note: The service interval is indicated in both calendar time and operating hours.
The interval should be interpreted as "whichever comes first"

3.1 Control cabinet

Scope:
Check and retighten all terminal screws at the terminal block

Service interval:
Inspect at 6000h or 24 months (Whichever comes first)

Tools needed:
- Cabinet key
- Torque screwdriver

Procedure:

1. Deactivate system
   (follow instructions in section 1.1)

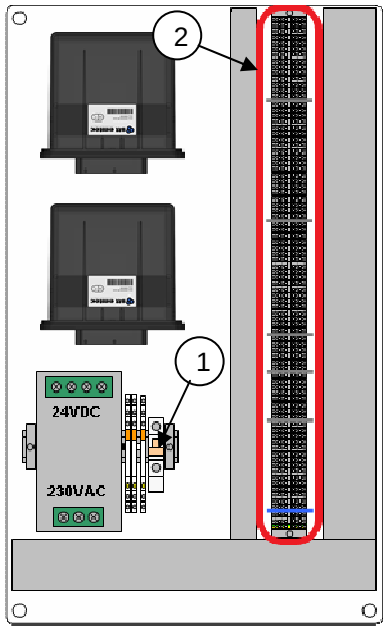
   Engine: OFF
   Cabinet Power (1): OFF

2. Locate terminal screws (2)
   <u>One by one</u> retighten screws and check cables

   a. <u>Retighten screw to **0,5 Nm**</u>

   b. <u>Check cable</u>
   Pull lightly on cable associated with the retightened screw to make sure the cable is secured in the terminal

   c. <u>Repeat for all terminal screws</u>
   until all screws have been retightened
   and all cables have been checked



3. Reactivate system **(follow instructions in section 1.2)**

3.2 DEF lines and connections

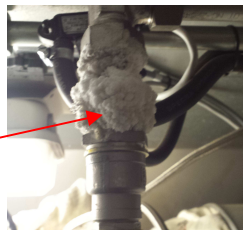
Scope:
Inspection for DEF and Air leakage in connections and lines

Service interval:
Inspect at 1500h or 6 months (Whichever comes first)

When dried, the liquid DEF forms white residue

The volatility of DEF makes it very hard to have 0% leakage over time
Small deposits of crystallization over time is ok!

This crystallization is easily cleaned with water



Procedure – DEF leakage inspection:

1. Deactivate and Power OFF system
   (follow instructions in section 1.1)

   Engine = OFF
   Cabinet power = OFF

2. Visually inspect whole DEF circuit for signs of leakage
   a. DEF tank and connections
   b. DEF suction line and connections (tank to pump)
   c. DEF pump and connections
   d. DEF pressure line (pump to DDU-inlet)
   e. DEF dosing unit (DDU) and connections
   f. DEF return line (DDU-return to tank-return)

3. If DEF leakage is observed
   a. Retighten or replace the connection/pipe/hose
   b. Clean any DEF-residue to later facilitate verification that the leakage has been stopped

Note! DEF is very volatile and will slip thru the slightest gap!

Note! Do not use copper or brass in compression fittings!

Note! Avoid air pockets when routing DEF lines or blockage may occur!

4. Reactivate system
   (follow instructions in section 1.2)
   If leakage has been repaired follow steps 5-7 below

5. Reprime the system to ensure the leakage has been stopped
   a. Start/Restart Engine to initiate SCR system priming sequence
   b. Inspect the previous leak point to ensure the leakage has been stopped
   c. Check that the priming sequence have been successful

      If cabinet display reads “Priming Failed”

      - Make sure there’s DEF in the service tank

      - Check DEF pump function
        i. Go to Actuator Test Menu on Cabinet Display [↓]
        ii. Scroll, find and activate pump test “PMP DEF1 prs” [2 x ➢] + [↓]
        iii. Keep holding “down button” 1min or until display shows a steady pressure readout
        <u>If DEF1 prs is OK > 3500mbar repeat from step a.</u>

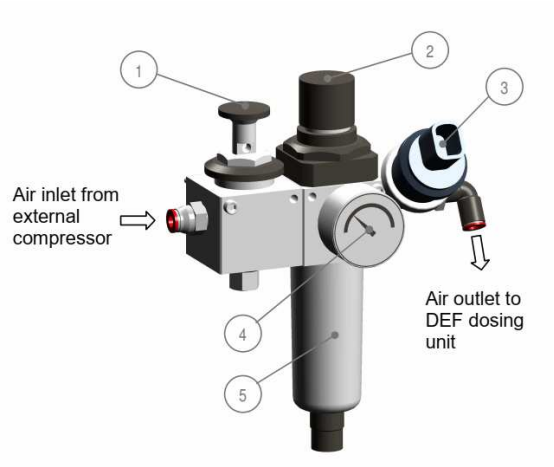
      

      - If DEF1 prs is < 3500mbar, check DEF filters for contamination
        (see section 3.5 & 3.6)

      - Repeat from step a.

6. Repeat from 1. until DEF circuit shows minimal sign of leakage
   After the system has been operational for a day inspect again for sign of leakage

Procedure – Air leakage inspection:



Filter-Regulator Unit

1. Deactivate system
   (follow instructions in section 1.1)

   Engine = OFF
   Air pressure (1) = OFF

2. Empty and clean the condensate trap (5)
   a. Push cup upward and rotate to remove
   b. Clean with water
   c. Refit to FR-unit

   Air pressure (1) = ON

3. Audibly and visually inspect the air feed
   from air compressor to the DDU via the FR-unit

4. If air leakage is observed
   a. Turn OFF pressurized air on FR-unit shut-off valve (1) and air feed to FR-unit
   b. Retighten or replace the connection/pipe/hose
   c. Turn ON pressurized air on FR-unit shut-off valve (1) and air feed to FR-unit
   d. Check that air leakage is stopped

5. Check that air pressure manometer on FR-unit is set to 4.5 bar
   If not adjust to 4,5bar with adjustment knob (2)

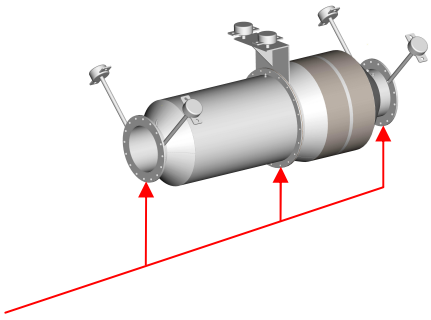
6. Reactivate system
   (follow instructions in section 1.2)

3.3 Flange connections

Scope:
Visual inspection of the Mixer and SCR chamber flanges and tightening of flange bolts.

Service interval:
Inspect at 1500h or 6 months (Whichever comes first)

Tools needed:
- Torque wrench with [24mm] socket
- [24mm] wrench



Procedure:

Engine = OFF

1. Remove heat insulation enough to expose all flanges for the SCR-assembly (Mixer + SCR catalyst chamber)

2. Inspect flanges for exhaust/soot leakage, replace gaskets if necessary

3. Make sure bolts are tight **(197 Nm)** [24mm]

4. Reinstall heat insulation to SCR assembly
   Take care to <u>not</u> cover the tops of the protection boxes
   (Follow instructions in section 2.2)

3.4 Injection nozzle

Scope:
Inspection procedure and replacement.

Service interval:
3000h or 12 months (Whichever comes first)

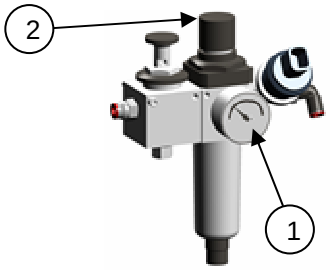
Parts needed per system:

- Injection Nozzle
  For part number please refer to technical file

- Injection Nozzle Service kit
  - 1 gasket
  - 2 washers
  - 2 studs M6
  - 2 copper nuts M6

Tools needed:

- [T30] Torx
- [10mm] Socket
- [2 x 22mm] Wrenches



Procedure:

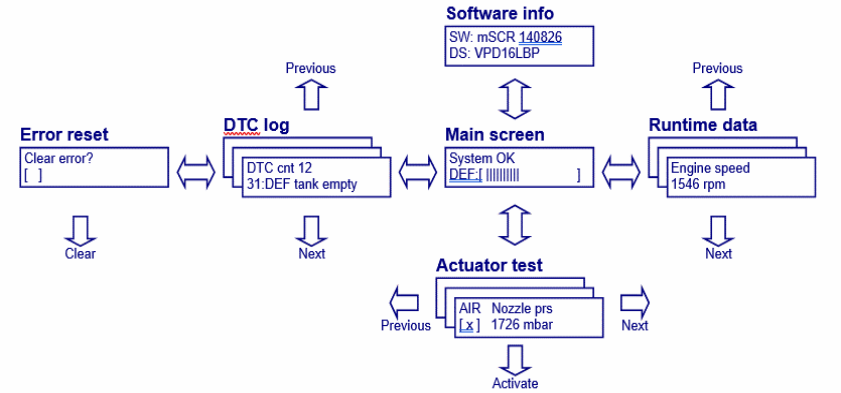
Inspection:

ENGINE = OFF

Follow the steps below to verify the nozzle function

1. Check that air pressure manometer (1) on FR-unit is set to 4.5 bar
   If not, adjust (2) to 4.5 bar

2. Use display on cabinet door and perform Air & Flush actuator tests described in steps 3 & 4 below.



3. Test - Air
   a. Go to menu Actuator test in the diagnose display [↓]
   b. Go to page 'AIR' and activate the control [1 x ➢] + [↓]
   c. Does air flow thru the nozzle tip?
   d. Does the meter "Nozzle prs" show 1400±200 mbar?

4. Test - Flush
   a. Go to menu Actuator test in the diagnose display [↓]
   b. Go to page FLS and activate the control [1 x ➢] + [↓]
   c. Does air flow thru the nozzle tip?
   d. Does the meter "DEF2 prs" show 4000±500 mbar?

5. If meters are outside the specified tolerances in Test - Air and/or Test - Flush Proceed to Replacement

Replacement:

6. Deactivate system **(follow instructions in section 1.1)**

7. Locate the nozzle (1) (braided outside)

8. Remove the nozzle from the DEF Dosing Unit (DDU)

   a. Release the coupling nut (2) [2x22mm]

   b. Unscrew the nozzle nipple (3) from the DDU [22mm]

   c. Retract the nipple straight out of the DDU
      take care not to damage the O-ring of the nipple

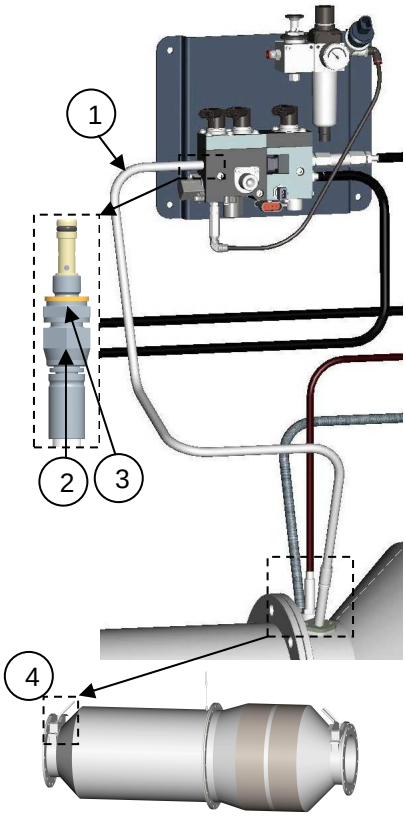
9. Disassemble inlet side protection box (4)
   (follow instructions in section 2.1)

10. Remove the nozzle from the mixer unit

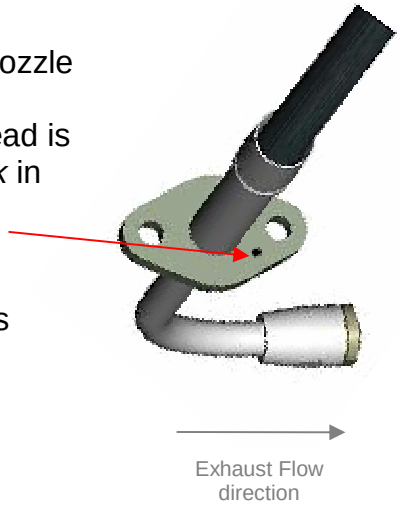
    a. Remove nozzle flange nuts [10mm socket]

    b. Remove nozzle from mixer
       (Needs to be turned and angled to be extracted)

11. Install new nozzle to the mixer unit



The nozzle steel braided hose can be bent to make a proper route from the manifold to the mixer unit, but the ***bending radius must not be less than 125mm.***



a. Install new gasket (from service kit) on the new nozzle

b. Insert nozzle into mixer. Make sure the nozzle head is pointing in the exhaust flow direction, *flange mark* in downstream position

c. If your nozzle counter flange don't have threaded studs or the studs are damaged, install new studs included in the service-kit

d. Reinstall the nozzle to the mixer unit with new nuts and washers (from service kit)

e. Reassemble inlet side protection box **(follow instructions in section 2.2)**

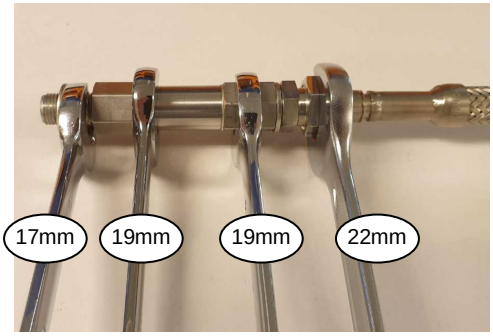
f. Reactivate system **(follow instructions in section 1.2)**

3.5 DDU DEF filter

The DDU DEF filter is an emergency filter to protect the DEF dosing unit (DDU) components in case of contaminated DEF. The DDU DEF filter is not intended for extended filtration of contaminated DEF.
DEF used by the system must be clean

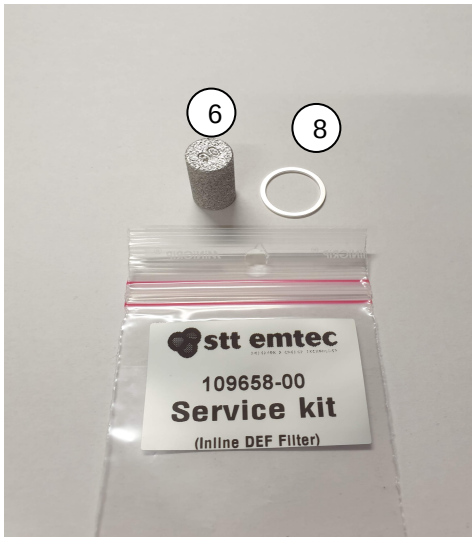
Scope:
Replacement of DDU DEF filter

Service interval:
Replacement 3000h or 12 months (Whichever comes first)
or upon performance problems with the dosing unit;
Typically noticed as reoccurring trouble codes for:
"25: Priming failed"
"31: DEF pressure control"
"24: DEF flow control"
"33: DEF consumption"



Tools needed:
- [22mm] wrench
- [17mm] wrench
- [2 x 19mm] wrenches

Parts needed / system:
- DEF-filter service kit
  - Filter element (6)
  - Sealing ring (8)



Procedure:

1. Deactivate system
   (follow instructions in section 1.1)

2. Remove inlet hose (5a) from filter unit (5)
   [22mm]

3. Remove filter unit (5) and seal washer (5b) from DDU (4)
   [17mm]

4. Open the filter unit (5)
   Make sure to collect the spring (7) inside
   [2x19mm]

5. Remove the used filter element (8) by tapping
   the filter housing half (9) gently against a hard surface

6. Remove old sealing ring (6)

7. Clean remaining components with warm water

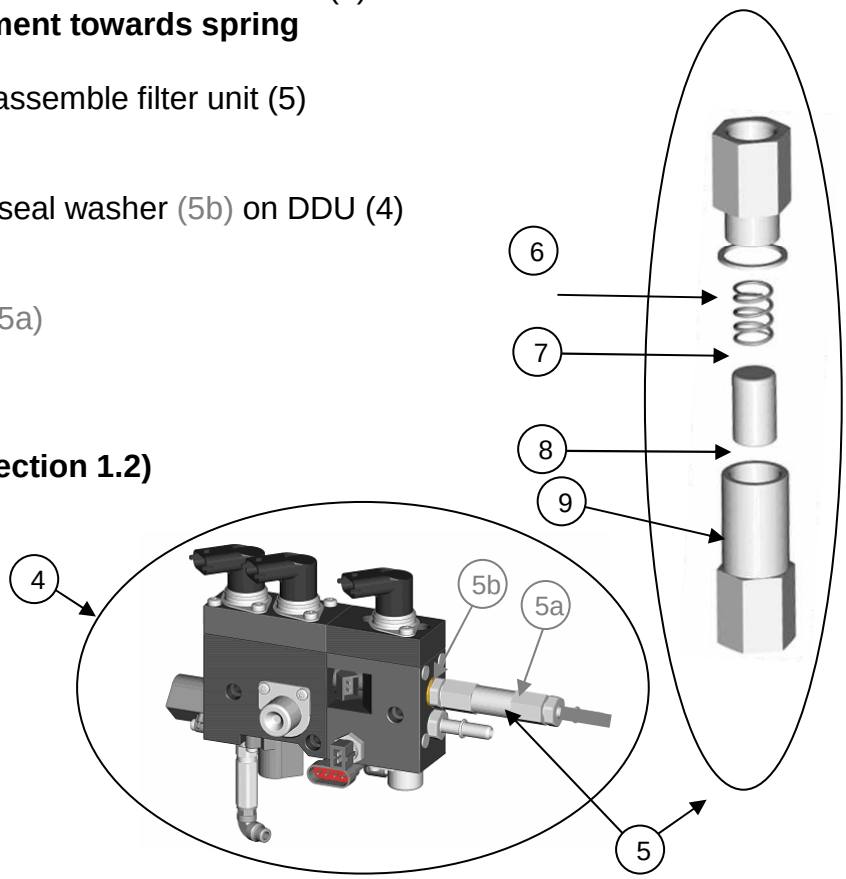
8. Install new sealing ring (6) and new filter element (8)
   Flat surface of filter element towards spring

9. Reinstall spring (7) and reassemble filter unit (5)
   [2x19mm]

10. Reinstall filter unit (5) and seal washer (5b) on DDU (4)
    [17mm]

11. Reconnect the inlet hose (5a)
    [22mm]

12. Reactivate system
    (follow instructions in section 1.2)



3.6 Tank DEF filters

Scope:
Inspection of DEF service tank filters (and bulk tank system filters, if fitted)

Service interval:
Inspect at 6000h or 24 months (Whichever comes first)

Tools needed:
- [22mm] wrench

Procedure:

1. Deactivate system
   (follow instructions in section 1.1)

<u>Inspection – Filling filter</u>

2. Remove filling cap and inspect filling filter

3. <u>If contaminated:</u>

   a. Remove filling filter from service tank
      Pushing in locking clips towards the center of filling filter on both sides simultaneously while pulling the filling filter towards you

   b. Clean filling filter by rinsing it with water

   c. If filling filter cannot be sufficiently cleaned replace it

4. Reinstall cleaned or new filter into tank making sure it locks in place

Inspection – Tank suction pickup

5. Remove hoses from top of the tank armature [22mm] and disconnect electrical connector

6. Rotate suction pickup counterclockwise 45° until it comes loose from tank
   Take care not to damage the plastic top

7. Lift up and angle the armature to remove suction device from the tank.

8. Inspect suction pickup filter

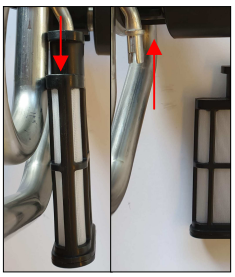
   - If contaminated:
     Clean suction pickup filter by rinsing it with water through the return connection on top of the armature

   - If pickup filter cannot be sufficiently cleaned, replace filter:

     a. Pull or drive the filter of the pipe
        Use punch and hammer if necessary

     b. Push on new filter on the pipe
        Make sure the filter seats against the stop on the pipe

If system is fitted with bulk tank system; move to next page



9. If pickup filter in service tank was contaminated

   a. Remove drain plug in the bottom of service tank
   b. Drain service tank from DEF
   c. Clean out service tank with water
   d. Refit drain plug to bottom of service tank

10. Refit tank pickup into tank

    Take care installing the receiver ring
    in the bottom of the suction pickup on its guide pin
    located in the bottom of the service tank

11. Refill tank with new clean DEF

12. Reactivate system
    (follow instructions in section 1.2)

Inspection – Bulk tank system (if fitted)

9. If pickup filter in service tank was contaminated

   a. Remove drain plug in the bottom of service tank

   b. Drain service tank and bulk system from DEF

   c. Clean out service tank and bulk system with water

   d. Refit drain plug to bottom of service tank

   e. Inspect bulk tank system with regards to components that will be in contact with DEF. Ensure that these components are resistant to DEF. If not, replace components with DEF resistant materials.

Note! All components subjected to DEF must be made of either stainless steel or DEF resistant plastic only

10. Refit tank pickup into tank

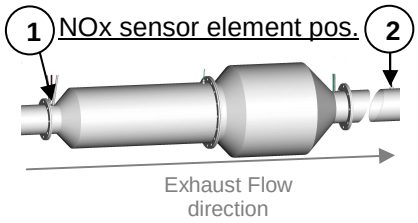
11. Refill bulk tank with clean DEF
    Refill service tank with bulk tank system and check for leaks

12. Reactivate system
    (follow instructions in section 1.2)

3.7 NOx sensors

NOx sensor 1 is an important sensor for the control of the reductant dosing system. To ensure correct performance of the after-treatment system the **NOx sensor 1 shall be replaced every 6 000 hours or in case of sensor malfunction.**

NOx sensor 2 is used for monitoring purpose and it is also **recommended** to change this sensor every 6000 hours.



Service interval:
NOx sensor 1: *Replace at 6000h*
NOx sensor 2**:** *Recommended to replace at 6000h*

Parts needed / system:
- NOx sensor
  For part number please refer to technical file

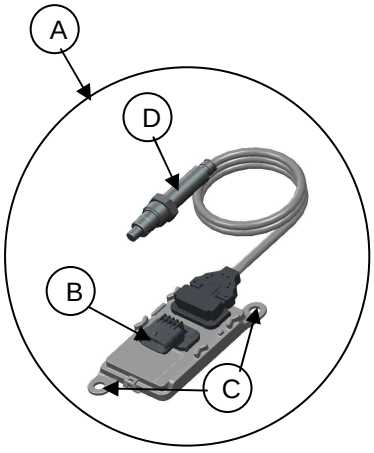
Tools needed:
- [22mm NOx] sensor socket + ratchet wrench

Procedure:
(Same for NOx sensor 1 & 2)

Engine: OFF

1. Deactivate system
   (follow instructions in section 1.1)

Cabinet Power: OFF



2. Locate NOx sensor (A) for replacement

3. Remove wiring connector (B)
   and fasteners (C)

4. Disassemble protection box
   (follow instructions in section 2.1)

5. Remove old NOx sensor element (D)
   [22mm NOx]

6. Unpack a new NOx sensor (A)

7. Install NOx sensor element (D)
   [22mm NOx]

8. Assemble inlet side protection box
   (follow instructions in section 2.2)

   Take care not to cover the cable with insulation

9. Reinstall NOx sensor ECU with fasteners (C)
   and reconnect control cabinet cable connector (B)

10. Reactivate system
    (follow instructions in section 1.2)

3.8 SCR catalyst

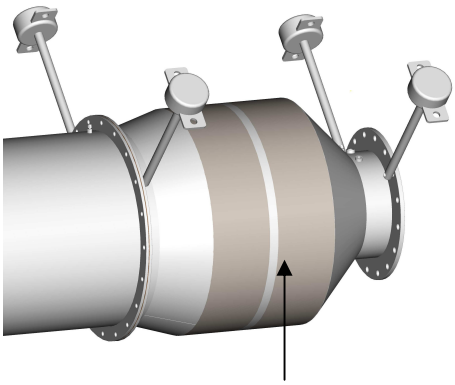
Scope: Control of NOx reduction rate and replacement instructions for SCR catalyst.

The SCR catalyst is designed not to trap soot and is therefore normally maintenance free. Engines with high oil consumption and or high PM (Soot) emissions can cause catalyst fouling over time and therefore might need regular cleaning maintenance.

Service interval: *Inspect at 12 months*

The durability of the SCR catalyst blocks is expected to be more then 16 000 hours with less than 10% deterioration from maximum NOx reduction capability.
This requires that the catalysts have not been exposed to any abnormal conditions outside its specification or been a victim of engine failure that can have caused high oil content, excessive temperatures, or other contaminants in the exhaust gas.

The main factors for premature degradation of the catalyst blocks are:
- Excessive temperature exposure (>550ºC).
- Excessive spill of oil or coolant into the exhaust stream (e.g., turbocharger failure).
- Use of unapproved fuel quality.



Procedure:

<u>Inspection</u>
If necessary, verification of the NOx conversion shall be performed.
NOx reduction rate measurement must be performed by approved service suppliers.

If the SCR catalysts show trends of elevated pressure drop it might need cleaning.

Please contact the system distributor for more information on cleaning and measurement procedures.

Replacement

1. Deactivate system
   (follow instructions in section 1.1)

2. Remove insulation from SCR-catalyst

3. Disassemble outlet protection box
   (follow instructions in section 2.1)

4. Uninstall components below from SCR catalyst and secure them
   - NOx sensor 2 element
   - Temperature sensor (T_SCR2)
   - Exhaust backpressure hose

5. Use equipment suitable for the weight and task of supporting and removing the SCR-catalyst

6. Make sure that the SCR catalyst and Mixer are secured from moving

7. Uninstall flange bolts, nuts, and washers from
   - SCR-catalyst Outlet to Exhaust flange
   - SCR-catalyst to Mixer flange

8. Uninstall support brackets and remove the SCR-catalyst

9. **Inspect the mixer unit (follow instructions in section 3.9)**

10. Use equipment suitable for the weight and task of installation and support to the new SCR catalyst

11. Install the new SCR catalyst to the support brackets
    The SCR-catalyst must be supported in all flanges

12. Install SCR catalyst to Mixer-flange and Exhaust-flange
    - Install new flange gaskets
    - Flange bolts, nuts and washers can be reused if ok.

13. Reinstall the following components to SCR catalyst
    (use graphite grease on all threads)
    - Temperature sensor (T_SCR2)
    - Exhaust backpressure hose

14. Reassemble outlet side protection box
    (follow instructions in section 2.2)

15. Reinstall SCR catalyst insulation.

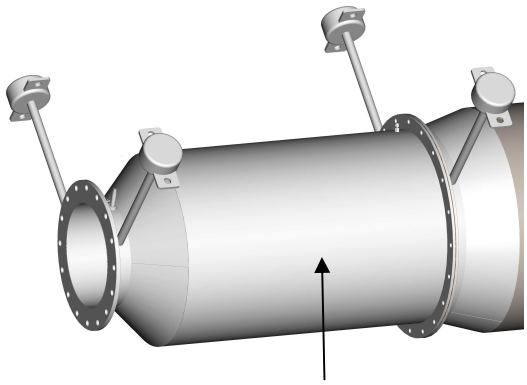
16. Reactivate system
    (follow instructions in section 1.2)

17. Perform SCR catalyst inspection
    See Procedure – Inspection above

3.9 Mixer unit

Scope: Inspection and possible replacement of Mixer unit

Service interval:
Inspect during SCR catalyst replacement



Mixer Unit

Procedure:

Inspection

1. Remove Mixer heat insulation

2. Inspect the mixer overall integrity for wear
   If discrepancies are found, repair or replace mixer with new unit

3. **With SCR-catalyst removed (see section 3.8)**
   Inspect mixer for deposit build up
   If found, clean

4. If mixer is OK
   Reinstall mixer heat insulation
   Resume replacement of SCR catalyst (Section 3.8)

5. If mixer needs replacing
   Follow steps below before resuming replacement of SCR catalyst

   Replacement
6. Disassemble inlet protection box
   (follow instructions in section 2.1)

7. Uninstall components below from Mixer and secure them
   - Injection Nozzle
   - NOx sensor 1 element
   - Temperature sensor (T_SCR1) located at outlet of mixer
   - Exhaust backpressure hose

8. Use equipment suitable for the weight and task of supporting and removing the Mixer

9. Make sure that the Mixer are secured from moving

10. Uninstall flange bolts, nuts, and washers from Exhaust to Mixer inlet flange

11. Uninstall support brackets and remove the Mixer

12. Use equipment suitable for the weight and task of installation and support to the new Mixer

13. Install the new Mixer to the support brackets
    The Mixer must be supported in all flanges

14. Install Exhaust to Mixer inlet flange
    New flange gasket, flange bolts, nuts and washers must be used

15. Reinstall components below to Mixer (use graphite grease on all threads)
    - Injection Nozzle
    - NOx sensor 1 element
    - Temperature sensor (T_SCR1)
    - Exhaust backpressure hose

16. Reassemble outlet side protection box
    (follow instructions in section 2.2)

17. **Resume replacement of SCR catalyst (Section 3.8)**

Appendix 04 Post-installation inspection

After an installation is completed it is important that the system is checked from a complete list of inspection points and adjustments before the system is and handed over to the operator.

The inspection includes:

- Checking that the installation is done according to installation guidelines
- Power supply
- Emergency stop
- Confirming firmware and data set
- Sensor wiring and function
- Compressed air supply
- DEF pressure and DEF leak check
- Engine signals and NOx sensor readings
- Function and performance verification
- Assessment of NOx reduction rate for IMO Tier III engines (procedure described in the technical file).

This protocol must be followed, completed and returned to STT Emtec AB in order to enable the product warranty.

This document is a part of the documentation package handed over to the system operator.

Group	System installation
Sub system / actuator/sensor	

System status during test

Item	**Status**
Compressed air	Off
Main switch electrical central for the control cabinet	Off
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	Not required
Engine	Off

Description

This section of the post installation inspection is to check that the installation guidelines have been followed during the installation of the system and that any deviations from the guideline is noted and clearly explained to the customer/installer of the system for further actions.

Deviations of a significant nature must be remedied before the post installation inspection can be completed.

Tests and result

Step	Check	Result	Signature
1	Check mounting position and orientation of the Mixer/SCR chamber unit and make sure that the support brackets are designed according to the recommendations in the installation guideline. Check that compensators have been used to remove stress from relative moments on the connecting flanges. Refer to section 2 in the installation guidelines for details.		
2	Check that the insulation has been performed according to the guidelines. Special attention is made to electrical sensors and wiring to make sure that no wiring are over insulated or risking being overheated by heat radiation. Refer to section 2 in the installation guidelines for details.		
3	Check that the relative positioning of the DEF dosing components and their orientation (DEF dosing unit and injection nozzle) are according to the installation guidelines. Refer to section 3 in the installation guidelines for details.		

Tests and result (continued)

Step	Check	Result	Signature
4	Check that the DEF suction, pressure and return lines are connected to the correct ports of the service tank, DEF supply pump and the dosing unit. Check that the DEF hoses or pipes provided by the Installer/yard are made of stainless steel and that that the installation guideline is followed with regards to the dimensions and routing. Refer to section 3 in the installation guidelines for details.		
5	If a bulk tank is installed and connected to the service tank, make sure that the bulk tank, pumps and pipes/hoses and made of materials suitable to carry DEF. It is strongly recommended to use a filtration device before the DEF enters the service tank. Refer to section 3 in the installation guidelines for details.		
6	Check the capacity of the compressed air system. A recommendation of compressor capacity per SCR system is given in section 3 in the installation guidelines.		
7	Check that compressed air supply is connected to the FR unit and to the DEF dosing unit and that the regulated air pressure is set according to the guidelines. Refer to section 3 in the installation guidelines for details.		
8	Check that the electrical control cabinet is grounded and have power supply. The control system requires a 24VDC back up power witch must be arranged by the Installer/yard. Check that the separate (slave) display panel is installed at permanently manned location. Refer to section 4 and 5 in the installation guidelines for details.		
9	Check that all sensors and actuators including engine signals, RUN signal and alarm output are electrically connected to the control cabinet. Refer to section 4 in the installation guidelines for details.		
10	Check that the NOx sensors has been mounted correctly and that the NOx sensor number 2 has been mounted at a position and orientation as described in the installation guideline section 4. Check that the wires and the NOx sensor control unit is not over insulated and risk being damaged by heat radiation.		

Tests and result (continued

Step	Check	Result	Signature
11	Check that the additional bosses for a NOx measurement device has been mounted according to the installation guidelines and that they are easy accessible. Refer to section 4 in the installation guidelines for details.		
12	Check that the temperature sensors are installed and that the minimum bending radius has been respected if bent. Check that the steel braded hose part of the temperature sensor and its press sleeve is not over insulated. Check that wires and connectors does not risk being damaged by heat radiation.		
13	Check that the exhaust back pressure sensor and its pressure hoses are mounted in such way that a downward slope, without backlash, towards the connection bosses on the exhaust mixer and the SCR chamber is maintained. Check that the sensor, wires and connectors does not risk being damaged by heat radiation.		

Deviations and comments:

Group	Power supply
Sub system / actuator/sensor	Control cabinet

System status during test

Item	**Status**
Compressed air	Off
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	Not required
Engine	Off

Tests and result
Follow the steps below for a 24VDC installation

Step	Test	Approved interval	Result	Signature
1	Make sure that the 24VDC main supply, (terminal connector A1) is properly grounded.	0 Ω between the cabinet and vessel.		
2	Measure voltage on terminal group A (24VDC) in the control cabinet. Measure between terminal connectors A2 and A3	23-29 VDC		
3	Measure voltage on terminal group C in the control cabinet. Measure between any terminal in group C and any terminal in group B.	23-29 VDC		
4	Measure voltage on terminal group E in the control cabinet. Measure between any terminal in group E and any terminal in group B.	4,5-5,5 VDC		

For installations using J1939 (CAN) communication with the engine

5	Measure voltage between terminal group B and the 0V reference in the engine control cabinet	-100mV - +100mV		

Follow the steps below for a 230VAC installation

Step	Test	Approved interval	Result	Signature
1	Make sure that the 230VAC main supply, (terminal connector A1) is properly grounded.	0 Ω between the cabinet and vessel.		
2	Measure voltage on terminal group A (230VAC) in the control cabinet. Measure between terminal connectors A2 and A3	210-250 VAC		
3	Measure voltage on terminal group C in the control cabinet. Measure between any terminal in group C and any terminal in group B.	23-29 VDC		
4	Measure voltage on terminal group E in the control cabinet. Measure between any terminal in group E and any terminal in group B.	4,5-5,5 VDC		

For installations using J1939 (CAN) communication with the engine

5	Measure voltage between terminal group B and the 0V reference in the engine control cabinet	-100mV - +100mV		

Group	Emergency stop
Sub system / actuator/sensor	Control cabinet

System status during test

Item	**Status**
Compressed air	Off
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	Not required
Engine	Off

Tests and result

Step	Test	Approved interval	Result	Signature
1	Make sure that the DDS is not stopped. LCD shall not read System STOPPED. If nessecery press the START switch	LCD does not read System STOPPED		
2	Press the Emergency Stop switch on the control cabinet and verify that the LCD reads System STOPPED	LCD reads System STOPPED		
3	Restore the system according to step 1. Disconnect sensor T_SCR1 and verify that the LCD reads System STOPPED. *Note: This may take a couple of minutes*	LCD reads System STOPPED		
4	Restore the system according to step 1. Disconnect sensor T_SCR2 and verify that the LCD reads System STOPPED. *Note: This may take a couple of minutes*	LCD reads System STOPPED		
5	Restore the system according to step 1. Disconnect sensor EBP and verify that the LCD reads System STOPPED. *Note: This may take a couple of minutes*	LCD reads System STOPPED		
6	Restore the system according to step 1.	LCD does not read System STOPPED		

Group	Control system
Sub system / actuator/sensor	System wiring

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	Off

Tests and result

Step	Test	Approved interval	Result	Signature
1	Connect the service tool to the control cabinet. Establish online connection and check that the correct Firmware and correct Dataset are used. The information is available under the TAB Sys. Info.	File names according to BOM		
2	Clear all errors by using EmtecDiag			
3	Check if any active errors occur. If any active error occurs, consult the trouble shooting guide for corrective actions. **Note.** Modbus RS-422 is used for obtaining engine signals, errors for engine signals can occur if engine control system is deactivated.	No active errors		

Group	Sensors
Sub system / actuator/sensor	Type K thermocouples

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	Off

Description

The temperature sensors are used for control of the DEF metering into the exhaust stream and for the emergency stop system.

The temperature sensors are located at the outlet of the exhaust mixer and the outlet of the SCR chamber and are marked with “T_SCR1” and “T_SCR2” respectively.T_SCR1 is located upstream and T_SCR2 is located downstream the SCR chamber.

Tests and result

Step	Test	Approved interval	Result	Signature
1	Check temperature readings for “T_ SCR1” and “T_ SCR2” meters. Check if the value is reasonable according to current conditions.	± 5°C to ambient temperature		
2	Unplug the connector at T_SCR1 and check that EmtecDiag identifies the correct sensor by changing temperature meter colour from green to red. And that the corresponding fault code becomes active (standard default is 0°C). Reconnect the sensors and check that the fault code becomes inactive and that the reading resume the original value Repeat the procedure with T_SCR2.	Sensors is at correct position		

Group	Sensors
Sub system / actuator/sensor	Exhaust pressure sensor

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	Off

Description

The exhaust pressure sensor is used to detect flow restrictions in the SCR chamber and/or mixer unit.

The exhaust pressure sensor is typically located on the bracket for the DDU and is marked with “EBP” (Exhaust Back Pressure. The sensor may be located elsewhere in order to maintain a slope on the connecting hoses from the sensor to the exhaust pipe connections.

Tests and result

Step	Test	Approved interval	Result	Sign.
1	Check that the value on the meter “Exhaust prs.” corresponds to 0 mbar.	0±2 mbar		
2	Disconnect the hose on the hose nipple marked H and apply a known pressure on the sensor. **Note: max pressure 350 mbar.**	± 2 mbar max difference to the applied pressure.		

Group	Compressed Air
Sub system / actuator/sensor	Connections and lines

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	Off

Description

Compressed air is used by the DDU to atomize the DEF into a fine mist during DEF metering and also to clean the injection components when metering is no longer required. An incorrect air setting will disable the DDS and may damage the injection nozzle.

The compressed air is connected to the DDU via an FR-unit (Filter/Regulator unit with a shut-off valve). See the installation guideline for more information about the FR-unit.

Tests and result

Step	Test	Approved interval	Result	Sign.
1	Visual inspection of all air connections and lines at the FR unit.	No air leaks		
2	Verify that the air pressure at the manometer at the FR-unit is 4,5bar and the shut-off-valve on the FR unit is open.	4,5bar ±0,2bar		
3	Close the shut-off-valve at the FR-unit and verify that the meter Air pressure goes from On to Off.	Air pressure meter according to shut-off-valve		

Group	Sensors
Sub system / actuator/sensor	DEF pressure in the DDU

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	Off

Description

The DEF2 pressure sensor is used for metering DEF injection and for monitoring the state of the injection nozzle (blockage detection). The DEF2 pressure sensor is located in the DDU. (Blue tie-wrap)

Tests and result

Step	Test	Approved interval	Result	Sign.
1	Check that the value on the meter “DEF2 pressure” corresponds to 0mbar when the engine is off.	0 mbar ± 200mbar max.		
2	Check that the value on the meter “DEF2 pressure” corresponds to 1400mbar when the engine is off and the Control "Air" is activated.	1400 mbar ± 200mbar max.		
3	Check that the value on the meter “DEF2 pressure” corresponds to 4000mbar when the engine is off and Control "Flush" is activated.	4000 mbar ± 500mbar max.		

Group	Sensors
Sub system / actuator/sensor	Nozzle pressure in the DDU

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for DDS control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	Off

Description

The nozzle pressure sensor is used to monitor the state of the injection nozzle (blockage detection) and as a secondary source to detect compressed air supply. The nozzle pressure sensor is located in the DDU. (Green tie-wrap)

Tests and result

Step	Test	Approved interval	Result	Sign.
1	Check that the value on the meter “Nozzle pressure” corresponds to 0mbar when the engine is off.	0 mbar ± 200mbar max.		
2	Check that the value on the meter “Nozzle pressure” corresponds to 1400mbar when the engine is off and parameter "Air" is activated.	1400 mbar ± 200mbar max.		
3	Check that the value on the meter “Nozzle pressure” corresponds to 1800mbar when the engine is off and parameter "Flush" is activated.	1800 mbar ± 200mbar max.		

Group	DEF supply pump and DEF lines
Sub system / actuator/sensor	DEF supply pump pressure in the DDU and DEF connections and lines

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag.
Engine	On

Description

When the engine is started the first time after installation the DEF supply pump will start a priming sequence to make sure that air is bled out from the DDU and the line from the DEF service tank.
The priming sequence has duration of 30 seconds followed by switching on the air pressure to the nozzle. If the pump is not properly primed the sequence will continue until the correct DEF pressure is achieved. The priming sequence can be followed on the meter “actual pump state”. When the pump is priming the message “Priming” is displayed and when ready the message “Ready” is displayed.

The actual DEF metering into the exhaust stream will not start until the engine and the system has reached the start conditions.
At first the NOx concentration sensor has to be pre-heated. The pre-heating (heating element inside the sensor) will not start until the exhaust temperature has reached 130°C (meters “T_SCR1” and “T_SCR2”)
The NOx sensors status can be followed on the meters “Engine NOx” (NOx sensor 1) and “Tail NOx” (NOx sensor 2). The meter will display “pre-heating” followed by “read delay” and then the actual NOx concentration.

Make sure that the DEF service tank is filled with AdBlue before starting the engine. Wait for the system to be completely ready before performing the inspections below.

The exhaust temperature must reach at least 230°C before the DDS starts DEF metering (dosing DEF/air mixture into the exhaust stream). The actual dosing rate can be seen on the meter “DEF massflow”. In order to inspect the DEF/Air line from the DDU to the nozzle (point 4 in the table below) the engine must have been operating in such conditions so DEF metering has occurred (an exhaust temperature above 230°C and at various loads)

The DEF1 pressure sensor is used to monitor the operation of the DEF supply pump and the DEF pressure regulator. The DEF1 pressure sensor is located in the DDU. (Yellow tie-wrap)

Step	Test	Approved interval	Result	Sign.
1	Make sure that the DEF service tank is filled with DEF before starting the engine.	Min 25% of full tank		
2	After the supply pump priming sequence is completed use the Control "Pump" to activate the DEF supply pump. Check that the value on the meter “DEF1 pressure” corresponds to 4000mbar.	4000 mbar ± 200mbar max.		

Run the engine at such conditions that DEF dosing is enabled according to the description above and continue with the steps below

3	Visual inspection of all DEF connections and lines at the DEF service tank.	No leakage		
4	Visual inspection of all DEF connections and lines at the DEF supply pump.	No leakage		
5	Visual inspection of DEF connection and line at the injection nozzle.	No leakage		
6	Check if any active error codes occur after at least 30 minutes of engine running. If any, consult the error code list for corrective actions.	No errors		

Group	Sensors
Sub system / actuator/sensor	Sensors

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for the control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	On

Description

The engine signals are used for computing the exhaust mass flow and thereby metering the DEF injection and are hence a crucial part of the DEF dosing algorithm.

Run the engine on idle and check all engine related signals. The signals are checked by comparing the readings on the relevant meters to the corresponding standard engine instrumentation.

The engine signals are supplied to the control system via the engine CAN (J1939) databus, modbus RS-422 system or discrete sensors depending on system configuration,

Note that some engines do not broadcast signals on databus if the engine is not running. If so, the DDS may display active error codes for these signals when the engine is stopped. The errors will clear as son as the engines is started.

Tests and result

Step	Test	Approved interval	Result	Sign.
1	Engine load	within ± 5% of standard instrumentation		
2	Engine speed	within ± 5% of standard instrumentation		
3	Boost pressure	within ± 5% of standard instrumentation		
4	Boost air temperature	within ± 5% of standard instrumentation		

Group	Sensors
Sub system / actuator/sensor	NOx sensors

System status during test

Item	**Status**
Compressed air	On
Main switch electrical central for DDS control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	On

Description

The NOx sensor 1 is used for the DEF dosing algorithm and the NOx sensor 2 is used for diagnostics
The NOx sensor elements are located up stream and downstream of the SCR chamber. A sensor electronic control unit is located around 600 mm from the sensor.

Tests and result

Step	Test	Approved interval	Result	Sign.
1	The meter “Engine NOx” should show actual NOx concentration before the SCR chamber when all exhaust temperatures (T_SCR1, and T_SCR2) have been above 130ºC for more than 3 minutes.	Stable and relevant values.		
1	The meter “Tail NOx” should show actual NOx concentration after the SCR chamber when all exhaust temperatures (T_SCR1, and T_SCR2) have been above 130ºC for more than 3 minutes.	Stable and relevant values.		

After finalization of the post installation inspection checks, clear the error code list and disconnect the service tool.

Make sure that all connectors and hoses are reinstalled properly and leave the disable switch inside the control cabinet on (enabled) and the compressed air valve open.

Performance verification of the complete exhaust aftertreatment system

System status during test

Item	Status
Compressed air	On
Main switch electrical central for DDS control cabinet	On
Emergency stop switch on the control cabinet	Off (System enabled)
Service tool connected to the control cabinet	EmtecDiag
Engine	On

Description

After completion of the post installation inspection a performance verification test of the complete exhaust aftertreatment system is performed.

Make sure that the DEF service tank is filled.

The exhaust system and exhaust mixer/SCR chamber must be insulated according to the relevant surface temperature demands and the recommendations in the installation guidelines before performing this test.

Use the service tool EmtecDiag to take readings.

The engine should be run at or as close as possible to the relevant emission test cycle E2 (constant speed) or E3 (Propeller law).
Start the test run at mode 1, rated speed and 100% load. Allow sufficient time for the engine and exhaust temperatures to stabilize before any readings is taken.

Run all 4 modes and fill out the performance verification table below.

The exhaust temperature T_SCR1 must reach a minimum of 240ºC at mode point 4 and a minimum of 300ºC at mode point 1-3. The exhaust temperature should not exceed 550ºC at any mode point.

If the complete Engine and SCR system is an IMO Tier III unit an assessment of the NOx reduction performance shall be performed using the methods described in the technical file. The performance verification described in this document can be done simultaneously. The difference is that the stabilization times described in the technical file should be used and that the NOx concentrations should also be measured with analyzer equipment as described in the technical file.

Performance verification table

Date:
Ship:
Engine:

Quantity	Unit	Mode 1	Mode 2	Mode 3	Mode 4
Engine speed	Rpm				
Engine load	%				
Boost pressure	mbarG				
Boost air temp.	ºC				
T_SCR1	ºC				
T_SCR 2	ºC				
Exhaust pressure	mbarG				
Nozzle pressure	mbarG				
Engine NOx (NOx sensor 1)	ppm				
Tail NOx (NOx sensor 2)	ppm				
DEF mass flow	g/h				
NOx reduction	%				

Comments:

Post installation inspection and performance verification performed by:

Name/company/date/place

Appendix 05 System process chart

Reductant Injection system, process overview and functional description

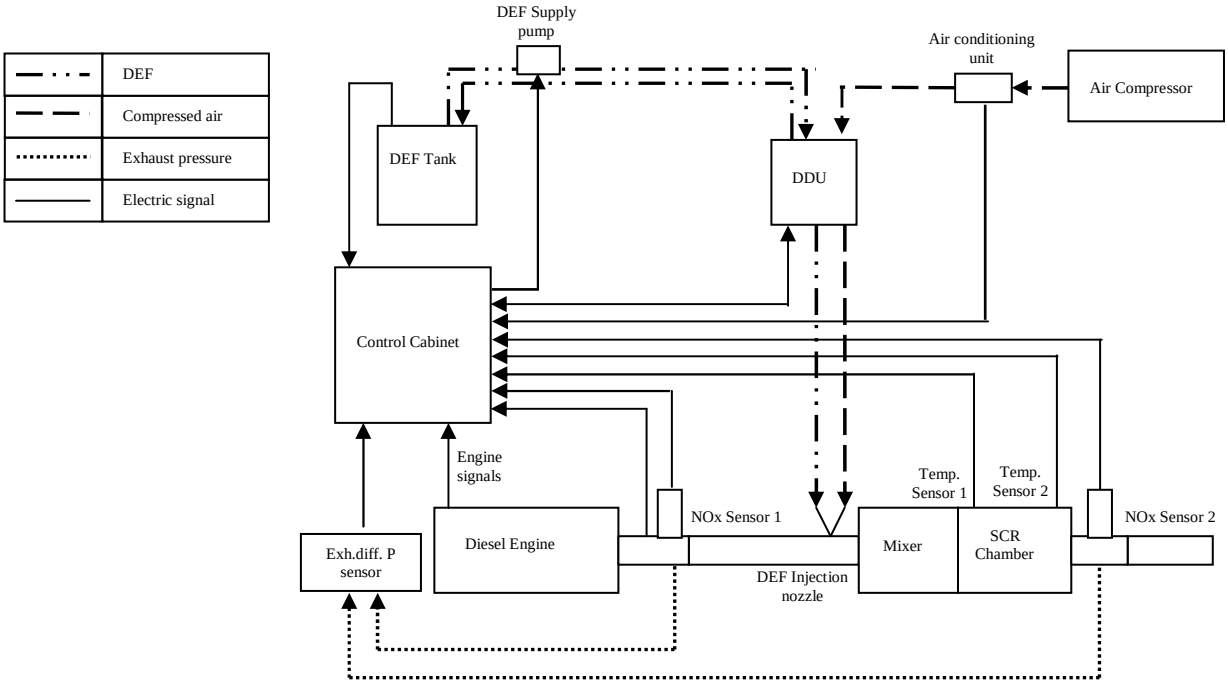


Figure 1. Process overview

The main components of the SCR system and its function are listed in the table below.

Component	Purpose
DEF tank	Reductant (DEF) storage for daily supply. The DEF tank Includes level sensor.
DEF supply pump	The DEF supply pump supplies the DDU with pressurized DEF.
DDU	DEF Dosing Unit (DDU) contains the DEF metering valve and the air solenoid valves controlling the compressed air for spray atomization and for flush and evacuation purpose. The DDU also contains DEF pressure sensors before and after the metering valve together with DEF temperature sensor and nozzle air pressure sensor. The DDU is supplied with pressurized DEF by the DEF supply pump and the DEF pressure is controlled by a pressure regulator built into the DDU. The return DEF flow is routed back to the DEF service tank.
Injection Nozzle	Transports the atomizing air and the metered DEF flow to the nozzle head where air and DEF is mixed and provide a highly atomized spray into the exhaust stream at the inlet of the exhaust mixer.

Component	Purpose
Mixer	The exhaust mixer has an internal labyrinth design to provide sufficient DEF mixing with exhaust gas and residence time to decompose DEF to ammonia.
SCR chamber	The SCR chamber holds the SCR catalyst blocks.
NOx sensor 1-2	The NOx sensor number 1 is used for calculation of the necessary DEF injection rate to reach the demand NOx reduction rate. The NOx sensor number 2 is used for system diagnostics and does not affect the DEF dosing rate.
Temp. 1-2	The temperature sensor number 1 is used for controlling the start and stop of DEF injection. The temperature sensor number 2 is used for compensating the required DEF flow during transient conditions. This is also a measure to minimize the risk of reductant slip.
Exh. ΔP sensor	The Exhaust pressure differential pressure sensor is used to monitor the pressure drop over the mixer and SCR chamber assembly. A high alarm is provided to alert the operator of possible deposit build up in the system.
Control cabinet	The control cabinet holds the control and monitoring system as well as a redundant emergency shut down circuit. On the cabinet door is a display that communicates the system status.
Air conditioning unit	Controls the air pressure to the DDU. The air conditioning unit contains an air pressure switch for monitoring purpose.
Air compressor	Supplies the compressed air to the system. Compressed air is used mainly for DEF spray atomisation but also for evacuation and flush of DEF in the system during periods of no DEF dosing or at engine shut down. Flush and evacuation is used to protect the system from crystallisation of DEF when no dosing occurs and to avoid risk of frost damage when sub zero temperatures is possible.

Functional description

DEF is supplied to the DEF dosing unit (DDU) from the DEF tank. The DEF supply pump is mounted on or close to the DEF service tank. The operation of the supply pump is controlled by the control system in the control cabinet. The supply pump can supply the DDU with pressurized DEF as well as change direction in order to evacuate the system from DEF during specific conditions.

The DEF pressure in the supply line to the DDU is controlled by a mechanical pressure regulator within the DDU. The pressure is controlled by the DEF return flow. Return flow is routed back to the DEF service tank.

The main purpose for the DDU is to meter the exact amount of DEF injection rate for each engine operational condition. The metering is done by an electric metering valve controlled both by PWM (pulse width modulation) and frequency. The control signal for the metering valve is provided by the control system mounted in the control cabinet.

The metered amount of DEF is routed through the inner tubing in the coaxial design of the injection nozzle tube to the nozzle head. Atomizing air is provided by an external air compressor and its routing is controlled by the DDU. Atomizing air is led trough the outer tubing of the injection nozzle tube and is mixed with DEF at the outlet of the nozzle head.

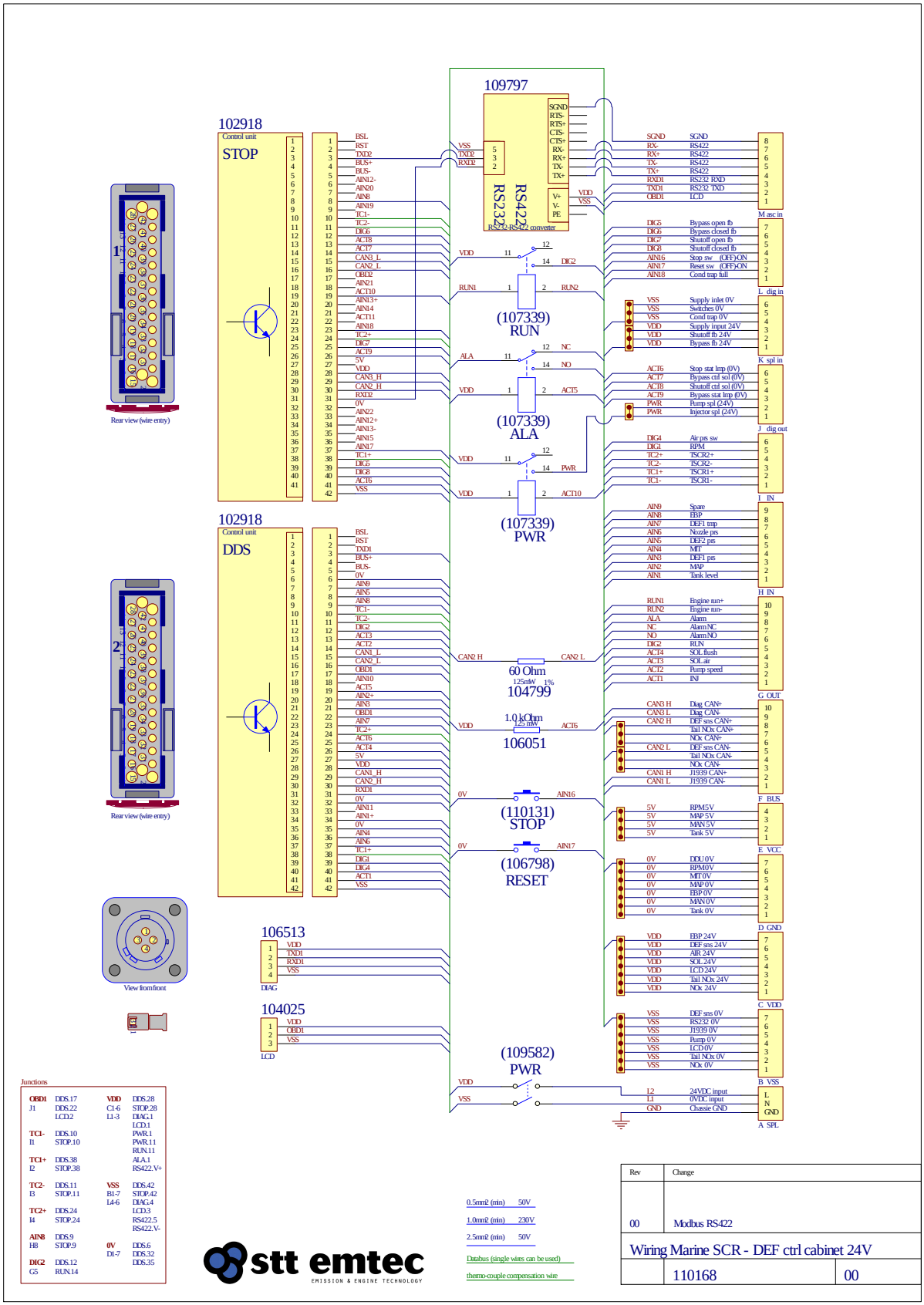
The control system and its control algorithm is a high accuracy model based system. The input for required DEF dosing rate is based on the actual NOx mass flow. The engine out NOx concentration is given from the signal from NOx sensor number 1. To determine the actual exhaust flow the engine parameters, inlet manifold absolute pressure (MAP), manifold inlet temperature (MIT), engine speed and the cylinder volume is used to calculate the exhaust flow. From the resulting NOx mass flow calculation the required DEF dosing rate is set for each operational condition based on SCR catalyst space velocity and exhaust temperature to give the requested NOx reduction rate.

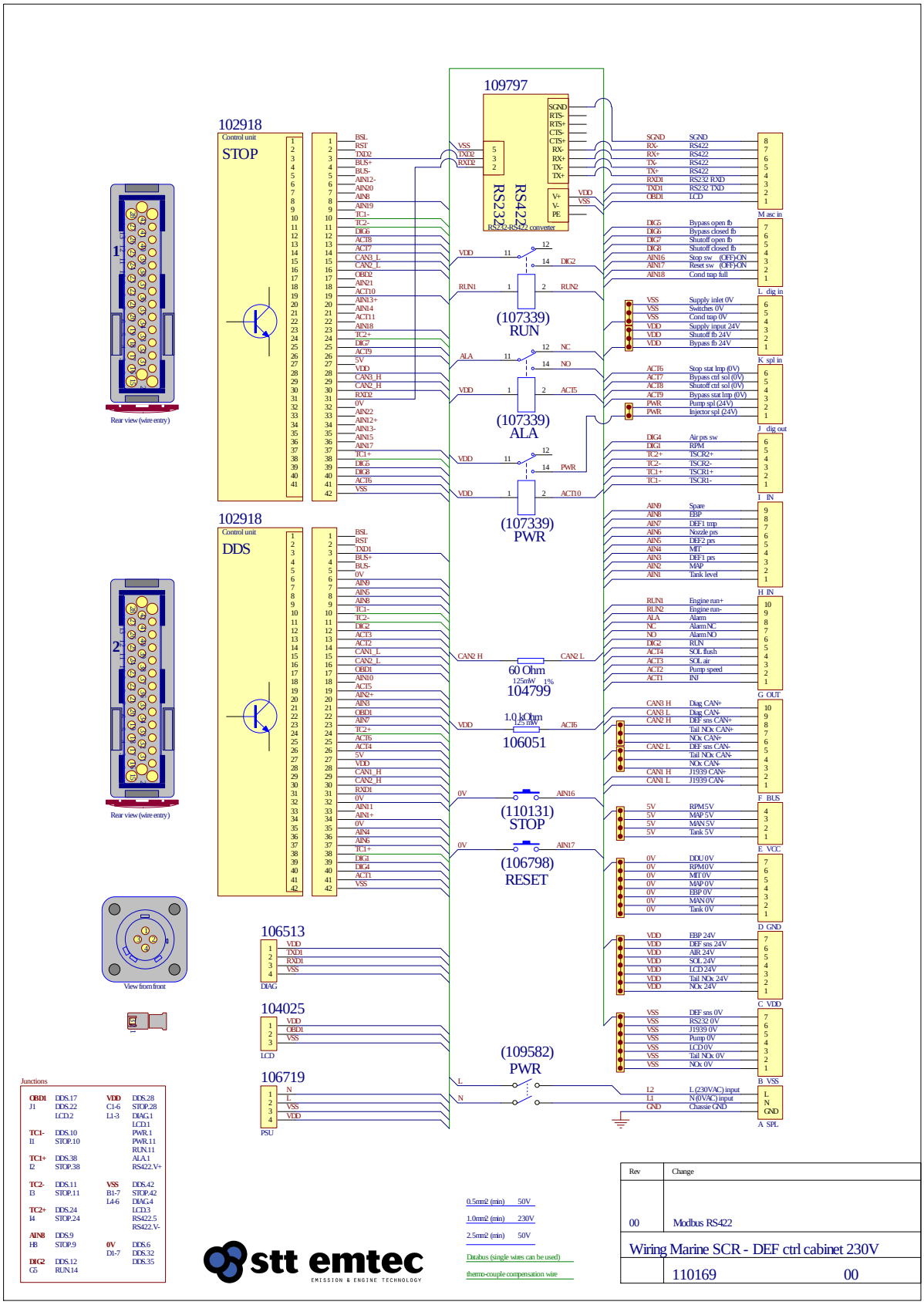
The requested DEF dosing rate is converted into a PWM and frequency signal to the metering valve in the DDU. Being a model based system the system compensates for changes in DEF pressure and metering valve back pressure coming from exhaust back pressure and atomizing air flow and pressure. This arrangement ensures high accuracy dosing over the complete dosing rage and is also a part of the efforts to minimise risks for reductant slip.

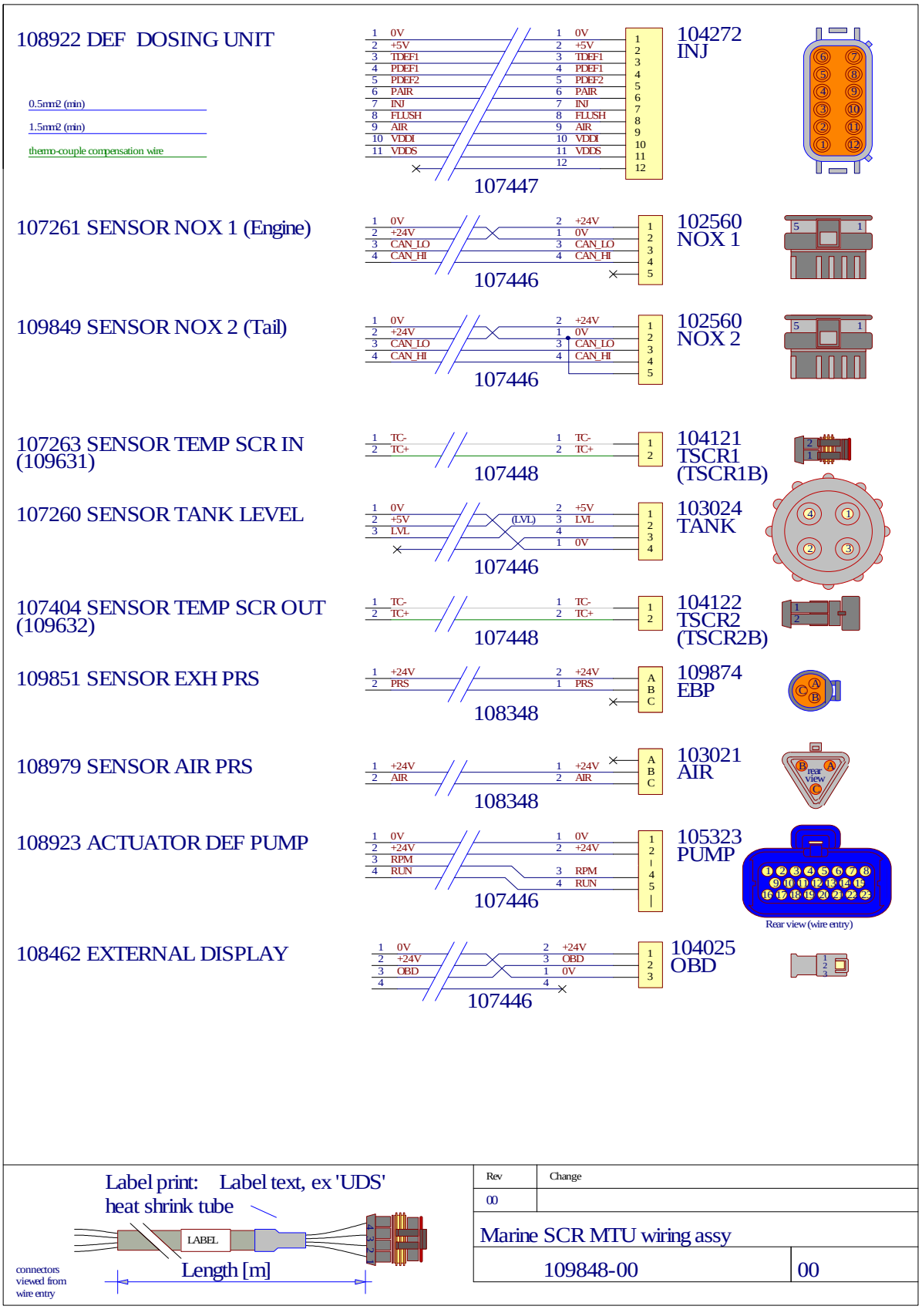
When the exhaust conditions is outside the limits for dosing DEF. i.e. to low or to high exhaust temperature the remaining DEF in the injection nozzle is evacuated trough reverse DEF flow followed by an air flush to avoid DEF to form solid urea crystallisations in the nozzle due to vaporization of water in the nozzle. During the flush sequence the compressed air is routed trough the flush valve in the DDU to the inner tubing of the injection nozzle tube.

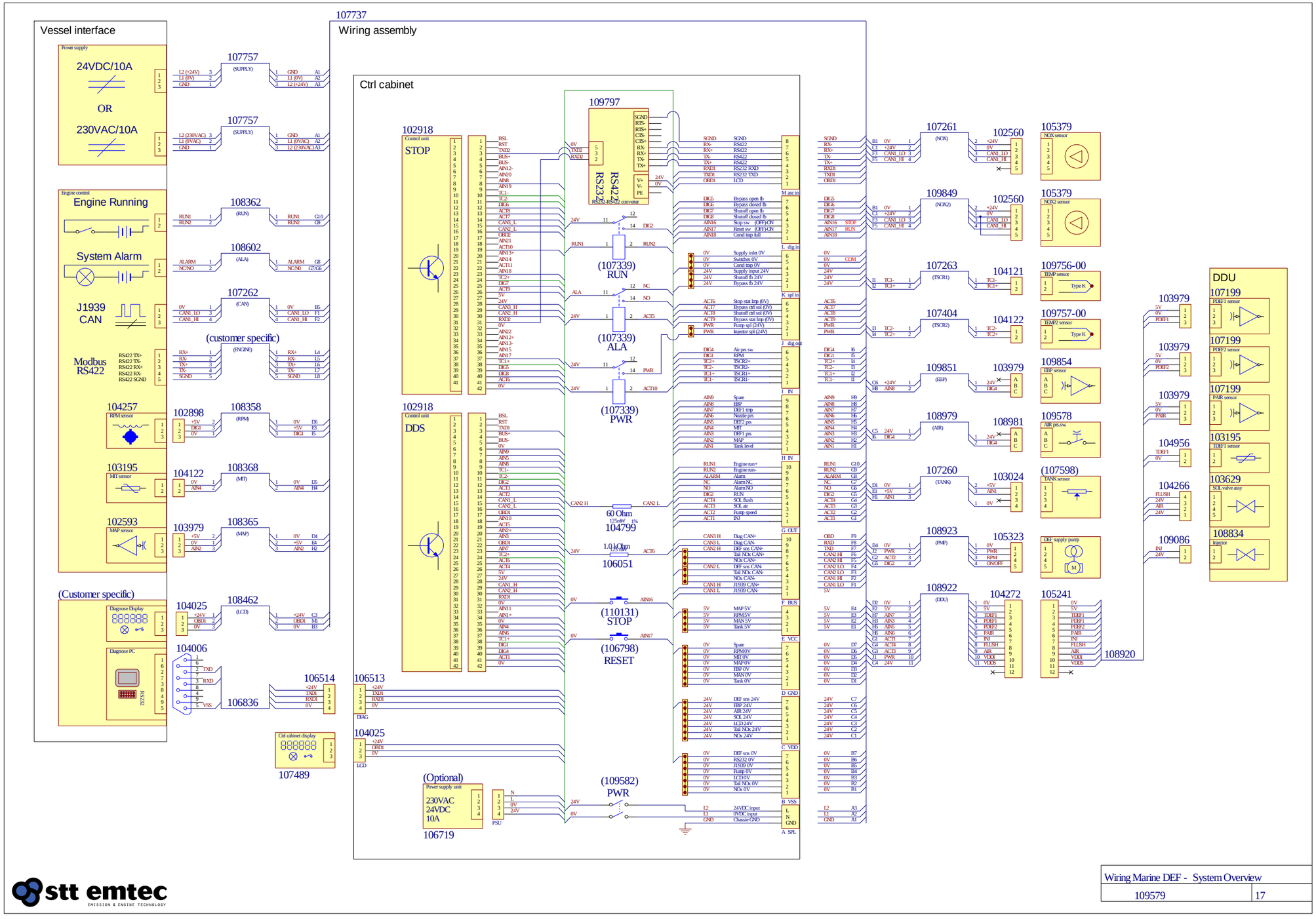
During longer durations of no DEF dosing, i.e engine shut down, the complete system is evacuated from DEF. This is done by reversing the DEF supply pump in combination with operating both the air and flush valves in the DDU. A complete evacuation also secures the system from freezing damage

Appendix 06 Electrical reference drawings


109797
102918
Control unit
STOP
102918
Control unit
DDS
(107339)
RUN
(107339)
ALA
(107339)
PWR
60 Ohm
125mW 1%
104799
1.0 kOhm
125 mW
106051
(110131)
STOP
(106798)
RESET
(109582)
PWR
106513
DIAG
104025
LCD
Rear view (wire entry)
Rear view (wire entry)
View from front
Junctions
0.5mm2 (min) 50V
1.0mm2 (min) 230V
2.5mm2 (min) 50V
Databus (single wires can be used)
thermo-couple compensation wire
Rev
Change
00
Modbus RS422
Wiring Marine SCR - DEF ctrl cabinet 24V
110168
00


109797
RS232 RS422
RS232-RS422 converter
102918
Control unit
STOP
102918
Control unit
DDS
(107339)
RUN
(107339)
ALA
(107339)
PWR
60 Ohm
125mW 1%
104799
1.0 kOhm
1/8 mW
106051
(110131)
STOP
(106798)
RESET
(109582)
PWR
106513
DIAG
104025
LCD
106719
PSU
Rear view (wire entry)
Rear view (wire entry)
View from front
Junctions
OBD1 DDS.17 J1 DDS.22 LCD.2
TC1- DDS.10 I1 STOP.10
TC1+ DDS.38 I2 STOP.38
TC2- DDS.11 I3 STOP.11
TC2+ DDS.24 I4 STOP.24
AIN8 DDS.9 H8 STOP.9
DIG2 DDS.12 G5 RUN.14
VDD C1-6 L1-3 DDS.28 STOP.28 DIAG.1 LCD.1 PWR.1 PWR.11 RUN.11 ALA.1 RS422.V+
VSS B1-7 L4-6 DDS.42 STOP.42 DIAG.4 LCD.3 RS422.5 RS422.V-
0V D1-7 DDS.6 DDS.32 DDS.35
0.5mm2 (min) 50V
1.0mm2 (min) 230V
2.5mm2 (min) 50V
Databus (single wires can be used)
thermo-couple compensation wire
Rev Change
00 Modbus RS422
Wiring Marine SCR - DEF ctrl cabinet 230V
110169 00


108922 DEF DOSING UNIT
0.5mm2 (min)
1.5mm2 (min)
thermo-couple compensation wire
1 0V
2 +5V
3 TDEF1
4 PDEF1
5 PDEF2
6 PAIR
7 INJ
8 FLUSH
9 AIR
10 VDDI
11 VDDS
12
107447
104272
INJ
107261 SENSOR NOX 1 (Engine)
1 0V
2 +24V
3 CAN_LO
4 CAN_HI
107446
102560
NOX 1
109849 SENSOR NOX 2 (Tail)
102560
NOX 2
107263 SENSOR TEMP SCR IN (109631)
1 TC-
2 TC+
107448
104121
TSCR1
(TSCR1B)
107260 SENSOR TANK LEVEL
1 0V
2 +5V
3 LVL
(LVL)
4
107446
103024
TANK
107404 SENSOR TEMP SCR OUT (109632)
104122
TSCR2
(TSCR2B)
109851 SENSOR EXH PRS
1 +24V
2 PRS
A
B
C
108348
109874
EBP
108979 SENSOR AIR PRS
1 +24V
2 AIR
103021
AIR
rear view
108923 ACTUATOR DEF PUMP
1 0V
2 +24V
3 RPM
4 RUN
105323
PUMP
Rear view (wire entry)
108462 EXTERNAL DISPLAY
1 0V
2 +24V
3 OBD
4
104025
OBD
Label print: Label text, ex 'UDS'
heat shrink tube
LABEL
Length [m]
connectors viewed from wire entry
Rev
Change
00
Marine SCR MTU wiring assy
109848-00
00


107737
Wiring assembly
Vessel interface
Power supply
24VDC/10A
OR
230VAC/10A
Engine control
Engine Running
System Alarm
J1939
CAN
Modbus
RS422
RS422 TX+
RS422 TX-
RS422 RX+
RS422 RX-
RS422 SGND
104257
RPM sensor
103195
MT1 sensor
102593
MAP sensor
(Customer specific)
Diagnose Display
Diagnose PC
RS232
107757
(SUPPLY)
108362
(RUN)
108602
(ALA)
107262
(CAN)
(customer specific)
(ENGINE)
102898
108358
(RPM)
104122
108368
(MT)
103979
108365
(MAP)
104025
108462
(LCD)
104006
106836
106514
Ctrl cabinet display
107489
Ctrl cabinet
102918
Control unit
STOP
102918
Control unit
DDS
109797
RS422
RS232
RS232-RS422 convertor
(107339)
RUN
(107339)
ALA
(107339)
PWR
104799
60 Ohm
106051
(110131)
STOP
(106798)
RESET
(109582)
PWR
106513
DDG
104025
LCD
(Optional)
Power supply unit
230VAC
24VDC
10A
106719
PSU
M aux in
L dig in
K spl in
J dig out
I IN
H IN
G OUT
F BUS
E VCC
D GND
C VDD
B VSS
A SPL
107261
(NOX)
109849
(NOX2)
107263
(TSCR1)
107404
(TSCR2)
109851
(EBP)
108979
(AIR)
107260
(TANK)
108923
(PMP)
108922
(DDU)
102560
104121
104122
103979
108981
103024
105323
104272
105379
NOX sensor
105379
NOX2 sensor
109756-00
TEMP sensor
109757-00
TEMP2 sensor
109854
EBP sensor
109578
AIR pressure
(107598)
TANK sensor
DEF supply pump
105241
108920
DDU
107199
PDEF1 sensor
107199
PDEF2 sensor
107199
PAIR sensor
103195
TDEF1 sensor
103629
SOL valve assy
108834
Injector
103979
104956
104266
109086
Wiring Marine DEF - System Overview
109579
17

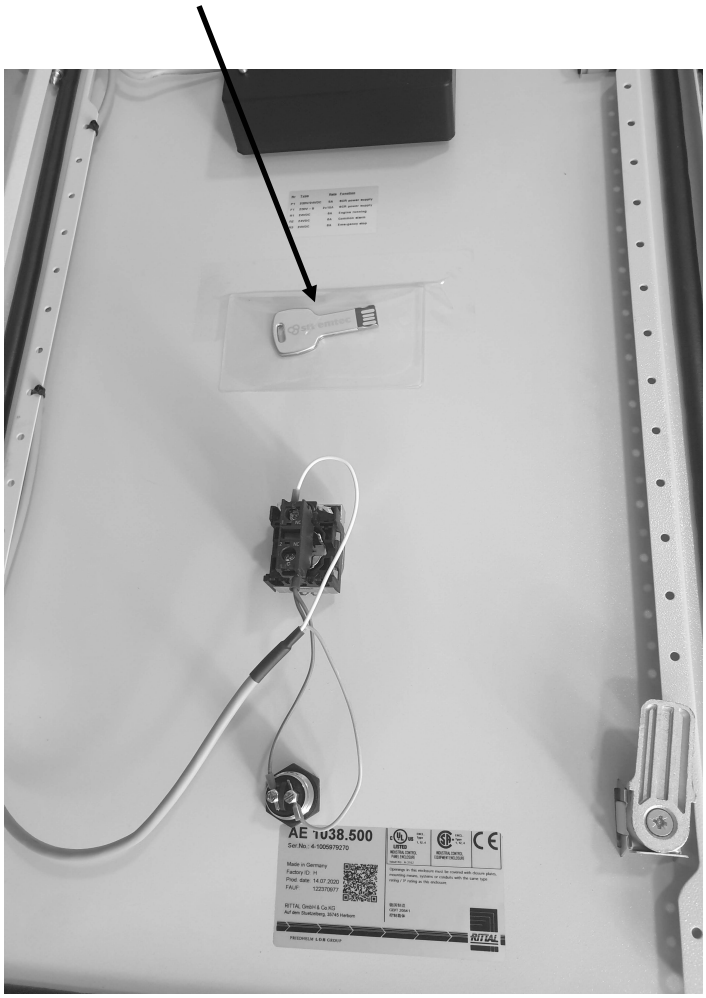
Appendix 7 Diagnostics

About the Marine SCR diagnose application
The Marine SCR diagnose application is a PC software designed to support system maintenance and troubleshooting

It is designed to run under Windows XP, Windows Vista, Windows 7 or later.

Your PC must have at least one available RS232 (serial) or USB port

The application installation software is delivered with all systems on a USB memory stick labelled “STT Emtec” on the inside of the control cabinet door.



USB memory stick (software) location in Control Cabinet

The latest version of the diagnose application can also be downloaded from http://www.sttemtec.com/

Table of contents

1 Overview

EmtecDiag is a monitoring and service tool for STT Emtec ECU's.
It can show runtime data and error codes, download diagnostic data, and update ECU calibration data in the form of complete calibration files.
All files (calibration-, diagnostic data-, and configuration files) are encrypted.

2 Software installation and connecting

2.1 System requirements

- 1GHz processor or better
- 512 MB RAM
- A Mouse
- Windows XP, Windows Vista, Windows 7 or later.
- Microsoft .NET Framework 3.51
- 50 Megabyte free space on the hard disk
- RS232 Serial port or USB

2.2 ECU drivers

Since many computers are not equipped with serial ports today STT´s latest generation of ECUs have the option of connecting with a RS232-USB adapter.
To be able to communicate with an ECU using USB, a set of drivers must be installed.
This is done automatically by the EmtecDiag installation program.

2.3 Software setup

Install EmtecDiag and its bundle of drivers and configuration files, by running EmtecDiag.msi on USB memory stick and follow the on-screen instructions.

The setup-program installs EmtecDiag, the drivers for USB-connected ECUs and any configuration files accompanying the setup files. After the setup-program completes, you can start EmtecDiag from the start-menu.

The setup-program will detect if your system already has Microsoft .NET framework 3.5
SP1 installed and updates your system automatically if needed.
The automatic update requires an active internet connection to access Microsoft's servers for downloading the .NET Framework files.

The .NET-framework update is a lengthy task and requires the computer to be restarted, so make sure you plan for it.

2.4 Connecting your diagnose equipment

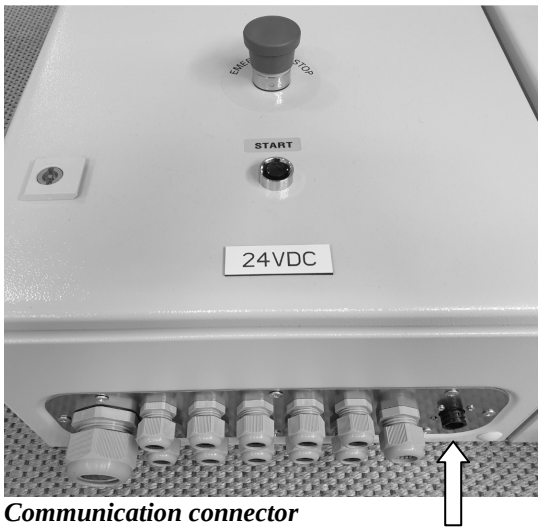
The Marine SCR control cabinet connects to your PC trough the DIAG serial cable. *(STT part no: 106836-01) – Delivered inside Control Cabinet*

If your PC does not feature a built-in RS232 connector you should use an additional USB adapter cable *(STT part no: 109731) – Bought separately from SCR system supplier*

You can use any RS232 or USB port (if you have USB adapter) on your PC, the diagnose application will automatically detect where the control system is connected.

DIAG. serial cable ***RS232-USB Adapter***

Connect the cable(-s) and make sure that the control cabinet has supply power
Hint: Supply power is on when there is text on the cabinet door display



Communication connector

Diagnostic Cable (serial)

3 EmtecDiag User Guide

When EmtecDiag is started, it automatically performs a scan of all serial ports on the computer. If it gets a response from a STT ECU, it scans any available configuration file for a match, and connects if one is found. The process requires no user input to connect to an ECU other than starting the program.

3.1 User Interface

The program window is named after the desktop file (.cfg) used to access the ECU (in the following examples “Marine DEF.cfg”).

At the bottom of the screen are a row of control buttons where the two rightmost are optional and can be hidden depending on the settings in the configuration file.

On the same level as the control buttons, on the far right of the screen is the communication-indicator which blinks when EmtecDiag is communicating with an ECU.

The runtime information can be grouped into pages showing different meters and buttons

In these examples, there are six pages:

- SYSTEM System main meters
- CAN/SNS CAN engine data and sensor data meters
- TESTS Control-buttons and meters for system testing
- DTC List of active and logged unactive diagnostic trouble codes
- Commissioning Compilation of all meters used during system verification
- Extra Compilation useful meters for troubleshooting

Switch between pages by clicking on the desired tab with your mouse.

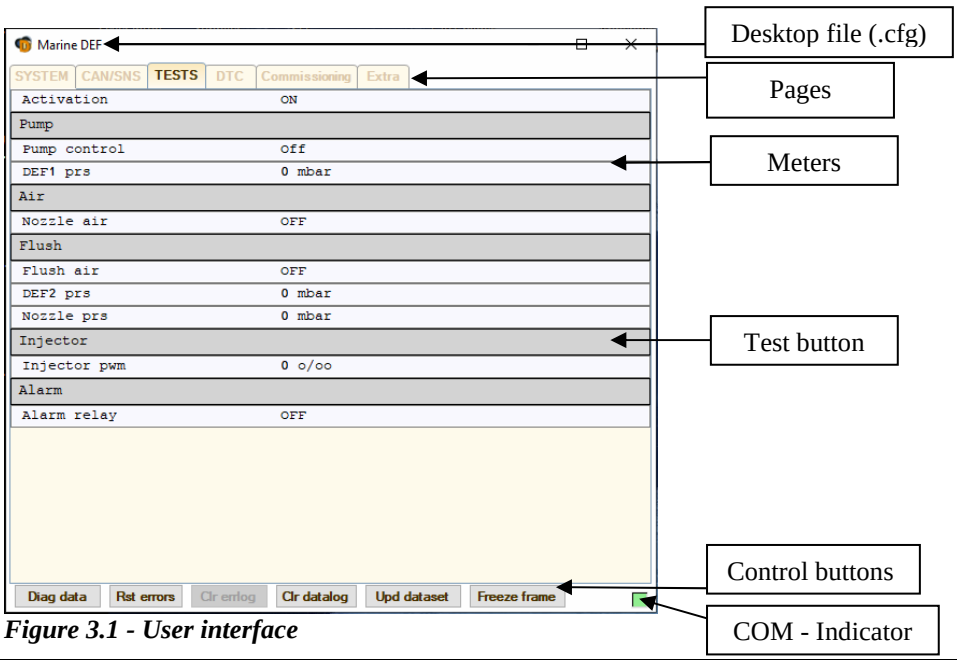


Figure 3.1 - User interface

3.2 Pages

Pictures of each available page in the DEF Marine desktop and Tables with description of the shown info boxes, meters, test buttons and parameters.

3.2.1 SYSTEM page

The System page contains meters showing the operational status of the mSCR system.

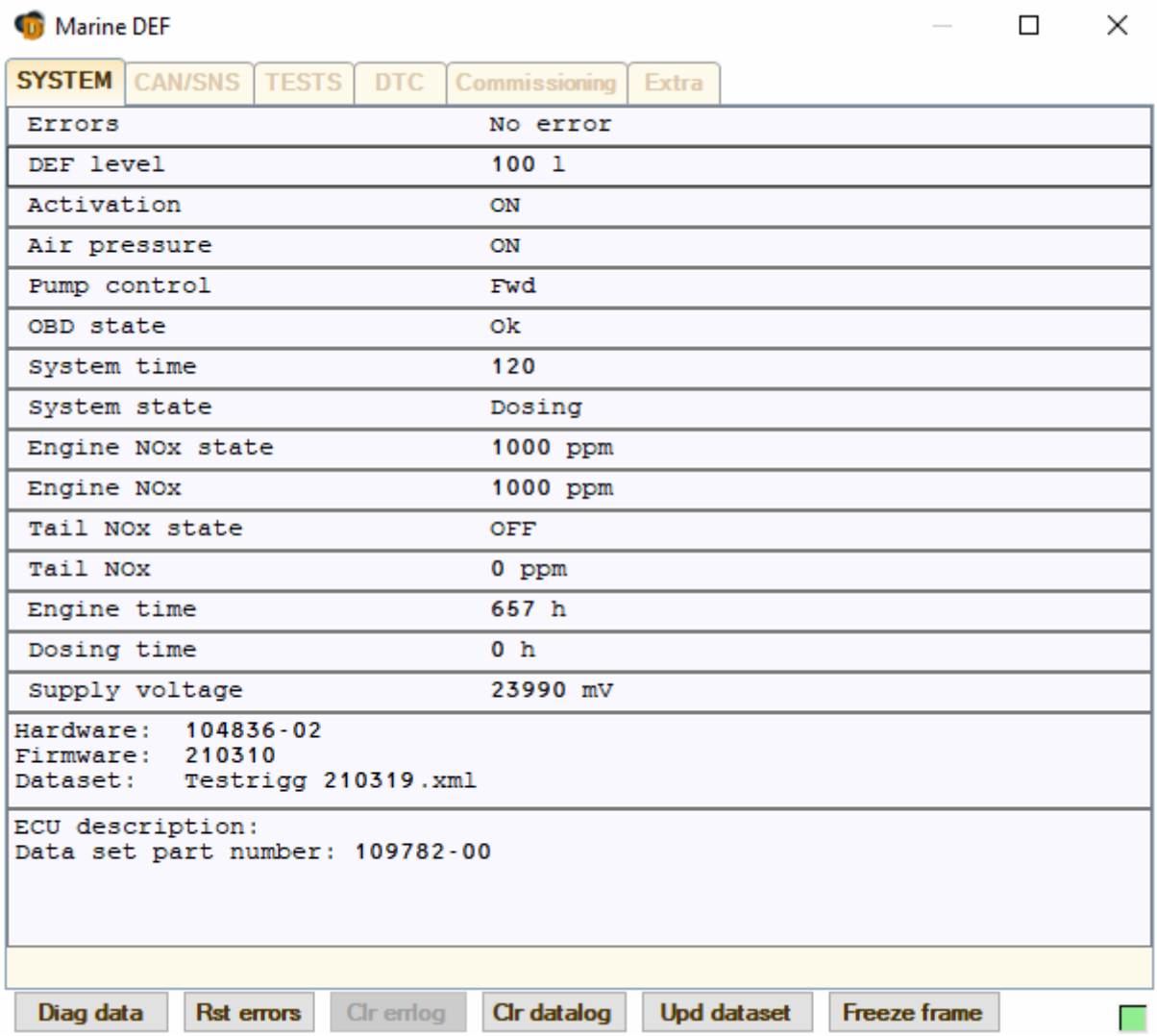


Figure 3.1.1 – SYSTEM page *(System Dosing)*

Table 3.2.1 – SYSTEM page

Name	**Description**	**Installation Guidelines**
Errors	Currently active Diagnostic trouble codes (DTCs)	Section 5.5.6
DEF level	Service tank DEF level	-
Activation	State of Engine running signal/relay	Section 4.5.5
Air pressure	State of pressure switch on FR unit	Section 3.5.1
Pump control	State of DEF-pump *States: OFF/ FWD/ REV*	
OBD state	Current system state as reflected on the LCD	Section 5.5.1
System time	Time until next system state in [s]	Section 5.5.1
System state	Current system state	Section 5.5.1
Engine NOx state	Current state of NOx sensor 1. *States: Heating → Read delay → NOx conc. at SCR chamber inlet [ppm]*	-
Engine NOx		-
Tail NOx state	Current state of NOx sensor 2. *States: Heating → Read delay → NOx conc. at SCR chamber outlet [ppm]*	-
Tail NOx		-
Engine time	Total engine running time in [h]	-
Dosing time	Total SCR dosing active time in [h]	-
Supply Voltage	Internal supply voltage in DDS cabinet	
Version [Info box]	ECU version information	
ECU description [Info box]	Dataset information	

3.2.2 CAN/SNS page

The CAN/SNS page contains meters showing

- CAN data from engine used by the system
- Sensor data used by the system

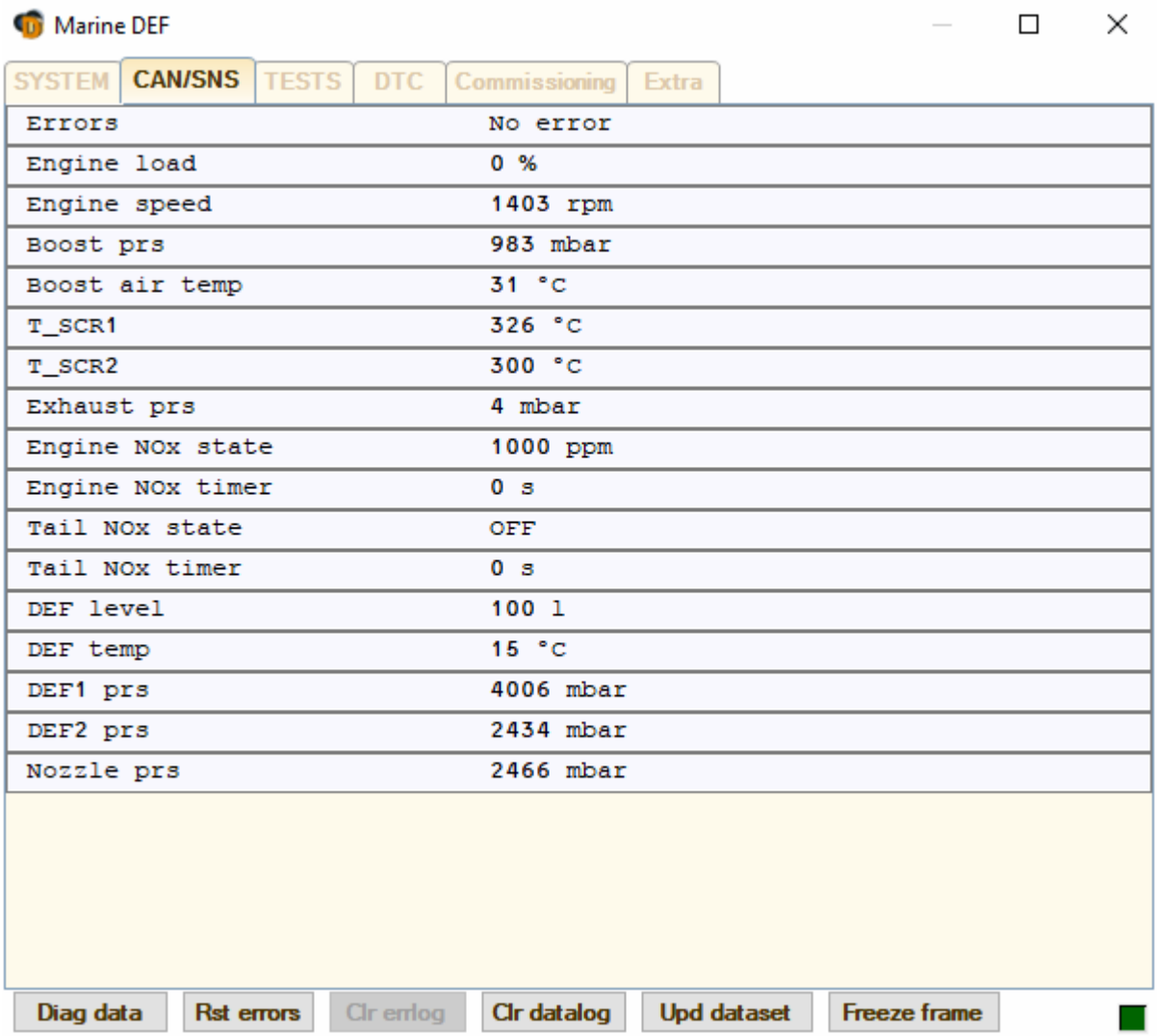


Figure 3.1.2 – CAN/SNS page *(System Dosing)*

Table 3.2.2 – CAN/SNS page

Name	Description	Installation Guidelines
Errors	Currently active Diagnostic trouble codes (DTCs)	Section 5.5.6
Engine load	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
Engine speed	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
Boost prs	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
Boost air temp	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
T_SCR1	Temperature at SCR chamber inlet	
T_SCR2	Temperature at SCR chamber outlet	
Exhaust prs	Pressure-drop over SCR	
Engine NOx state	Current state of NOx sensor 1. *States: Heating → Read delay → NOx conc. at SCR chamber inlet [ppm]*	
Engine NOx timer	Countdown to next Engine NOx state	
Tail NOx state	Current state of NOx sensor 2. *States: Heating → Read delay → NOx conc. at SCR chamber outlet [ppm]*	
Tail NOx timer	Countdown to next Tail NOx state	
DEF level	Service tank DEF level	
DEF temp	DEF temperature in DDU	
DEF1 prs	Pressure at DEF dosing valve inlet (prs regulator)	
DEF2 prs	Pressure at DEF dosing valve outlet	
Nozzle prs	Backpressure in injection nozzle resulting from atomization air	

3.2.3 TESTS page

The TESTS page show test buttons and meters used for activating/testing the function off

- DEF-pump Engine RUN signal needed to run pump. Activation = ON
- Air-solenoid (In DEF dosing unit)
- Flush-solenoid (In DEF dosing unit)
- Dosing valve [Injector] (In DEF dosing unit)
- Alarm-Relay (In mSCR cabinet) to connect to sum alarm

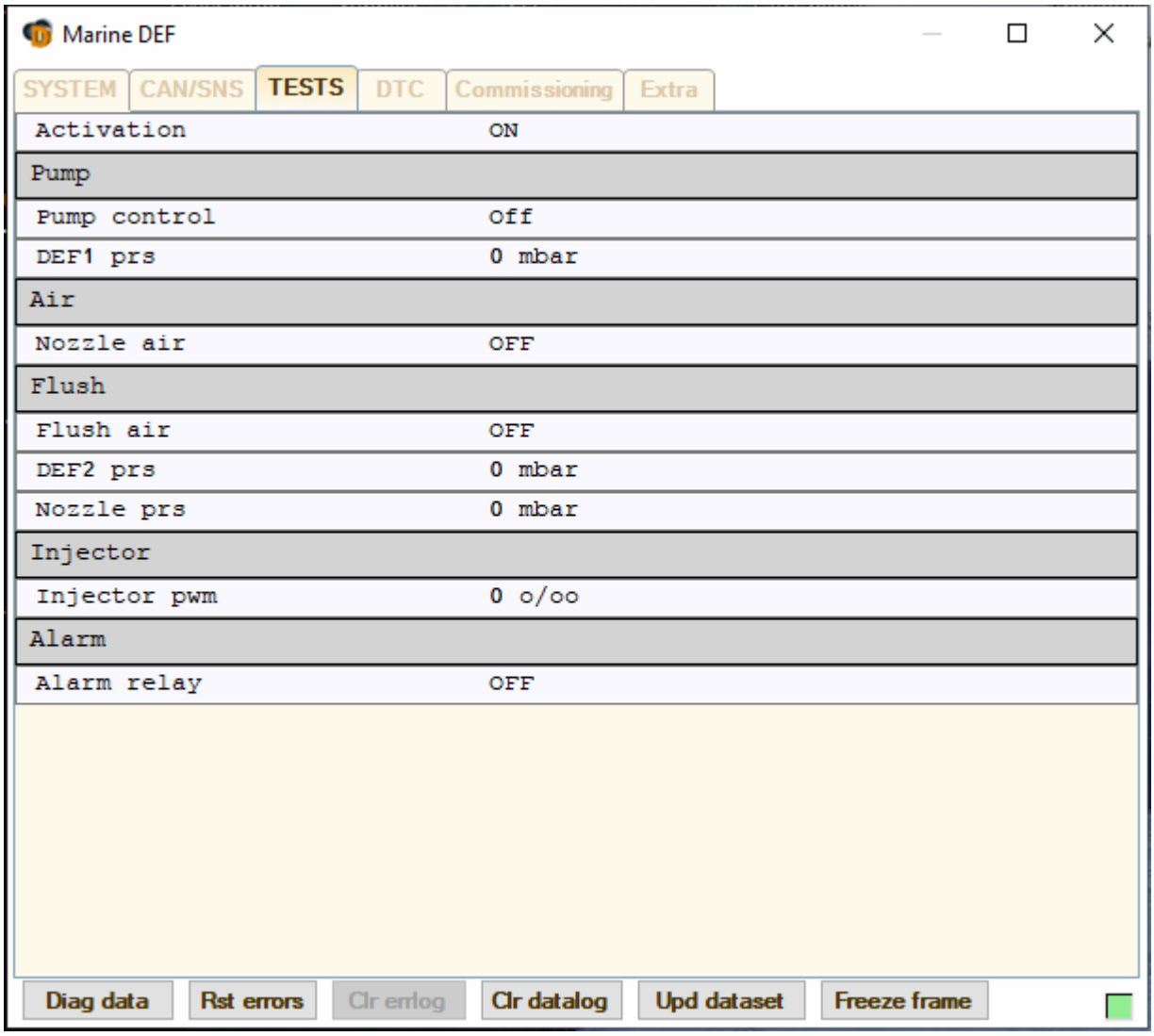


Figure 3.1.3 – TESTS page *(System Dosing)*

Table 3.2.3 – TESTS page

Name	Description	Installation Guidelines
Activation	State of Engine running signal/relay	Section 4.5.5
Pump [Button]	Click to activate DEF pump - Full rpm FWD (Activation needs to be ON)	
Pump control	State of DEF-pump *States: OFF/ FWD/ REV*	
DEF1 prs	Pressure at DEF dosing valve inlet (prs regulator)	
Air [Button]	Activates Nozzle air solenoid	
Nozzle Air	Shows Nozzle Air solenoid state	
Flush [Button]	Activates Flush air solenoid	
Flush Air	Shows Flush Air solenoid state	
DEF2 prs	Pressure at DEF dosing valve outlet	
Nozzle prs	Backpressure in injection nozzle resulting from atomization air	
Injector [Button]	Activates the DEF dosing valve	
Injector pwm	Shows DEF dosing valve duty	
Alarm [Button]	Activates alarm relay	
Alarm relay	Shows sum alarm relay state	

3.2.4 DTC page

The DTC page shows a list currently active and stored DTCs (Diagnostic Trouble Codes)

Stored, not currently active DTC (gray)

Currently active DTC (red)

R : [yymmdd]	Date for latest reset of this DTC
F : [yymmdd]	Date for first registration of this DTC
L : [yymmdd]	Date for latest registration of this DTC
C : [yymmdd]	Count of number of registrations of this DTC

Descriptions for all Diagnostic Trouble Codes (DTC) and tips for troubleshooting can be found in Installation Guidelines, Section 5.5.6

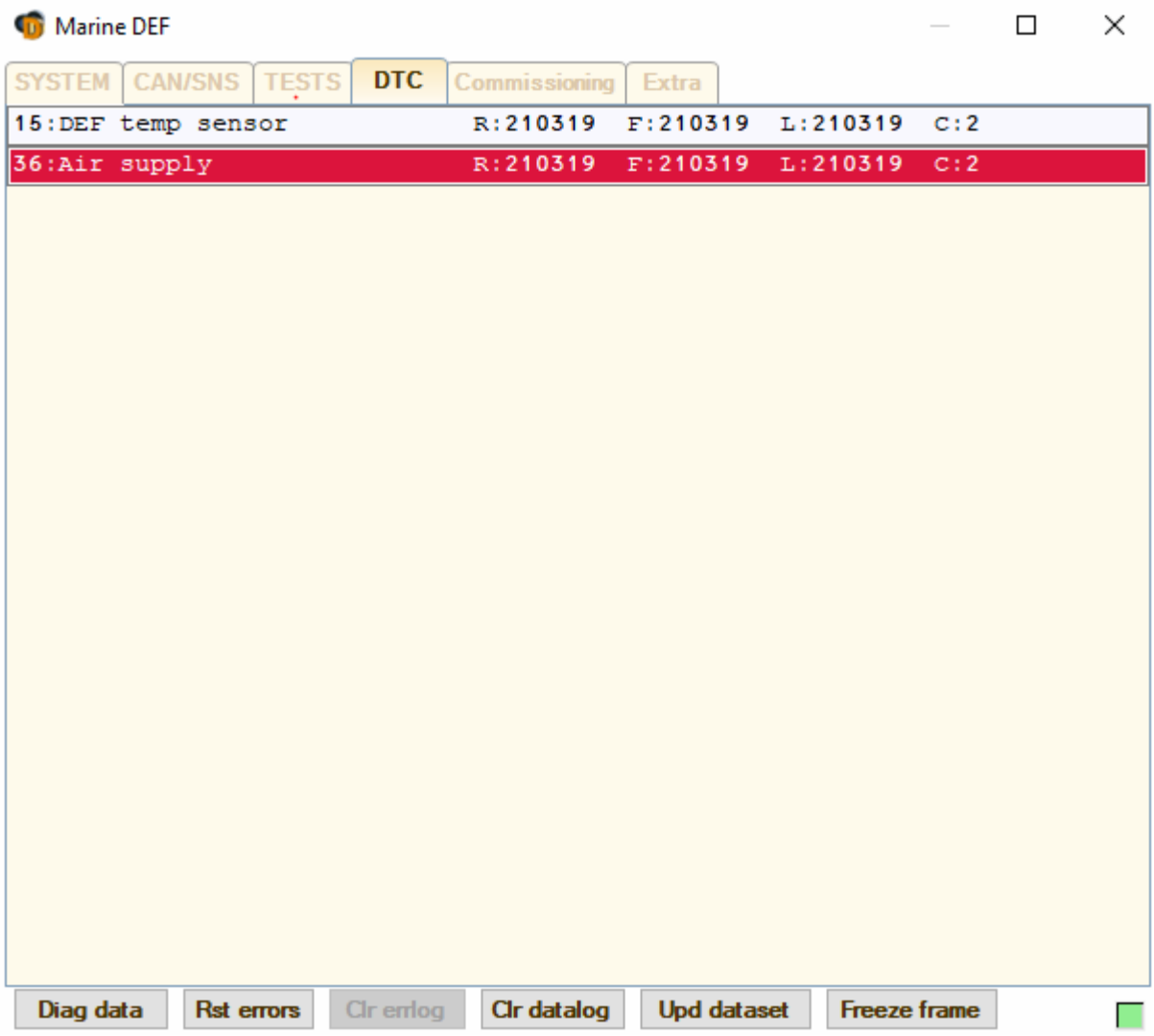


Figure 3.2.4 – DTC page

3.2.5 Commissioning page

The commissioning page shows data used during the system verification test

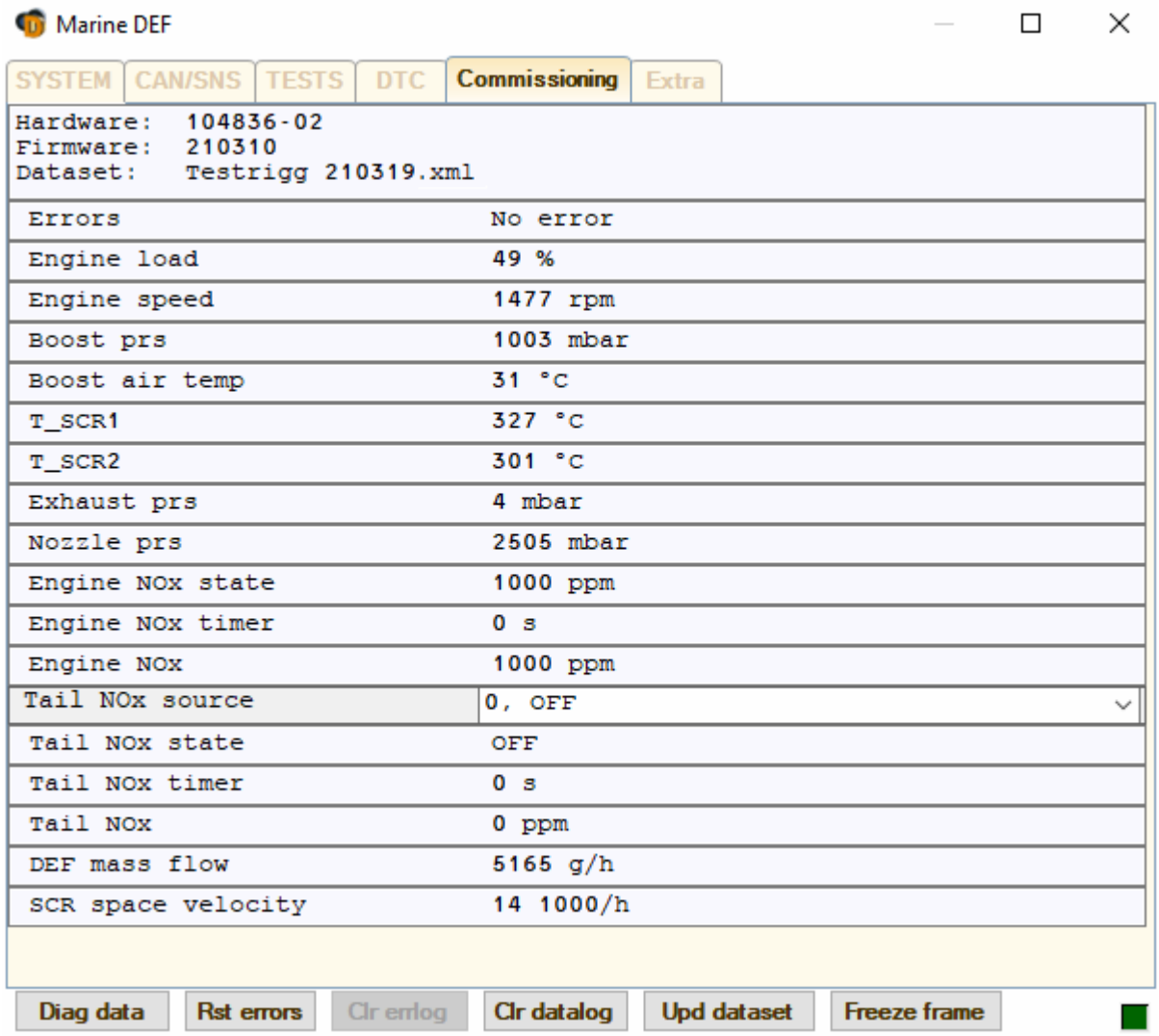


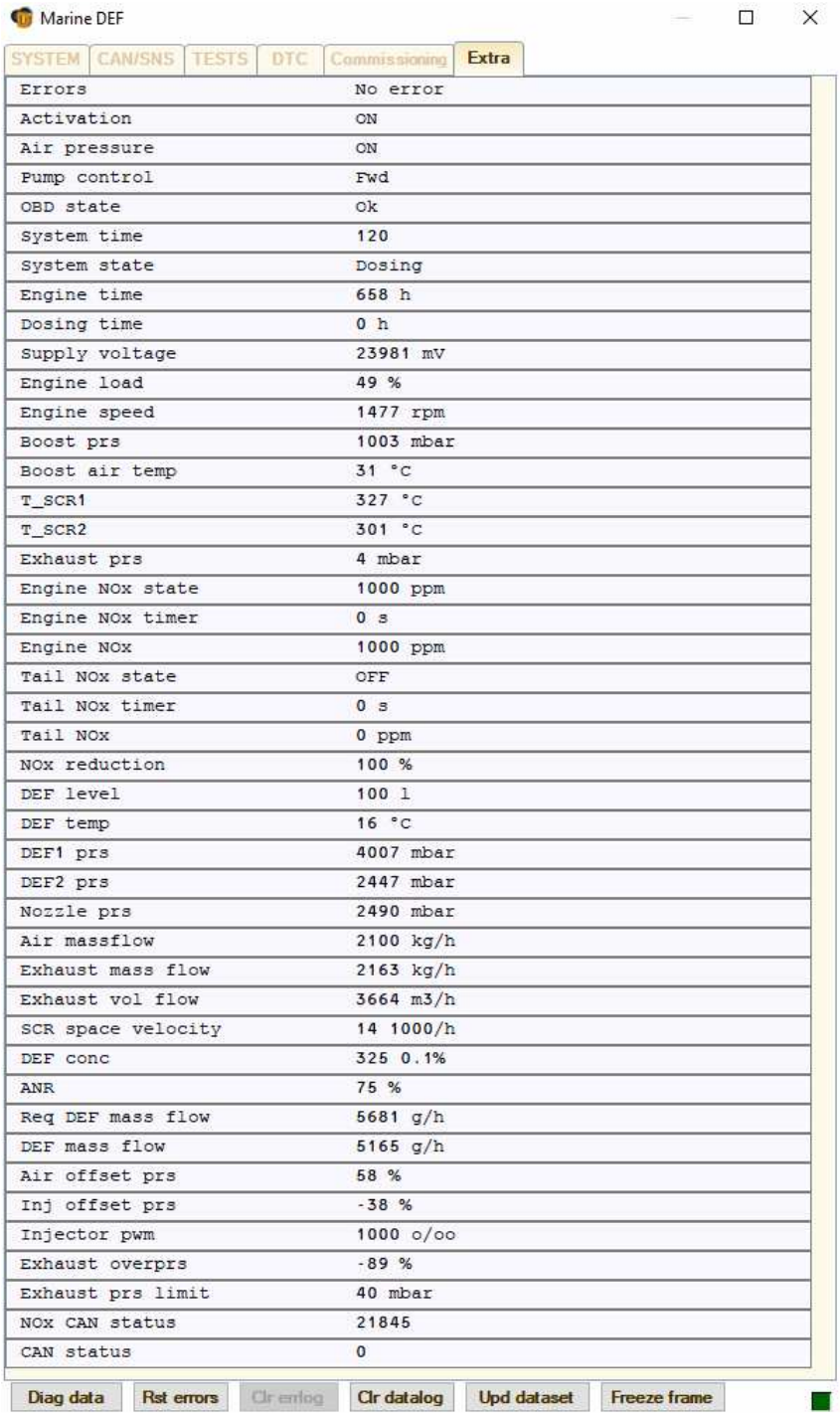
Figure 3.2.5 – Commissioning page *(System Dosing)*

Table 3.2.5 – Commissioning page

Name	**Description**	**Installation Guidelines**
Version [Info box]	ECU version information	
Errors	Currently active Diagnostic trouble codes	Section 5.5.6
Engine load	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
Engine speed	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
Boost prs	From engine J1939/Modbus(or optional discrete sensor)	Section 5.5.4
Boost air temp	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
T_SCR1	Temperature at SCR chamber inlet	
T_SCR2	Temperature at SCR chamber outlet	
Exhaust prs	Pressure-drop over SCR	
Nozzle prs	Backpressure in injection nozzle resulting from atomization air	
Engine NOx state	Current state of NOx sensor 1. *States:* *Heating → Read delay → NOx conc. at SCR chamber inlet [ppm]*	
Engine NOx timer	Countdown to next Engine NOx state [s]	
Tail NOx source [Parameter]	***0, OFF*** Default if system is without NOx sensor 2 ***47, CAN1:TailNOxConc*** Default if system have NOx sensor 2	
Tail NOx timer	Countdown for next Tail NOx state [s]	
Tail NOx state	Current state of NOx sensor 2. *States:* *Heating → Read delay → NOx conc. at SCR chamber outlet [ppm]*	
DEF mass flow	Actual DEF mass flow	
SCR Space velocity	Calculated Space velocity thru SCR catalyst	

3.2.6 Extra page

Compilation of useful meters for troubleshooting



Errors	No error
Activation	ON
Air pressure	ON
Pump control	Fwd
OBD state	Ok
System time	120
System state	Dosing
Engine time	658 h
Dosing time	0 h
Supply voltage	23981 mV
Engine load	49 %
Engine speed	1477 rpm
Boost prs	1003 mbar
Boost air temp	31 °C
T_SCR1	327 °C
T_SCR2	301 °C
Exhaust prs	4 mbar
Engine NOx state	1000 ppm
Engine NOx timer	0 s
Engine NOx	1000 ppm
Tail NOx state	OFF
Tail NOx timer	0 s
Tail NOx	0 ppm
NOx reduction	100 %
DEF level	100 l
DEF temp	16 °C
DEF1 prs	4007 mbar
DEF2 prs	2447 mbar
Nozzle prs	2490 mbar
Air massflow	2100 kg/h
Exhaust mass flow	2163 kg/h
Exhaust vol flow	3664 m3/h
SCR space velocity	14 1000/h
DEF conc	325 0.1%
ANR	75 %
Req DEF mass flow	5681 g/h
DEF mass flow	5165 g/h
Air offset prs	58 %
Inj offset prs	-38 %
Injector pwm	1000 o/oo
Exhaust overprs	-89 %
Exhaust prs limit	40 mbar
NOx CAN status	21845
CAN status	0

Figure 3.2.6 – Extra page *(System Dosing)*

Table 3.2.6 – Extra page

Name	Description	Installation Guidelines
Errors	Currently active Diagnostic trouble codes (DTCs)	Section 5.5.6
Activation	State of Engine running signal/relay	Section 4.5.5
Air pressure	State of pressure switch on FR unit	Section 3.5.1
Pump control	State of DEF-pump. [*States: OFF/ FWD/ REV*]	
OBD state	Current system state as reflected on the cabinet LCD	Section 5.5.1
System time	Remaining time in current system state	Section 5.5.1
System state	Current system state	Section 5.5.1
Engine time	Total engine running time [h]	-
Dosing time	Total SCR dosing active time in [h]	-
Engine load	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
Engine speed	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
Boost prs	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
Boost air temp	From engine J1939/Modbus (or optional discrete sensor)	Section 5.5.4
T_SCR1	Temperature at SCR chamber inlet	
T_SCR2	Temperature at SCR chamber outlet	
Exhaust prs	Pressure drop over SCR	
Engine NOx state	Current state of NOx sensor 1 *States:* *Heating → Read delay → NOx conc. at SCR chamber inlet [ppm]*	
Engine NOx timer	Countdown for next Engine NOx state [s]	
Engine NOx	Mapped NOx value during Engine NOx sensor states: *Heating and Read Delay*	
Tail NOx state	Current state of NOx sensor 2 *States:* *Heating → Read delay → NOx conc. at SCR chamber inlet [ppm]*	
Tail NOx timer	Countdown for next Tail NOx state [s]	
Tail NOx	NOx concentration at SCR chamber outlet [ppm]	
NOx reduction	Calculated momentarily NOx reduction %	
DEF level	Service tank DEF level	
DEF temp	DEF temperature in DDU	
DEF1 prs	Pressure at DEF dosing valve inlet (prs regulator)	
DEF2 prs	Pressure at DEF dosing valve outlet	
Nozzle prs	Backpressure in injection nozzle resulting from atomization air	
Air massflow	Calculated Air mass flow	
Exhaust massflow	Calculated Exhaust mass flow	
Exhaust vol flow	Calculated Exhaust vol flow	
SCR Space velocity	Calculated Space velocity thru SCR catalyst	
DEF conc	System setting for concentration of DEF reduction fluid to be used (Typically 32.5% or 40%)	
ANR	Ammonia to NOx ratio	
Req DEF mass flow	Calculated required DEF mass flow to achieve ANR	
DEF mass flow	Actual DEF mass flow	
Air offset prs	Deviation from baseline nozzle pressure	
Inj offset prs	Deviation from baseline DEF pressure	
Injector pwm	Current modulation of the dosing valve [0-1000 ‰]	
NOx CAN status	Status of Engine NOx and Tail NOx as reported by the sensors	
Exhaust prs limit	Maximum exhaust differential pressure over SCR	
Exhaust overprs	Maximum deviation from normal Exhaust prs	

3.3 Control buttons

At the bottom of the screen are a row of control buttons where the two rightmost are optional and can be hidden depending on the settings in the configuration file

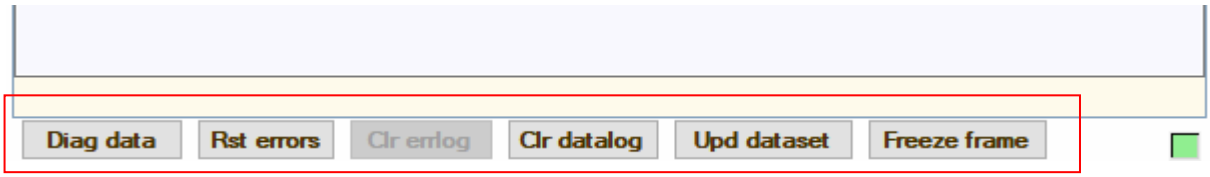


Figure 3.3 – Control buttons

3.3.1 Download diagnostic data

Diag data

Downloads all stored error codes and logger data in the ECU to an encrypted file (.enc)
that can be sent to the system supplier for analysis and troubleshooting.

You will be asked for a file name when the Diagnostic data button have been pressed.
The download will start when the Save button have been pressed.
The logger data will be shown to the user as a graph after download is completed.
Normal operation is resumed after the download is completed.

The downloaded diagnostic data file is in binary form and not in readable text
Contact system supplier to get the diagnostic data decrypted

3.3.2 Reset errors

Rst errors

Resets diagnostic trouble codes
The current error-states of all Errors are set to “OK” while the ECU re-evaluates them all
Active errors will reappear in the DTC-log
Stored errors will be cleared in the DTC-log but will remain in the error log.

3.3.3 Clear error log

Clr errlog

Not available

3.3.4 Clear logger data

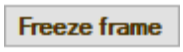
- Clears all logged data in the ECU
- Resets currently active error codes in the ECU.
  The current error-states of all Errors are set to “OK” while the ECU re-evaluates them all. Stored errors in the error log will remain.

3.3.5 Save config to ECU

This button can be used to update the dataset in the ECU if you have received such by system distributor. Normally not needed.

A file-selection window pops up when the button is pressed. Navigate to the new dataset-file (extension .mml), select it and press the OK-button. The text “Saving config to ECU” is shown while the update is in progress.

3.3.6 Freeze frame



Performs a snapshot operation putting the current values of all currently visible meters into a .txt file

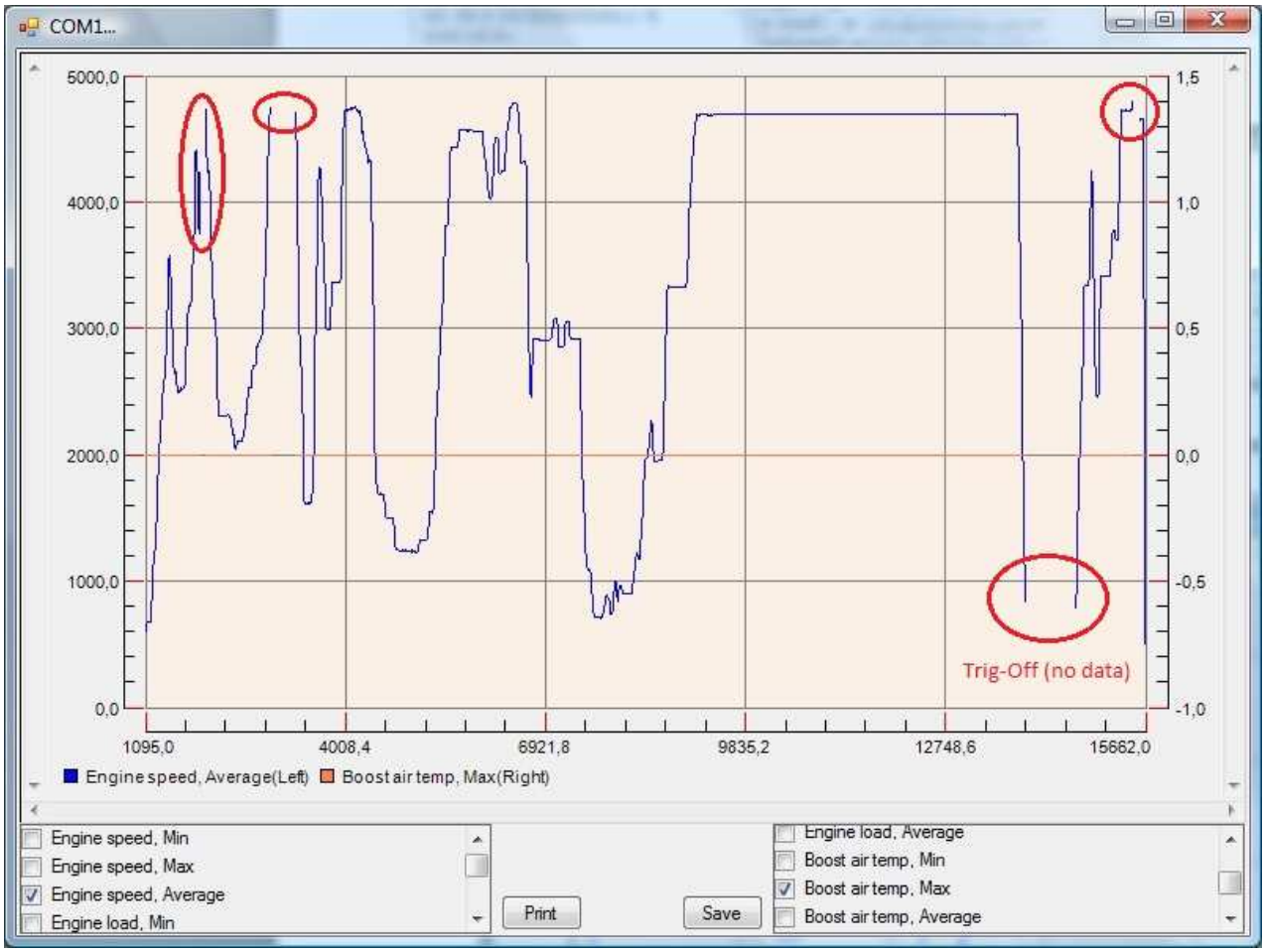
3.4 Log data graph

If the settings in the configuration file allow it, some- or all the data is presented in graph form.

The log data viewer can plot data on both the left- and right axis of the graph.

Use the checkboxes to select on which axis to plot the data.
The selected traces are plotted, each in a different color and a legend with information on which axis they belong to is shown below the graph area.

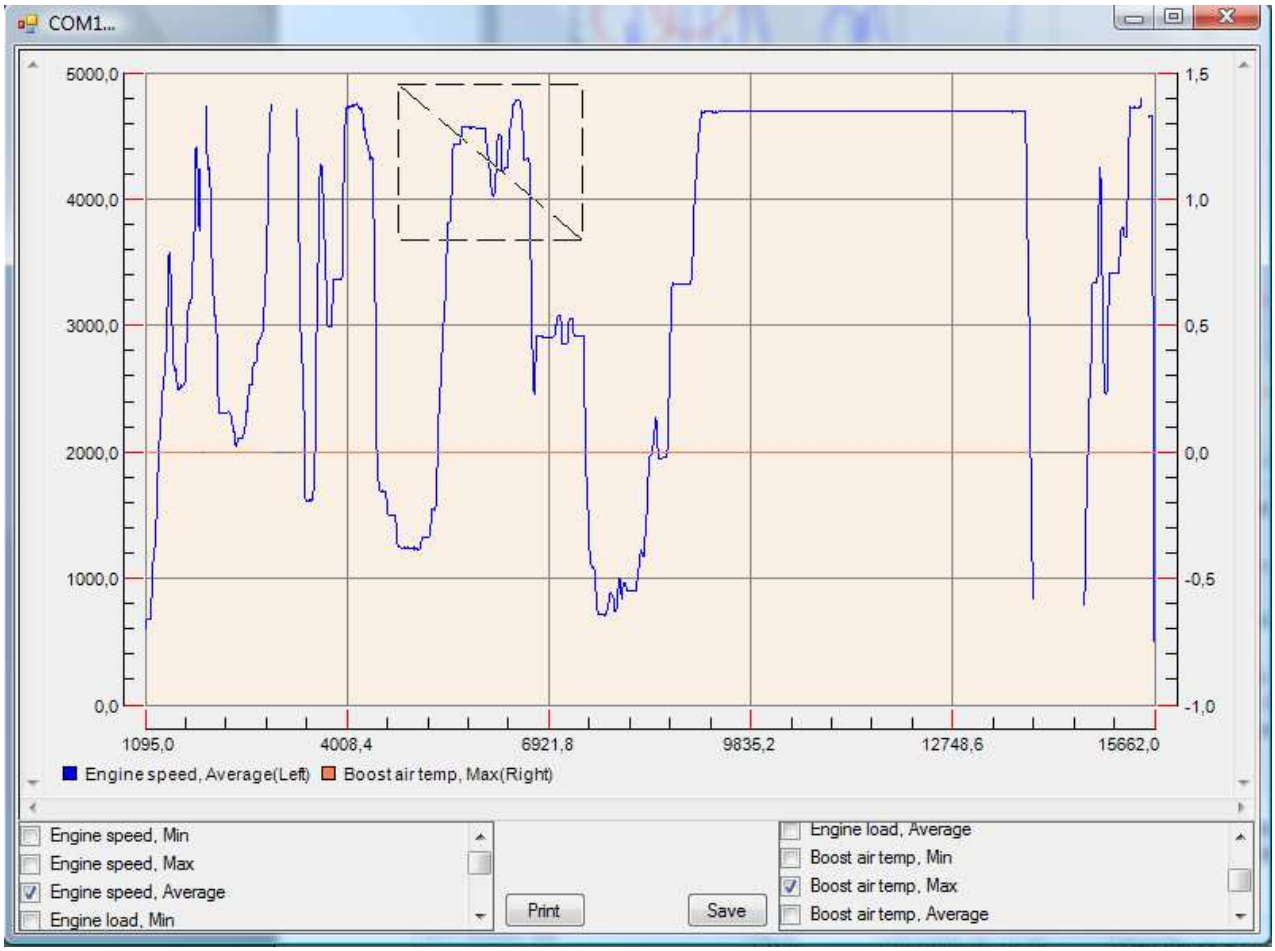
If the trace is broken, the logger has been trigged-off during that time.



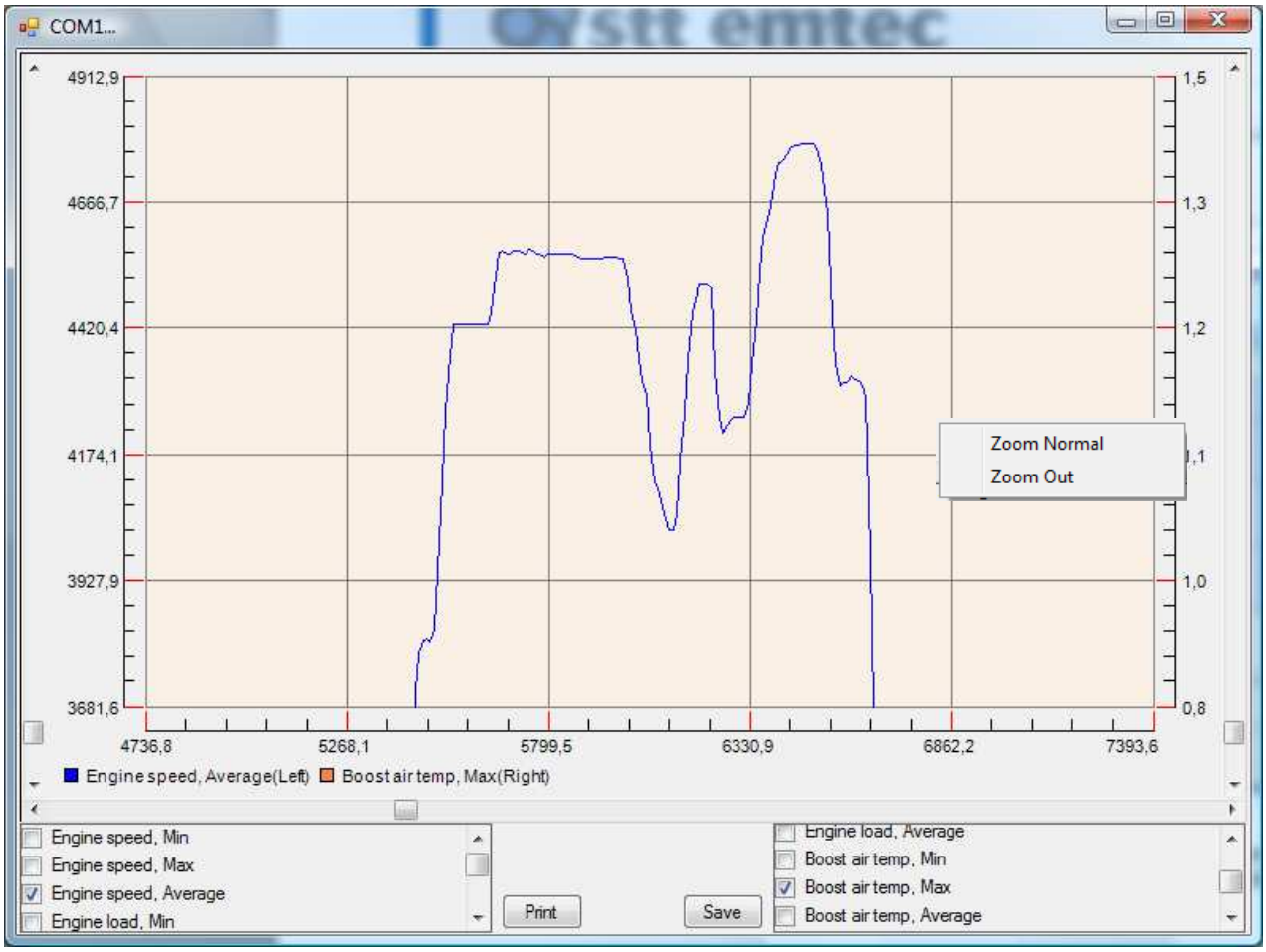
Example Log data graph (Engine Speed and Boost air temp)

Examining and saving log data graph

Zoom in to view details by selecting an area
Press-and-hold the left mouse button in the graph area and drag the mouse to mark the area you want to see in detail. Release the left mouse button to zoom in.



Log data graph, selecting graph area zoom



Log data graph, after zoom

- When zoomed in, use the scroll bars to **pan around** in the graph area.
- Click outside the graph-area to get a popup-menu to **reverse the zoom**.
- The **Print-**button will print the current graph, as seen on the screen
- The **Save**-button saves the current view to a TAB-separated text file for easy import into a spreadsheet.
    - o Selected traces only
    - o Only the time span shown on screen (the zoomed in data only)