**SCR System Operation Introduction**

**GRADALL** Series IV Highway Speed excavators use engines that comply with US EPA Tier 4i emissions standards effective in 2011 for the horsepower class of engine used. The engine is supplied by Tognum/MTU, a joint venture between Rolls Royce Industrial Engines and Mercedes Benz. In North America, Detroit Diesel is owned by Tognum which sells and supports the engine.

**GRADALL** uses the Mercedes Benz OM926 off highway engines for power for both over the road travel and excavator operation. The engine meets the Tier 4i standards through internal changes for better combustion efficiency along with Selective Catalyst Reduction (SCR) within the exhaust to achieve the reduced emissions as required by the EPA regulations.

Selective Catalyst Reduction (SCR) involves spraying a small amount of automotive grade urea (Ad Blue, Diesel Exhaust Fluid, DEF) into the exhaust outlet at the turbocharger. The Ad Blue reacts with a catalyst in the muffler to reduce the Nitrogen Oxide (NOx) emissions to required levels.

This program will introduce you to the SCR system and its interaction with the **GRADALL** machine. The program will also cover maintenance and basic troubleshooting of the SCR system.
Tognum MTU has a global presence. The company is based in Friedrichshafen, Germany with major regional headquarters in Detroit Michigan, Shanghai, China, and Singapore. MTU has been in business since the late 1890’s and specializes in off highway engines in marine, generator, construction, military, mining, and agricultural industries.
Mercedes Benz has chosen Selective Catalyst Reduction exhaust after treatment to meet the European Stage IIIB and US EPA Tier 4i emissions standards for industrial off highway rated engines.

Some advantages of the SCR technology:

- Reduces NOx levels to legal levels
- Reduces exhaust particulates with internal engine changes
- Reduces fuel consumption
- No changes in maintenance intervals – oil/filter changes, coolant change, etc
- Has a large installed base in over the road trucks already.
The chart shows the Euro regulations which very closely mirror the US EPA Tier levels for engine emissions. This chart shows the dramatic reduction in diesel engine emissions from unregulated engines to what will be known as Tier 4 Final. We are currently meeting Euro III/Tier 4i levels with the GRADALL Series IV machines.
The Theory of SCR Operation

SCR involves the chemical breakdown of the urea (Ad Blue, Diesel Exhaust Fluid - DEF) in the exhaust stream and the interaction with the materials in the catalyst to reduce harmful exhaust to much less harmful materials which come out the exhaust pipe of the machine.

A urea solution (32.5% concentration) is used as a reducing agent (trade name AdBlue). Honeycomb type catalytic converters are used, which essentially consist of titanium dioxide (TiO₂), tungsten oxide (WO₃) and vanadium pent oxide (V₂O₅). The catalytic converter is integrated into the silencer housing of the vehicle.

The ammonia (NH₃) which is needed for the reduction is produced from the injected AdBlue (urea) by the thermolysis and hydrolysis process.

In the SCR cat., the nitrogen oxides (NO, NO₂) coming from the engine are converted into non-toxic molecular nitrogen and water with the help of the ammonia.

![Diagram of SCR Operation]

**AdBlue** + **Water** → **Thermolysis, hydrolysis** → **Ammonia** + **Carbon dioxide**

**CO(NH₂)₂ + H₂O** → **2NH₃ + CO₂**

**Nitrogen oxides** + **Oxygen** + **Ammonia** → **Nitrogen** + **Water**

**NO + NO₂** → **4NH₃** + **O₂**

**4NO** + **O₂** → **4NH₃**

**4NO₂** + **O₂** → **4NH₃**

**Reduction** → **2N₂ + 3H₂O**

**4N₂ + 6H₂O**

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This chart provides a basic flowchart of the SCR injection strategy as used by the SCR frame module software to determine dosing requirements and amounts to achieve meeting emission levels.
Typical SCR Arrangement

This shows a typical arrangement of an SCR system installed. The following slides will cover the theory of SCR operation along with details of the GRADALL installation and operation.
The SCR system consists of a frame mounted air valve, engine mounted dosing unit and nozzle, a frame mounted Ad Blue tank and Ad Blue pump, a Frame mounted muffler/catalyst, and a SCR frame module to control the operation of the SCR system.
SCR Functional Diagram

DEF Tank

Air from chassis
#1 tank

3/2 Valve
(Pressure regulator)

Nozzle

Heating Valve

Dosing Unit

DEF Pump

M25 AdBlue pump
Y106 SCR air pressure limiter solenoid valve
Y107 SCR tank heater solenoid valve
8.0 Check valve

30.03 Pressure limiting valve

5 SCR compressed-air controller unit

7 AdBlue injection nozzle

A Coolant for feed line (from engine)

B Coolant for return line (to engine)

C AdBlue feed line

D AdBlue return line

E Compressed air

F Aerosol (AdBlue-air mixture)
Components required for the Tier 4i installation and certification are provided by Mercedes Benz and GRADALL. This slide will list which components are supplied by Mercedes and GRADALL.

**Supplied by Mercedes Benz and required for certification**

- Engine OM926
- DEF Pump Unit
- Engine Electronics including:
  - Ambient & Humidity Sensor
  - Engine ADM 3 Controller
  - Chassis SCR Module
  - NOx Sensor – catalyst/muffler
  - Exhaust Temp Sensors – catalyst/muffler

**Supplied by GRADALL and used by GRADALL to meet certification**

- Ad Blue (DEF) Tank
- 3/2 Air Valve
- Air Cleaner & Piping
- Exhaust Piping
- Additional components supplied by GRADALL:
  - Wiring harnesses (other than engine)
  - Air supply
  - Charge Air Cooler
  - Ambient Air Temperature Sensor
  - All lines, fittings, clamps, and sleeves required for fuel, Ad Blue supply, and air system supply.

**Supplied by GRADALL and required for proper engine operation**

- Engine OM926
- Catalyst/Muffler
- DEF Pump Unit
- Engine Electronics including:
  - Ambient & Humidity Sensor
  - Engine ADM 3 Controller
  - Chassis SCR Module
  - NOx Sensor – catalyst/muffler
  - Exhaust Temp Sensors – catalyst/muffler

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The engine has internal changes to reduce particulate emissions and provide more efficient combustion. Pistons and injectors are optimized for most efficient combustion. Engine software is enhanced.

External components provide the SCR operation. The major component involved is the Dosing Unit. This is a metering valve that mixes air and Ad Blue and meters the mixture into the exhaust.

Anytime the engine is running, the dosing unit allows air flow to cool the Aerosol Pipe and Injector Nozzle. On shutdown, a purge cycle occurs to flush the dosing unit of Ad Blue.

The Heating Valve is uses engine coolant to warm the Ad Blue (DEF) tank in cold weather.

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The Heating Valve is uses engine coolant to warm the Ad Blue (DEF) tank in cold weather.
The dosing unit is mounted at the right rear of the engine. The dosing unit has sensors that connect to the SCR Frame Module, an air pressure connection from the chassis 3/2 valve, an Ad Blue supply from the Ad Blue pump, and an Ad Blue outlet into the engine exhaust.

The correct operation of the dosing unit is critical to the SCR system operation. If the dosing unit does not properly meter Ad Blue into the exhaust, incorrect NOx readings will cause engine warnings to be illuminated and ultimately cause engine derate.
The dosing unit controls the injection of the Ad Blue into the exhaust to activate the catalyst. The dosing unit mixes the Ad Blue with compressed air from the chassis to form an aerosol that is injected into the exhaust stream. The Ad Blue mixes with the exhaust and reacts at the catalyst to reduce emissions.

Anytime the engine is running, air is supplied to the dosing unit. The air keeps the mixing chamber clear and cools the nozzle in the exhaust stream.

Sensors within the dosing unit reads Ad Blue pressure, Air pressure in the mixing chamber, and Ad Blue temperature.

The diffuser/heater is a heated orifice to heat the Ad Blue to reduce crystallization and clear the mixing chamber if it is blocked.
Diffuser heater is located above the mixing chamber of the dosing unit. Diffuser heater has a small orifice through the middle to control air flow into the mixing chamber.

The heater will heat the diffuser to 270°F (132°C) to decrystallize the Ad Blue if the air chamber starts to limit or blocks the air supply into the mixing chamber.

The air pressure sensor reads air pressure in the mixing chamber which is at 21.75 psi (1500 mBar) during operation.
The injector nozzle is located in the exhaust system after the turbocharger. The Ad Blue in the aerosol mixture from the dosing unit is injected into the exhaust stream when injection is required to reduce emissions.

The nozzle is cooled by a steady flow of air from the dosing unit when not being used to “dose” the exhaust system.

If any crystallization exists in the dosing unit, the nozzle must be removed and cleaned.

Use care when reinstalling the nozzle and tube. The tube must be tight to prevent leaks of the Ad Blue mixture. Over tightening of the fittings can cause the nuts to crack and leak. It is good practice to replace the tube anytime the dosing unit or nozzle are removed.

If the tube or nozzle do not seal, crystallized DEF may be found at the fitting or on the bottom of the exhaust pipe. If this condition exists, the nozzle and tube must be replaced.
The tank heating solenoid valve is located at the rear of the engine. When the ambient temperature is low enough (50°F, 10°C), the SCR frame module turns on the tank heating solenoid valve to route warm engine coolant to the Ad Blue tank to warm the Ad Blue solution. The coolant lines are also routed alongside the Ad Blue lines to the dosing unit to keep the fluid warm between the Ad Blue pump and the engine. Sheathing is provided to help insulate the lines.

If the coolant lines are serviced, the sheathing must be replaced to properly insulate the Ad Blue supply line.
The Ad Blue (DEF) tank is located on the right hand side of the chassis in front of the fuel tank. The DEF tank uses a special insert to limit nozzle size to prevent using a diesel fuel nozzle in the tank. Only automotive grade DEF (Ad Blue) should be put in the tank. Any type of fluid other than Ad Blue will contaminate and possibly destroy DEF components!

The DEF tank has a special blue cap. Do not run the machine with cap off or remove the cap with the engine running!

Tank is plastic and has heating tubes internally to allow engine coolant to warm the DEF during cold weather. Engine coolant from the heating valve on the engine warms the DEF lines and the fluid in the tank.

A level sensor provides DEF level to the SCR frame module and the DEF level gauge. The sensor also reads DEF temperature to work with the SCR frame module to regulate tank temperature. An o-ring seals the sensor to the tank and must be replaced anytime the sensor is removed!

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The Ad Blue (DEF) pump is located on the left hand side of the chassis. The Ad Blue pump moves the DEF from the tank to the dosing unit when the engine is running and requires Ad Blue.

The DEF pump has a maximum output of 87 psi (6 bar).

A filter protects the pump components from contaminates. The filter should be changed at every engine oil change (see GRADALL Service Information 41200109) for more detail on the filter.

A bladder is provided to act as an accumulator. The pressure in the bladder should be checked yearly. The bladder has 54 PSI (3.7 bar) and is filled with nitrogen. Contact your local MTU dealer to service the bladder.

The pump moves the DEF from the tank to the dosing unit when required. If contaminated DEF or other fluid is in the system, the pump will suffer significant damage.
The Ad Blue pump unit is shown in detail showing the components within the pump. The pump pressure filter along with 2 small screen type filters protects the pump from contamination. If any of the filters are dirty, SCR operation may be affected due to inadequate Ad Blue volume being moved through the pump.

The bladder type accumulator is also shown.

1 – Pump Pressure filter (P/N 80884008)
2 – DEF feed line – to dosing unit
3 – DEF Return Line to tank
4 – Switching valve & filter – air controlled
5 – Air connection – 80 PSI (5.5 bar nominal)
6 – Air Bladder (accumulator)
7 – Filter/Reservoir housing
8 – Coolant outlet
9 - Accumulator fill valve – 54 PSI (3.7 bar)
10 – Fill Valve Cap
11 – Coolant inlet
12 – Pump Housing
13 – Pump Housing Cover
14 – Electrical Connector
15 – Cover Ventilation Diaphragm
16 - Inlet line for Ad Blue (DEF)
17 – Ad Blue intake filter (inside fitting)

M25 – SCR Ad Blue Pump
The bladder within the DEF Pump Module acts as an accumulator when the pump is activated to balance pressure within the pump and lines. The bladder is filled with dry nitrogen and should be checked yearly. The correct pressure is 54 PSI (3.7 bar).

It is recommended the local Mercedes Benz dealer perform the Pump Unit Bladder pressure check.

The fill port for the bladder is located on the bottom of the DEF pump unit.
A box type muffler and catalyst assembly is located on the boom rest of the GRADALL excavator. The muffler has a honeycomb type catalyst that reacts with the Ad Blue to provide reduction of the exhaust into acceptable emissions. The muffler has a stainless steel body, the catalyst body is made of a ceramic material coated with catalyst materials.

3 sensors are provided as part of the muffler/catalyst assembly – 2 temperature sensors and a NOx sensor/module. The temperature sensors read inlet and outlet exhaust temperature (PRE SCR SGN, POST SCR SGN - @ wiring harness).

Exhaust system piping from the turbocharger outlet to the muffler/catalyst is provided and installed by GRADALL. Exhaust outlet piping after the muffler/catalyst is also provided and installed by GRADALL.
The NOx sensor/module and temperature sensors constantly monitor NOx emissions and exhaust temperatures during engine running.

All 3 sensors are important to determine when dosing is required as well as the amount of the dosing required.

NOx sensor determines the NOx concentration in the exhaust. The information is sent to the module as an analogue signal, the module sends the information to the SCR frame module on the CAN bus network. The module also supplies power for operation and heating of the element within the sensor.

The 2 temperature sensors use a PTC (Positive Temperature Coefficient) resistor to measure exhaust temperature. Resistance rises as temperature rises. The signals are sent to the SCR frame module to be digitized and sent to the engine MR control.

The temperature sensors help determine when the engine is making enough power (inlet exhaust heat) to work with the NOx sensor signals to determine dosing requirements. The outlet temperature sensor works with NOx sensor to determine if the catalyst is working correctly. The catalyst raises exhaust temperature when it is working correctly.

The temperature sensors must be wired correctly. The inlet sensor goes to connector with “PRE SCR SGN” wire, outlet sensor goes to connector with “POST SCR SGN” wire. Later production machines will have the inlet temperature sensor identified with a red tie wrap on the sensor connector.
A Humidity/Ambient Temperature Sensor is located in the air intake piping after the air cleaner. This sensor measures both humidity and ambient air temperature to allow SCR Frame Module to provide proper output information to the dosing unit.

Also located on the air intake pipe after the air cleaner is the connection for the air compressor air intake and the engine crankcase breather connection.

Air cleaner condition indicator should be checked daily after each shift. Regular checking and maintenance of the air cleaner is important for best engine performance and SCR operation.

All air intake piping clamps should be checked at each engine oil change to verify they are tight. If the clamps are loose prior to the turbocharger, dirt may get into the engine, if they are loose after the turbocharger, boost pressure may be lost and engine may perform poorly.

If machine has codes indicating the NOx Sensors are out of range, one check should be the air intake pipe after the turbocharger for the presence of oil. The oil may be introduced by the turbocharger or crankcase breather.
SCR Frame Module

SCR frame module is mounted on the chassis cab under the front cover. The SCR frame module takes inputs from specific sensors and provides outputs to control operation of the SCR system.

The SCR frame module reads information through a CAN bus network. Resistors in the CAN bus network provide noise filtration on the network. 2 – 120 ohm resistors are within the wiring harness.

The SCR frame module is read through the engine MR via the connector on the dash using a Mini Diag.

Input:
- AdBlue tank – Level & Temperature
- Catalyst/Muffler temperature sensors (2)
- Ambient air temperature and humidity sensor – Air Intake Tube
- NOx-Sensor – Catalyst/Muffler
- Dosing Unit – Ad Blue Pressure/Temperature, Air Pressure

Output:
- SCR-Pump module
- 3/2 directional control valve
- Diffuser/Heater @ Dosing unit

Diagnosis of the SCR-Frame module and of the connected components is carried out via the engine control unit (MR).
In addition to the SCR frame module, the engine is equipped with 2 additional controllers. Mounted to the engine is the MR controller, mounted to the front of the cab is the ADM3 controller. The MR controller is the primary control of all engine function. The ADM3 is the interface between the cab controls and the engine MR controller.

The SCR frame module communicates with the MR controller via a CAN bus circuit. Resistors are part of the circuit to act as noise filters.

The MR has 2 connectors. The smaller 16 pin connects to the GRADALL harness and provides power, ground, ignition, and CAN network between the machine, SCR frame module, and ADM3. The larger 55 pin connector connects the engine harness supplied with the engine.

ADM3 has 4 plugs that connect to the GRADALL cab harness. If the ADM3 is ever changed, the template must be saved or a new template will have to be loaded manually to allow correct engine operation.
The internal values used by the SCR frame module are shown in this diagram. The values are shown in metric units as this will be the values shown when using the Mercedes Benz Mini Diag for testing. These values will also be used when communicating with the service dealer.
Ad Blue or diesel exhaust fluid (DEF) is the term used by Mercedes Benz to describe the fluid used in the SCR system to achieve legal emissions level. Ad Blue is injected into the exhaust stream and reacts with a catalyst to breakdown harmful emissions.

• Ad Blue is an automotive grade urea product that is 32.5% urea, 67.5% distilled water. Never use any Ad Blue that is not automotive grade! Do not attempt to make Ad Blue from locally available materials.

• Ad Blue freezes at 12° F (-11°C). Do not add any additive to alter the freezing point as it will contaminate the Ad Blue. A heating circuit is provided to warm the Ad Blue within the tank and lines during cold weather operation.

• Ad Blue should be stored in approved containers and never in direct sunlight. Never put Ad Blue in non alloy steel, aluminum, copper, copper alloy, or zinc plated containers.

• Nothing other than Ad Blue should ever be put into the Ad Blue tank on the GRADALL machine. If anything contaminates the Ad Blue, serious damage to the SCR system may occur and engine derate may occur as well.

• Any components in contact with Ad Blue (tools, lines, pumps, valves, etc) should only be cleaned with hot, soapy water, then washed with hot water. Use of any other fluid to clean anything in contact with Ad Blue may contaminate the component.

• The machine must not be run with the Ad Blue tank cap off. Evaporation and contamination of the Ad Blue may occur as well possible engine function issues that could lead to a derate.

• Machines working in remote locations should carry a small supply of Ad Blue in case of a low Ad Blue situation. Low Ad Blue levels in the tank will result in illuminating warning lights as well as possible loss of power due to engine derate.
Air to power the SCR system (pump & dosing unit) comes from the chassis air supply. Air is supplied directly from the outlet of the #1 air tank to the frame mounted 3/2 Valve.

The 3/2 Valve is controlled by the SCR Frame Module. The 3/2 valve is switched on when the engine is started to allow constant, regulated (80 – 85 psi) air flow (.9 CFM) through the dosing unit for cooling of the nozzle. The air is also used to operate the DEF pump as well as mix with the Ad Blue to create the correct aerosol that is injected into the exhaust.

The 3/2 Valve is also cycled on/off after engine shut down to provide a “purge” cycle for 5 minutes to flush Ad Blue out of the dosing unit and pump.

A small filter is located between the chassis air supply and the 3/2 valve to protect the 3/2 valve from contamination.
The 3/2 Valve (GRADALL P/N 80783222) is mounted on the frame near the Ad Blue tank. The 3/2 valve not only provides a solenoid to turn the valve on/off at command from the SCR frame module, but also acts as a flow and pressure regulator for the SCR system.

The 3/2 valve regulates flow to the SCR system at 0.9 CFM (25.5 l/min) to the dosing unit for cooling and mixing.

The air pressure from the chassis air system normally runs in the range of 105 – 120 PSI (7.25 – 8.25 bar). Low air system pressure may affect 3/2 valve operation and cause SCR system issues. Outlet port and check valve of the 3/2 valve should be checked for contamination as well.

The 3/2 valve regulates the pressure to 80 +4.3/-1.4 PSI (5.5 bar) to the pump and dosing unit. Output pressure of the valve should be checked yearly or any time the SCR system may indicate a need for maintenance. 3/2 Valves are set at 85 +/-1 psi at Gradall final test (beginning August 2013).

A 24V solenoid valve is used to turn the 3/2 valve function on and off.

After engine shutdown, if conditions have been met to “dose” the catalyst while running, the 3/2 valve is used to “purge” the dosing unit and pump of Ad Blue. The SCR frame module turns the 3/2 valve on & off over a 5 minute period to flush the Ad Blue out of the components. If air pressure is low on shutdown, it can cause an incomplete purge resulting in crystallization and engine derate. A typical purge cycle uses 20 – 30 PSI (1.4 – 2 bar) of tank pressure during the purge cycle. Due to the purge cycle, the power (battery disconnect switch) must not be switched off and air tanks must not be drained until the purge cycle is complete. Air system must be at governor cutoff (120 PSI, 8.25 bar) when engine is shutdown to insure adequate air is available for the purge cycle.
Air System Operation/Changes

The SCR system uses air from the chassis air system to power the DEF pump and air for the dosing unit/nozzle operation. Air is supplied from engine mounted air compressor. From the air compressor, air flows to the air dryer then to the #1 (wet) air tank. #1 tank outlet provides air to the frame mounted 3/2 solenoid valve for the engine SCR system.

For proper operation, the SCR system has a nominal air pressure requirement of 80 PSI (5.5 bar). The GRADALL system normally runs between 100 – 125 PSI (6.9 – 8.6 bar), which is adequate for normal operation. If machine air pressure is below normal range, cause must be found and corrected to avoid causing an SCR fault.

On a typical machine with no air pressure at start up, it will take 4 – 5 minutes at idle to fully charge the air system to cut off pressure (120 – 125 PSI). When cut off pressure is reached, the air dryer purge valve will vent any accumulated moisture or oil inside the air dryer.

The oil coalescing cartridge (P/N 80784177) within the air dryer was added not only remove water vapor in the air supply from the compressor but also oil aerosols from the compressor. The heat of the compressor operation introduces both the oil and air into the air stream going to the air dryer. The cartridge is to be changed yearly or every 1500 hours, whichever comes first. The air dryer also has a heater for cold weather operation to avoid freezing the purge valve.

The “Ping” tank and supply lines were added to make the operation of the air dryer more efficient by slowing air velocity and allowing the air to cool after it leaves the compressor. The supply lines are larger than used in the past to slow the velocity of the air, the ping tank provides an initial expansion of the air for cooling purposes.

Note – the ping tank affects operation of the air dryer purge valve. When the air dryer purge is activated, the purge valve will continue to vent air after the primary purge cycle occurs. This is normal due to the volume of air contained in the ping tank.

Lanyard type drain valves were added to the air tanks to allow daily check of air system condition. If moisture or oil is found when venting the tank, the cause of the problem must be found and corrected immediately. Air tanks must never be drained or vented until the SCR system “purge” cycle is complete.

The “purge” cycle is an automatic feature of the SCR system. The dosing unit, nozzle, lines, and DEF pump are purged to avoid crystallization of the Ad Blue. When shutting the machine down, the air system must be at governor cutoff (120 – 125 PSI) at shutdown. It is possible the SCR system can use as much as 30 PSI (2 bar) of air pressure during the purge cycle. Only after the purge cycle (5 full minutes after shutdown) is complete should the air tanks be checked or the battery disconnect turned off!

A small inline filter was added between the supply line and the 3/2 solenoid valve. This filter has an automatic drain and provides additional oil coalescing protection and air filtration protection to the 3/2 solenoid valve and SCR system.
Chassis Air System

Air Compressor
(Supplied w/engine)

Air Dryer with oil coalescing cartridge
(Cartridge P/N 80784177)

#1 (Wet) Air Tank

“Ping” Tank

Not Shown:
Lanyard type drain valves on each air tank – check daily
Governor, on boom rest, senses air pressure and starts/stops air compressor charge cycle.
Connection from #1 tank to 3/2 solenoid valve.
Air filter at 3/2 solenoid valve – see slide #33
A filter (P/N 80783273) was added as a running change to provide additional and “last chance” protection for the 3/2 solenoid valve and SCR components. The filter mounts at the inlet of the 3/2 valve and receives air from the supply line from the #1 air tank.

Filter is oil coalescing type filter to not only remove particles and moisture but also oil in aerosol form from the air. The filter has an automatic drain valve to allow any contaminants to be ejected automatically. The filter has a clear bowl for visual examination. The filter should be replaced yearly or 1500 hours, whichever comes first.
“Inducement” is a requirement of the EPA regulations to warn the operator of SCR system problems and begin to “derate” or reduce power until the engine will only run slightly above idle. The problem has to be corrected and the engine “recommissioned” to restore normal operation. Inducement is activated due to low/no Ad Blue in the tank, poor quality Ad Blue, inadequate quantity of Ad Blue injection, or tampering with the SCR system.

3 warnings are provided with the machine. Fuel/Ad Blue level gauge (chassis cab), Check Engine Light (both cabs), & LIM light (both cabs). An audible alarm will also sound in the chassis.

The Ad Blue level gauge will provide warning of DEF level and inducement. Check engine light will warn of system failures and tampering. LIM light will be on as a warning of early inducement and begin to flash when severe inducement begins.

The inducement levels for specific types of inducement triggering events will be covered in the following slides.
Ad Blue Level Low Early Stage

When the Ad Blue level in the tank drops to 14% or less of full capacity, the light in the Ad Blue gauge will turn yellow as a warning to the operator to refill the Ad Blue tank. This is considered “Trigger 1” by the software.

If the fluid is allowed to drop to 10% or less of capacity, “Trigger 2” is activated in the software. This begins a 30 minute countdown to correct the fluid level or “Early Inducement” begins.

30 minutes after the Ad Blue tank level is at 10% or less of capacity (Trigger 2), the Ad Blue gauge will begin blinking and the LIM light will come on. Early inducement will begin.

Early inducement is a reduction in peak torque that the engine can generate. Peak torque is reduced to 80% of maximum torque. Early inducement will last 30 minutes before final inducement begins.

Early inducement limits maximum torque available from the engine. This is to force the operator to refill the Ad Blue tank to restore normal operation.
Ad Blue Level Low Late Stage

After 30 minutes of early inducement, the “ramp down” to final inducement begins, unless Ad Blue is added to the tank to bring the level above the 14% critical level.

The torque output of the engine begins to be reduced gradually. As long as torque remains above the 50% level, the Ad Blue level light will flash and the LIM light will be lit continuous. When torque drops below 50% of maximum available torque, the Ad Blue level light will continue to flash and the LIM light will begin to flash. The audible warning in the chassis cab will also sound to match the LIM light.

90 minutes after early inducement begins, the engine will be at final inducement and will produce 20% of maximum torque at 1000 RPM. At this stage, the engine requires “recommissioning” by an authorized engine dealer.

The chart shows the time line and torque reduction from the time a confirmed failure occurs until final inducement occurs.
Additional system testing during June 2013 has found the published inducement information for DEF level is not correct. The initial warnings are published to begin at the 14% fluid level.

It has been found the warnings actually start at the 10% level which coincides with the beginning of the 30 minute countdown to inducement. Currently no fix for this condition exists.

It is recommended that anytime the DEF level gauge reaches 1 green bar illuminated, the operator should immediately add DEF from an approved container. If no container of DEF is available, the machine should be parked in a safe place until DEF is available to raise the level in the tank to at least 2 green bars.

You must add DEF when only one bar is illuminated green! If the bar turns yellow, the machine must be shutdown until DEF is added.

You must add sufficient AD Blue to raise the level to 20%+ of tank capacity to end the low DEF signal to the SCR system! The system will not recognize levels below 20% as being adequate to bring the system out of the low Ad Blue trigger.
Ad Blue Quality Inducement

If the Ad Blue quality is incorrect, the NOx sensor will detect incorrect emissions levels (codes 1.29.71, 1.29.72) Once the incorrect quality is confirmed, the software uses this as the Trigger and starts a 60 minute countdown until the first “ramp down” of torque (power) begins. The engine will run at full power and RPM during the 60 minutes.

60 minutes after the Ad Blue quality is determined to be incorrect, the Ad Blue gauge will begin blinking and the LIM light will come on. Early inducement will begin.

Early inducement is a reduction in peak torque that the engine can generate. Peak torque is reduced to 80% of maximum torque. Early inducement will last 120 minutes before final inducement begins.

After 120 minutes of early inducement, the “ramp down” to final inducement begins, unless Ad Blue quality is corrected.

The torque output of the engine begins to be reduced gradually. As long as torque remains above the 50% level, the Ad Blue level light will flash and the LIM light will be lit continuous. When torque drops below 50% of maximum available torque, the Ad Blue level light will continue to flash and the LIM light will begin to flash. The audible warning in the chassis cab will also sound to match the LIM light.

180 minutes after early inducement begins, the engine will be at final inducement and will produce 20% of maximum torque at 1000 RPM. At this stage, the engine requires “recommissioning” by an authorized engine dealer.
Note the time from a confirmed failure to final inducement is different due to Ad Blue quality or tampering fault. The time from confirmed failure to early inducement is longer.

Early inducement period is also longer. However, the ramp down to final inducement remains the same.

During the inducement phases, the operator is allowed to move the machine to a service area. But once final inducement begins, the machine is essentially disabled.
“Tampering” inducement is intended to address issues involving accidental or deliberate disconnect of the SCR system components during operation. In actual practice, the tampering code and inducement may also occur due to blockage due to crystallization within the dosing unit, lines, and nozzle. Issues with wiring, connectors, and components may allow a tampering code (1.42.69) to be stored in the system as well.

The following items are listed as the cause of a “tampering” code:

- Disconnected tank level sensor
- Disconnected Ad Blue dosing line or valve
- Blocked Ad Blue dosing line or valve
- Disconnected Ad Blue pump wiring connector
- Disconnected SCR wiring harness
- Disconnected NOx sensor module
- Disconnected Ad Blue temperature sensor
- Disconnected exhaust temperature sensor(s).

The inducement time intervals are identical to the time intervals for Ad Blue quality inducement.
Tampering Inducement Warnings

Once one of the triggers listed on slide # 39 is confirmed by the software, the Ad Blue level lights change color to a solid yellow along with the check engine light being illuminated. Full engine performance will be available for 60 minutes. After the 60 minutes time has elapsed, early inducement begins.

Once the early inducement phase starts, engine power is reduced to 80% of peak torque. The Ad Blue level lights will flash, the check engine light will be illuminated, the LIM light will illuminate. Early inducement will begin 60 minutes after the tampering trigger is detected and will last 120 minutes before final inducement begins.

After 120 minutes of early inducement, the “ramp down” to final inducement begins, unless the tampering issue is corrected.

The torque output of the engine begins to be reduced gradually. As long as torque remains above the 50% level, the Ad Blue level light will flash, the check engine light and the LIM light will be lit continuous. When torque drops below 50% of maximum available torque, the Ad Blue level light will continue to flash, the LIM light will begin to flash, and the check engine light will be illuminated. The audible warning in the chassis cab will also sound to match the LIM light.

180 minutes after early inducement begins, the engine will be at final inducement and will produce 20% of maximum torque at 1000 RPM. At this stage, the engine requires “recommissioning” by an authorized engine dealer.
The 3 types of problems listed in the previous slides (Ad Blue level, Ad Blue quality, and tampering) can be corrected (self heal) as long as the initial problem is addressed before the beginning of final inducement. Once final inducement begins, the ability to self heal ends. Only a proper recommissioning can remove the fault and restore engine operation once final inducement starts.

When the system “self heals” after one of the trigger items is corrected before final inducement, normal engine operation is returned. As long as a new trigger does not occur, the engine will perform as full power.

In cases where the original problem is corrected before final inducement and the system self heals, a timing event begins to watch for a repeat trigger. The time allowed for no repeat of the failure is 40 hours of engine running time. If a repeat trigger (low Ad Blue for example) occurs within the 40 hour time limit, the times allowed for each step of the inducement process will be reduced in half. A 3rd repeat trigger will reduce the time by half again.
Anytime an inducement situation begins, use of the ignition switch can affect the inducement cycle and times.

The system records the time when an event occurs that can start inducement. Engine on/off cycle is considered a completed event and the timer restarts on engine start.

If the key is switched off then back on, the system records this as a complete cycle and reduces the remaining time by half on inducement on machine restart. The system considers this a “second offense” within the 40 hour grace period from the initial event.

As an example if you are in early inducement for low DEF level and switch the key off then restart the engine, your allowable time for early stage inducement is reduced from 30 minutes to 15 minutes. Late stage inducement will be reduced from 90 minutes to 45 minutes.

If you switch the key off and back on again without correcting the problem, the time will be reduced in half again!

If you receive inducement warnings, it is strongly recommended that the machine be moved to a safe place BEFORE turning the key off to avoid shortening the inducement time with the machine in a less than ideal location to be disabled by derate.
The SCR system requires specific maintenance to maintain correct operation. And specific troubleshooting steps in case of a system problem affecting engine operation.

Most maintenance is a customer requirement. Limited maintenance needs to be performed by the GRADALL dealer or MTU dealer.

**Daily:**

- Drain air tanks to see if any moisture or oil is in the air system. It is recommended that the air be drained first thing in the morning. If air is drained at the end of the work day, the operator must shut the machine down at governor cutoff (120 psi) and wait for more than 5 full minutes to allow the purge cycle to be complete before draining any air from the system.

- Check Ad Blue level in the tank before the start of the work shift. It is good practice to fill the Ad Blue tank at the same time fuel is added to the fuel tank. Use only containers approved for DEF/Ad Blue when filling the tank. If in doubt about the container, DO NOT USE the container.

- Verify the Ad Blue cap is installed. Never run the machine with the Ad Blue cap loose or missing.

- Check air filter condition indicator at the outlet of the air cleaner.

- Verify air system builds pressure correctly to governor cutoff (120 PSI nominal), air dryer purge valve cycles correctly as air governor cuts off, and air system is able to maintain air pressure.

- Never turn battery disconnect off at the end of the work day until the purge cycle is complete – 5 full minutes after engine shutdown.

**Weekly:**

- Drain ping tank drain valve to clear any accumulated moisture. It is recommended the ping tank be drained before the first start of the machine.

**Each Oil Change – 500 hrs.**

- Check/tighten all clamps on air intake piping between air filter, charge air cooler (CAC), and engine.

- Change Ad Blue pump filter (GRADALL P/N 80884008)

**Yearly, 1500 hours, whichever comes first.**

- Check Ad Blue pump bladder pressure
Troubleshooting

Troubleshooting of the SCR system requires an understanding of the SCR system operation and identifying the failure mode. In most cases, fault codes will need to be retrieved from the engine ECU (MR, SCR frame module). A diagnostic plug is provided in the cab to allow connection of an up to date Mercedes Benz “Mini Diag” diagnostic tool to the machine to retrieve codes. All active and inactive fault codes must be retrieved and recorded for use during troubleshooting.

Mercedes Diagnostic Connector

Diagnostic connectors located under chassis dash panel.

A few simple checks that should always be performed with an SCR problem is to check the Ad Blue tank for physical level and not rely solely on the sensor/DEF gauge for level. Also check for contamination with diesel fuel. Remove the cap and smell the tank. If the smell of diesel fuel is present, the system has suffered serious damage and requires complete replacement to restore operation! This type of failure is not covered by any warranty.

Test strips are also available (GRADALL P/N 80784200) to test the quality and purity of the Ad Blue.
Fault Codes

T4i _ SCR FAULT CODE LISTING

code memory fault path 01 CAN connection (low speed)

<table>
<thead>
<tr>
<th>code</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0100</td>
<td>CAN-high defect</td>
</tr>
<tr>
<td>0101</td>
<td>CAN-low defect</td>
</tr>
<tr>
<td>0102</td>
<td>CAN data not plausible</td>
</tr>
<tr>
<td>0104</td>
<td>no connection to CAN</td>
</tr>
<tr>
<td>0149</td>
<td>CAN parameter setting fault</td>
</tr>
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</table>

code memory fault path 02 CAN connection (high speed)

<table>
<thead>
<tr>
<th>code</th>
<th>description</th>
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</thead>
<tbody>
<tr>
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<td>no connection to CAN</td>
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</tbody>
</table>

code memory fault path 03 crankshaft sensor

<table>
<thead>
<tr>
<th>code</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0308</td>
<td>shortened to ground</td>
</tr>
<tr>
<td>0309</td>
<td>interruption</td>
</tr>
<tr>
<td>0310</td>
<td>signal level to low</td>
</tr>
<tr>
<td>0311</td>
<td>not plausible with camshaft sensor</td>
</tr>
<tr>
<td>0312</td>
<td>crankshaft signal time out</td>
</tr>
<tr>
<td>0313</td>
<td>sensor connector mixed up</td>
</tr>
</tbody>
</table>

An example of the fault codes are shown. Anytime a fault code is noted by the system, it is either an active fault (current) or an inactive fault (historical). Before any fault codes are deleted, each fault code should be written down along with any supporting information from the MR history file.

Use of the fault codes will isolate the component causing the fault. Understanding of the system operation will help determine if the actual component is causing a fault or is it being caused by other components.

The full fault code list can be found on the T4i GRADALL website.
The air system must work correctly to power the operation of the SCR system. If the air system does not reach governor cutoff setting, does not maintain proper air system pressure, or is contaminated, the SCR system will fault due to low air pressure or contaminated SCR components.

As part of the routine air tank drain maintenance, the operator should note any water or oil that may be expelled. If water or oil is present in the air system, the machine should be checked for cause and corrected.

The air compressor should be able to build air pressure from no pressure to governor cutoff at idle in 4 – 5 minutes. Excess time to build pressure may indicate supply side leaks (compressor to air dryer to tanks), leaks in the signal lines to the air governor, failed air governor, or compressor problems.

With engine running and no other functions activated, air pressure will drop from governor cutoff to governor cut in on a regular basis due to air being used by the SCR system. As long as this cycle is not excessively short (less than 5 minutes), the system is working normally. If the cut off/cut in cycle is short, or the air system never reaches cutoff, air leaks exist in the system – air lines, air dryer purge valve, air valves, etc are allowing excess air to escape and must be corrected.

If the air system functions correctly and is not contaminated, install an air pressure gauge at the outlet of the 3/2 valve (P/N 80783222) on the right hand side of the machine near the DEF tank. With the air system at normal operating pressure (100 – 125 psi), the 3/2 valve must be able to maintain a constant 80 – 85 PSI output pressure to the SCR system. If the 3/2 valve pressure is incorrect, the 3/2 valve should be checked for contamination in the inlet and outlet port. If contamination is found, the source of the contamination must be determined and corrected. The 3/2 valve will also require replacement if it is contaminated.
Always do a physical check of DEF level when a machine has a problem with the DEF system! If the gauge is inaccurate due to a level sender or wiring problem, the system will still go into inducement since the system is receiving a signal the DEF level is low.

The DEF level sender should read $\approx 19800 \, \Omega$ when the sender float is at the full upper stop, $\approx 2030 \, \Omega$ at the mid point (10½”, 267 mm from bottom of sender), and $\approx 240 \, \Omega$ at the low stop. The float should move smoothly, the resistance reading should change consistently as the float is moved through the range of travel. If removing the sender for service, the o-ring must be replaced under the sender.

If condition of the DEF is suspect, remove the DEF tank cap (engine MUST be off) and smell the fluid. If the fluid has a smell like diesel fuel, gasoline, or oil, the tank has been contaminated. If the engine has been run with contaminated fluid, the SCR system will require every component be replaced as serious damage to the SCR components will occur if the DEF is contaminated by diesel fuel or any other petroleum based fluid.

If the DEF is of incorrect quality due to dilution with water or use of incorrect urea based fluid, it will be necessary to remove the DEF tank to drain the tank and flush it with warm water. All lines will need to be flushed or replaced as well.

Remember, only automotive grade Ad Blue (DEF) is to be used in the system. Use of any other type of fluid may cause engine derate and possible system damage.

Test strips to check the quality of the DEF are available from the engine dealer or GRADALL as part number 80784200.
Incorrect handling and storage of DEF may result in damage to the emissions components and possible loss of warranty coverage of emissions components and/or engine due to damage.

If the DEF becomes contaminated or degraded in any way, damage will occur to the SCR components. Repair may not be covered under warranty if the failure was due to improper storage or handling of the DEF.

Damage may occur due to improper storage or handling containers.

Due to the purity requirements for proper SCR operation, DEF should never be made out of locally available material. The DEF should also never be mixed with water or other urea based fluid of unknown purity.

DEF freezes at 12°F (-11°C). With DEF using the correct 32.5% solution, both the urea and water will begin to freeze at the same point. No additives should be added to the DEF tank to affect the freezing point as the purity of the DEF will be affected by the additives.

DEF should be stored in a cool, dry place out of direct sunlight. If the DEF is stored at temperatures below 77°F (25°C), it will have a shelf life of 1 year. If stored in temperatures above 95°F (35°C), shelf life is reduced to 6 months. Containers of automotive grade DEF will have a date code on the container. DEF containers should be used oldest first to avoid having DEF that is possibly degraded.

DEF should only be stored in approved containers. DEF should never be stored in any container that has contained any other material.

DEF containers should be made out of approved alloy steel, approved plastic containers, or approved plastic coated metal containers. DEF should never be stored in non alloy steel, aluminum, copper, copper alloy, or zinc coated steel containers.

DEF should only be transferred from bulk storage containers directly to the machine using pumps and hoses that are approved for handling Ad Blue. If in doubt, don’t use the pumps, hoses, or DEF from a bulk container.

Only automotive quality DEF should be put into the DEF tank, no other fluid, compound, or solid should ever be put into the DEF tank. If anything other than automotive quality DEF is introduced into the DEF tank, the machine should not be run until the tank is removed and replaced. Cleaning the tank is not recommended and should not be attempted.

If the machine is run with anything other than automotive grade DEF in the tank, the entire SCR system will require replacement due to damage from contaminated DEF in the tank. A contaminated SCR system can not be adequately cleaned and only replacement will provide correct SCR operation.

The machine should never be run or stored with the DEF tank cap missing.

It is strongly recommended that DEF only be added to the machine from an approved bulk tank at a truck stop or fuel station. If a bulk tank at an approved fueling station is not available, the use of 2.5 gallon container available from fuel stations, auto parts stores, fuel suppliers, etc be used to fill the DEF tank.
It is good practice to have a fresh 2.5 gallon container of Ad Blue with the machine at all times. This container should be used weekly during normal fill up of the DEF tank and be replaced by a fresh container.

Never mix partial containers of DEF! Contact your DEF supplier for proper disposal procedures of partial containers.

It is good practice to fill the DEF tank any time you add fuel to the machine. Never allow fuel into the DEF tank or allow Ad Blue to get into the fuel tank! If either tank gets contaminated with fluid inadvertently, Do not start the machine! The contaminated tank must be removed and replaced before you can start the engine to avoid damage.

If the DEF equipment looks like this, DON’T use it!
This specific code indicates a failure of the SCR CAN bus system between the engine and the SCR frame module. The failure can be due to a loose connector at the engine MR, SCR frame module, or chassis wiring harness to engine harness, a loose or damaged terminal within one of the connectors, or resistors that have broken or shorted within the harness.

Remove the connector from the SCR Frame Module under the cover at the front of the cab (see slide #25) and the small connector at the engine MR controller (see slide #26). The SCR CAN bus circuit is located in the 2 connectors. A resistance check across the SCR CAN bus circuit will check for acceptable resistance and for an open circuit. Testing of the terminals in these connectors requires that a volt ohm meter be used with test probes no more than .030" in diameter. Use of larger probes will damage the terminals!

The SCR CAN circuit should have a steady ≈ 60Ω due to the 2 - 120Ω resistors located in the harnesses near each connector. If the circuit has ≈120Ω, one of the terminating resistors has failed. You should also move the harness end near the connector to see if there is a change in the resistance reading. If a change occurs, you may have a broken resistor that needs to be replaced. An open circuit will need to be traced to find the break in the CAN bus circuit and corrected.

To simplify finding which resistor is failing or the open circuit, disconnect the engine to chassis harness at the RH side frame rail. Pins “U” & “W” are SCR CAN bus wires. Do the resistance check between the chassis harness side of the connector and SCR frame module connector and engine harness connector to MR engine connector to isolate the failing resistor or the open connection in the harness.
SCR CAN Bus Resistor Repair

The resistor in the chassis harness for the SCR CAN bus is located approximately 14” behind the SCR Frame Module connector. Carefully cut open the loom avoiding damaging any wires to find the resistor. The replacement resistor is GRADALL P/N 80784176 (120Ω 1W resistor). The resistor must be carefully installed in the harness and heat shrink used to protect the leads. Carefully wrap and tie wrap the loom back around the harness.

The resistor in the engine harness is located 5” from the 16 pin MR connector. The resistor is the same part number as used in the chassis harness and the same repair procedure must be followed.

For open circuits you will need to do a resistance check of each wire and terminal to determine the cause of the open circuit. If the circuit shows open, look for terminals not seated in the connectors.

If the resistors and CAN bus circuit are ok, you will need to contact the MTU dealer as the problem may be something other than the wiring harnesses.
“1.42.19” indicates the SCR dosing unit air section is blocked. This code frequently has codes “1.42.20 - SCR dosing unit, pressure duct is blocked / dirty” and “1.42.69 – Euromat 3b-T4i: Tampering” either active or stored in the system.

In most cases, the dosing unit needs a complete cleaning or replacement. In some cases, the heater/diffuser may need to be replaced. The lines and inlet screen to the dosing unit should be checked as well.

Output of the 3/2 valve should also be checked when code 1.42.19 is present (see page #30). Also check air system to see if oil or water is present in the air tanks.

It is possible an interrupted purge cycle may cause blockage of the dosing unit. The operator and customer personnel should understand the purge cycle. Verify the customer is not turning off the battery disconnect switch or draining the air tanks until the purge cycle is complete after engine shutdown – more than 5 full minutes after shutdown!
“Tampering” code, “1.42.69 – Euromat 3b-T4i Tampering” is intended to address issues involving accidental or deliberate disconnect of the SCR system components during operation. In actual practice, the tampering code and inducement may also occur due to blockage from crystallization within the dosing unit, lines, and nozzle. Issues with wiring, connectors, and components may allow a tampering code (1.42.69) to be stored in the system as well.

The following items are listed as the cause of a “tampering” code:

- Disconnected tank level sensor
- Disconnected Ad Blue dosing line or valve
- Blocked Ad Blue dosing line or valve
- Disconnected Ad Blue pump wiring connector
- Disconnected SCR wiring harness
- Disconnected NOx sensor module
- Disconnected Ad Blue temperature sensor
- Disconnected exhaust temperature sensor(s).

Since this code frequently accompanies other codes, particularly “1.42.19, 1.42.20”, The MTU dealer needs to pay particular attention to the air chamber of the dosing unit for blockage.

If this code shows up from time to time as a historical or stored code, wiring connections needs to be checked at the catalyst area (NOx module & temperature probe connectors), AdBlue pump wiring, level sensor wiring, and connections between the engine and chassis harness. Other sensors are connected by the MTU wiring harness and should be checked by an authorized MTU dealer. Be very careful with probe sizes when checking terminals as a number of terminals are small and will be damaged by using standard VOM probes.

This code may also triggered by removing the cap on the AdBlue tank when the engine is running, low air system pressure, low DEF level in the tank, or plugged AdBlue pump filter.

Please see page 51 for additional “Tampering Code” information.
“Tampering” code, “1.42.69 – Euromat 3b-T4i Tampering” is a code that is supposed to become active during engine start up.

- When the engine is started, a sequence of 50 signals are sent from the MR2 to the ADM. The ADM must acknowledge the 50 signals.
- The signal routine lasts about 50 seconds after engine start.
- If the signal routine is disrupted during the 50 seconds, the routine is repeated up to 3 times over a 180 second span.
- If after 3 times/180 seconds of disrupted or incorrect response to the signals, the “Tampering” code is logged as active.

There is some evidence that a tampering code can be generated by corrupted DEF level sender signals. A corrupted signal can be caused by terminals not being fully seated in connectors, damaged terminals within connectors, connectors that are not fully connected, or damaged wiring.

When a “Tampering” code is present, it should not automatically be assumed the customer is at fault, unless one of the components listed on page 50 is found disconnected.
“1.68.20 – SCR pressure too high” results from blockage within the dosing unit mixing chamber, tube, or nozzle. Complete cleaning or replacement is required by the MTU dealer to correct the problem.
Code X.29.71 – NOx threshold 1 exceeded

“X.29.71 – NOx threshold 1” exceeded frequently also has codes “X.29.72 – NOx threshold 2 exceeded” and “X.42.48 – NOx emissions: AdBlue quality/minimum dose” either active or stored as inactive/historical code. When the NOx levels are incorrect, the system will either consider it an AdBlue quality or dose volume problem. The customer should always be questioned about the AdBlue type they are using along with the amount they have historically been using per day.

Code X.29.71 indicates the NOx is greater than 500 PPM. The software will try additional dosing to correct the problem. If code X.29.72 is shown, the NOx has exceeded 1000 PPM and additional dosing has not corrected the problem.

The MTU dealer should also do an actual dosing volume check. This requires the Mini Diag to be connected to the machine to measure dosing volume while running under a load.

The interaction of inlet exhaust temperature, outlet exhaust temperature, and internal NOx measurement determine the correct operation of the system and emissions level.

This series of codes tend to have a number of issues that cause the code to be generated. Just replacing the NOx sensor or temperature sensors rarely corrects these codes. Air leakage between 3/2 valve to dosing unit, catalyst problems, blockage of the nozzle or line between dosing unit & turbo outlet, low air system pressure, incorrect/contaminated AdBlue fluid, and engine health can all lead to these codes.
**Code – 1.69.95 – SCR system General EGA switch off**

This code will be found inactive after the engine has been recommissioned from a prior derate. No action is needed when this code is found as an inactive code. It is ok to clear the code.
Engine Condition

Condition of the engine will also affect the SCR system operation. If the engine “health” is compromised in anyway, the SCR system may detect an engine that is not running correctly and begin to produce codes indicating an SCR system problem.

Always inquire about oil consumption. If excess oil consumption is reported, remove the crankcase breather hose between the engine and air intake and check for oil.

Remove the steel air intake pipe between the turbocharger outlet and charge air cooler on the RH side of the engine. Check for oil in the intake piping. Also check tail pipe for soot buildup. An engine running correctly will not have any soot in the tail pipe.

Check engine oil level. Note if oil appears “milky” indicating water or coolant in the oil.

The engine dealer needs to check the cylinder balance and cylinder compression when running. It may be necessary to do a physical compression check of each cylinder. The engine dealer needs to determine based upon their findings if further repair is required.

The engine dealer also needs to check fueling of each cylinder with the engine running to determine condition of the injectors and transfer tubes.

All air intake and exhaust plumbing should be checked for tight clamps, leaks, etc. Correct any issue found.
Thank you for reviewing the GRADALL SCR System Operation training! Please contact your regional product support manager for additional assistance.