



LON1 Phase B Environmental Permit Variation Application

Best Available Techniques and Operating Techniques Assessment, LON1 Phase B

NTT Global Data Centers EMEA Limited

Prepared by:

SLR Consulting Limited

Floor 3, 86 Princess Street, Manchester, M1 6NG

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Basis of Report

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1.0 Introduction

SLR Consulting Limited (SLR) has been instructed by NTT Global Data Centers EMEA Limited (via RED Engineering Design Limited) to prepare an Environmental Permit (EP) variation application (EP reference EPR/CP3902LV) for the NTT Global Data Centers EMEA Limited owned data centre facility (LON1), which is operated by NTT Global Data Centers EMEA UK Limited (NTT). LON1 is located on Yewtree Avenue, Dagenham, UK, RM10 7FZ.

Electricity for operation of the data centre is provided from connections to the national electricity transmission network; however, given the nature of data centres and their requirement to have an available electricity supply at all times, the data centre also incorporates a number of emergency stand-by generators (SBGs).

The EP currently permits a total of 42 SBGs, each SBG having a thermal rated input of 4.1MWth; the aggregated total combustion capacity being 172.2MWth. The SBGs are to be installed in phases:

- **Current EP activities (based on the initial EP application):** The initial EP application related to Phase A of the LON1 development (LON1A). Of the 42 permitted SBGs (as stated in the EP), to date 12 have been installed (generator model SDMO KD1800). The installation of the remaining SBGs (up to a maximum of 28 SBGs) will be completed as required, based on customer demands.
- **EP Variation (submitted March 2023):** An EP variation relating to a change in the number, model and capacity of the remaining 28 SBGs to be installed in LON1A was submitted to the Environment Agency (EA) in March 2023 (SLR project reference 410.V62278.00001). The EP variation application related to NTT's intention to now install 16 larger SBGs to that which was applied for in the initial EP application; NTT intends to install 16 Kohler KD83V16 SBGs, each being 6.947MWth. The 16 SBGs will be installed in two phases, 9 SBGs initially, followed by the remaining 7 SBGs. This variation application has yet to be determined by the EA.
- **Current EP variation application:** This current EP variation application (SLR project reference 410.V61547.00001) relates to Phase B of the LON1 data centre development (LON1B). LON1B will involve the construction of a new data centre building located to the south LON1A, and the installation of 24 new SBGs within this building (with 22 IT SBGs having a thermal rated input of 7.6MWth and 2 house SBGs with a thermal rated input of 3.8MWth). The SBGs will be fuel by hydrogenated vegetable oil (HVO), with Selective Catalytic Reduction (SCR) abatement installed on the SBGs to reduce emissions of oxides of nitrogen (NO_x) to atmosphere (each SCR abatement system will be powered by the SBG it serves). It should be noted that if HVO is not available then the SBGs will be operated on diesel.

The SBGs will provide power to the data centre in the event of an emergency situation such as a brown- or black-out of the national electricity transmission network where there are fluctuations or loss of the electrical power provided by the network. On occurrence of such an event, there is the potential for a delay between fault detection and initial operation of the SBGs; on-site battery arrays will provide a temporary uninterruptible power supply in order to cover such delays and the potential for a loss/reduction in the power supply to the on-site equipment.

Based on the proposed changes, the aggregated total combustion capacity for the site will now be 335.15MWth as summarised below:

- 12 x KD1800 SBGs - 49.2MWth (already installed in LON1A);



- 16 x KD83V16 SBGs - 111.15MWth (proposed for LON1A (phases 2 and 3)); and
- 22 x MTU model DS3600 SBGs (IT SBGs) – 167.2MWth (proposed for LON1B)
- 2 x MTU model DS1650 SBGs (house SBGs) – 7.6MWth (Proposed for LON1B)

This Best Available Techniques and Operating Techniques (BATOT) document is submitted on behalf of NTT, the operator, to support the application for a variation to the issued EP for the data centre. This report is an integrated document which describes both the operating techniques that are implemented at the facility with respect to operation of the SBGs to ensure compliance with the conditions of the EP, and also demonstrates that BAT will be employed.

For the purpose of this BATOT, key technical standards in the following documents have been referenced:

- Develop a management system: environmental permits guidance, 03 April 2023;
- Risk assessments for your environmental permit guidance, 31 August 2022;
- Emergency backup diesel engines on installations: best available techniques (BAT), 23 August 2023;
- Best Available Techniques: environmental permits, February 2016;
- Data Centre FAQ, Draft Version 21.0 to TechUK for Discussion 15/11/22; and
- Specified generator: comply with permit conditions, 28 December 2022.

2.0 Regulated Activities

The LON1 data centre will comprise in total a thermal input of 335.15MWth (52 SBGs). Testing of the SBGs (either routinely or following maintenance) will be undertaken at up to 100% of full load.

This application (including the associated modelling studies and risk assessments) has been prepared on the basis of the proposed additional SBGs to be installed in LON1B (22 x MTU model DS3600 and 2 x MTU model DS1650 (house SBGs)).

2.1 Schedule 1 Activities

Combustion activities that require an EP are defined in Part 2, Schedule 1 of the Environmental Permitting (England and Wales) Regulations 2016 (as amended) (EP Regulations):

- Section 1.1 Part A(1)(a) burning any fuel in an appliance with a rated thermal input of 50 or more megawatts.

The EP Regulations clarify that:

“...where two or more appliances with an aggregate rated thermal input of 50 or more megawatts are operated on the same site by the same operator, those appliances must be treated as a single appliance with a rated thermal input of 50 or more megawatts.”

The LON1 data centre currently exceeds 50MWth and is therefore a Section 1.1 Part A(1)(a) combustion activity in accordance with the EP Regulations. Based on the proposed change in number of SBGs, the total number of SBGs for the data centre will now be 52. The SBG provision includes for a level of redundancy to the SBG system such that, even in a worst-case blackout scenario, only the required number of SBGs would start up to deliver the required electricity IT load for the data centre; the number of operational SBGs at the time of a blackout would be dependent on the extent of the blackout. However, it is noted that,



without specific physical controls preventing operation of an SBG, that the thermal input of all SBGs is required for determining the capacity of the site. Therefore, the capacity of the LON1 data centre in total will be 335.15MWth based on:

- 49.2MWth (12 x KD1800 SBGs (already installed in LON1A);
- 111.15MWth (16 x KDKD83V16 proposed LON1A phase 2 and 3 SBGs); and
- 174.8MWth (22 x MTU model DS3600 SBGs and 2 x MTU model DS1650 house SBGs).

2.2 Stationary Technical Unit (STU)

The definition of a STU is not included in the EP Regulations. However, the EA 'RGN 2 Understanding the meaning of regulated facility' (April 2019) states:

"The essence of a "technical unit" is that it can carry out the Activity, or Activities, on its own. This means that the technical unit must include enough plant and machinery to allow the Activity to take place in a controlled manner for a sufficient period of time for the operation to reach its designed or intended output."

Each SBG could be considered as an STU (for the purposes of combusting fuel) however, in accordance with A2.5 of RGN 2:

"If there are two or more STUs on the same site they will be treated as a single STU if they are technically connected and one of the following criteria is met:

- a) they carry out successive steps in an integrated industrial activity;*
- b) one of the listed activities is a Directly Associated Activity (DAA) of the other; or*
- c) both units are served by the same DAA."*

In the event of a worst-case blackout scenario of the national electricity transmission system, potentially all the SBGs in the data centre will be operated to deliver the required IT load. In the event of operational redundancy in case of engine failures or SBGs under maintenance, the remaining SBGs will be operated to the required load, but this can only be identified at that time. Therefore, the operation (under emergency) of individual SBGs is linked to the 'availability' of other engines and all SBGs in the data centre are thus considered to be technically connected.

Fuel storage for the SBGs, the SCR abatement systems and associated AdBlue storage (AdBlue will be used in the abatement systems) are considered to be a directly associated activity (DAA). Discussions of the DAA (abatement systems, AdBlue storage and fuel oil storage) at the site are provided in later in this document.

2.3 Directly Associated Activities

Schedule 1, Part 1 Regulation 2(1) of the EP Regulations provides that a DAA is an operation that, in relation to any other activity:

- Has a technical connection with the activity;
- Is carried out on the same site as the activity; and
- Could have an effect on pollution.

As stated in A2.19 of RGN 2, a DAA must "serve" a STU. Therefore, a DAA will normally be something that would not be in place if the STU was not present on-site. A2.22 continues that there are four types of technical connection with a STU including "...input activities concerned with the storage and treatment of inputs into the stationary technical unit."

A2.11 of RGN 2 states:



“Storage facilities may be technically connected. [...] Stores at the same location are normally technically connected, and as their operation can give rise to pollution, either locally or at the Activity, they are likely to be DAAs.”

In addition to the above, it must also be clear how a DAA may affect emissions from the Installation. Incorrect storage of a raw material/fuel could cause off-site releases of these substances.

Therefore, the generator SCR abatement systems, storage of fuel for the SBGs (HVO and potentially diesel) and storage of AdBlue at LON1B associated with the proposed 24 SBGs is considered to be DAAs of the ‘combustion’ STU for the data centre.

3.0 Data Centre Location

The LON1 data centre site, centred at NGR TQ 50944 85355, is located in Londoneast-UK Business & Technological Park which is accessed via Yewtree Avenue, Dagenham, RM10 7FZ.

The immediate surrounding area is predominantly open land to the north, east and south, with mixed industrial and commercial developments to the west. A summary of the immediate environmental site setting is provided in Table 3-1.

Table 3-1 Environmental Site Setting

Boundary	Description
North	Sports fields, open land and Eastbrookend Country Park and lakes.
East	A lake, The Chase Nature Reserve and Beam River.
South	A railway line, Beam Valley Country Park, lake and residential properties.
West	Mixed industrial and commercial properties and residential properties.

The immediate surrounding land use is described in detail below.

Residential properties are located to the south and west of the site, and further afield to the east beyond The Chase Nature Reserve. The nearest residential properties to the site are located approximately 336m to the south and 450m to the west. Arcus Academy training centre is located approximately 40m west of the site.

There are no European or Internationally designated sites (i.e. Ramsar Sites, Special Areas of Conservation and Special Protection Areas) within 10km of the data centre site.

There are numerous national sites of ecological importance located within 2km of the site’s boundary. The sites are shown on Drawings 004A Local Receptors and 004B Natural and Cultural Heritage.

Five Local Nature Reserves (LNR) are located within 2km of the site’s boundary, with the closest three being:

- Beam Valley LNR, approximately 96m south;
- The Chase LNR, approximately 200m east;
- Eastbrookend Country Park LNR, approximately 200m north;

Eleven Local Wildlife Sites (LWS) are located within 2km of the site’s boundary, with the closest three being:

- Beam Valley LWS, approximately 96m south;
- The Chase and Eastbrookend Country Park LWS, approximately 100m north;
- Mid Beam in Havering LWS, approximately 450m southeast;



Searches on the MAGIC map confirmed none of the following are present within a 2km radius of the site:

- National Nature Reserves;
- Areas of Outstanding National Beauty;
- Sites of Special Scientific Interest;
- Biosphere Reserves; and
- Ancient Woodland.

With respect to cultural heritage, there are several listed buildings within a 2km radius of the site to the north, east, south and west. The closest Grade II listed building is Canteen at Head Office of Rhone Poulenc Limited which is located approximately 230m west of the site. The closest Grade II* listed building is Bretons which is located approximately 710m southeast of the site. All listed buildings within 2km of the site are illustrated on Drawing 004A Local Receptors.

Searches on the MAGIC Map confirmed that none of the following are present within a 2km radius of the site:

- Registered Parks and Gardens;
- Registered Battlefields;
- World Heritage Sites; and
- Scheduled Monuments.

The following drawings accompany this application for an Environmental Permit for the site:

- Drawing 001 – Site Location;
- Drawing 002 – Site Layout and Emission Points;
- Drawings 003 – Environmental Permit Boundary; and
- Drawings 4A and 4B – Local Receptors and Natural and Cultural Heritage respectively.

4.0 Dagenham Data Centre

Development of the data centre site will be phased. Phase LON1A of the data centre site currently consists of one data centre building and will incorporate in total 28 diesel-fired SBGs located externally adjacent to the south of this building.

Phase LON1B, which this current EP variation application relates to, will involve the development of a second data centre building, LON1B, which will incorporate 24 SBGs. The generating capacity of the LON1B SBGs is summarised in Table 4-1.

Table 4-1 LON1B SBG Generating Capacity

LON1B Generator Reference	SBG Model	Thermal Rated Input per SBG (MWth)
GEN-01-HA GEN-01-HB	MTU model DS1650	3.8
GEN-01-C1/1 GEN-01-C1/2 GEN-01-C1/3 GEN-01-C6/1 GEN-01-C6/2	MTU model DS3600	7.6



LON1B Generator Reference	SBG Model	Thermal Rated Input per SBG (MWth)
GEN-01-C6/3		
GEN-01-C2/1		
GEN-01-C2/2		
GEN-01-C2/3		
GEN-01-C2/4		
GEN-01-C5/1		
GEN-01-C5/2		
GEN-01-C5/3		
GEN-01-C5/4		
GEN-01-C3/1		
GEN-01-C3/2		
GEN-01-C3/3		
GEN-01-C3/4		
GEN-01-C4/1		
GEN-01-C4/2		
GEN-01-C4/3		
GEN-01-C4/4		
Total (24 SBGs)		174.80

4.1 Diesel Firewater Sprinkler Pumps

Two diesel-fired firewater sprinkler pumps will be installed at LON1B. Each sprinkler pump will have a thermal rated input of 0.206MWth. As the thermal rated input of the proposed pumps is less than 1MWth these will not require permitting as MCP and are therefore not considered further in this EP variation application. However, on the basis of cumulative impacts, the combustion emissions from these two pumps have been considered in the air emissions risk assessment (AERA) submitted with this EP variation application.

4.2 Staffing

The LON1 data centre operates 24 hours 365 days a year. The LON1 data centre (LON1A and LON1B) will have the following employees (these figures are approximate):

- Up to 30 staff; and
- Minimum of circa 6 staff (comprising security and facilities management personnel) on site.

4.3 SBG Selection and Resilience Configuration

The LON1B data centre comprises of a number of customer suites. The data centre has been designed to ensure the maximum number of SBGs per data centre suite are installed to service potential clients and to ensure resilience.



For LON1B, a smaller number of larger SBGs will be installed. The SBGs have been selected based on the customer demand electrical load for each customer suite. This approach ensures that:

- The SBGs are operated at their optimal design capacity, as operating SBG sets at low loads (i.e. underloading) for extended periods of time can potentially impact uptime and engine life; and
- That only the necessary minimum number of SBGs will be operated to deliver the required electrical load for each suite, this allows for the required number of SBGs to be run dependant on the failure/emergency scenario. In the event of a reduction in electrical power delivered from the National Grid, the power monitoring and management system (PMS) would automatically start-up the minimum number of SBGs necessary to service the customer suites.
- This approach will result in the reduced consumption of fuel and hence generation of less emissions to air from the SBGs.
- As part of the annual maintenance programme, testing of the SBGs throughout the year for short periods of time is required. To minimise the mass emission rate to air of combustion emissions and potential adverse impacts on air quality, NTT will test the LON1B SBGs individually (i.e. one SBG tested at a time). It should be noted that LON1A and LON1B may have separate tenants who have different testing requirements, therefore it is possible that the SBGs in LON1A and LON1B are potentially tested in parallel, however NTT will seek to minimise such occurrences, where possible. NTT recognises that the installation of a smaller number of larger SBGs may potentially result in a greater mass emission rate of combustion pollutants to air at any one time from larger SBGs during testing and maintenance, however to minimise emissions to air NTT will seek to minimise the planned maintenance and testing hours of the LON1B SBGs, where possible (refer to Section 6.0 for details). Additionally, NTT will install SCR abatement on each of the SBGs to minimise emissions of oxides of nitrogen (NO_x) to air.

The LON1B MTU model SBG manufacturer specification for both MTU SBG models, states these engines are emissions optimised EPA Tier 2 compliant. As stated in the EA Data centre FAQ, Tier II USEPA is the minimum appropriate for new SBGs. The manufacturer specifications for the MTU models are presented in Appendix A.

The Data Centre FAQ also requires NO_x emissions for new SBGs to not exceed 2,000mg/m³. The proposed larger MTU DS3600 model SBGs, even though Tier II USEPA compliant, do exceed this emission threshold when operating at loads of approximately 75% and greater (refer to the SBG manufacturer specifications provided in Appendix A for details on emissions). To ensure that this emission threshold is not exceeded, NTT will install SCR abatement on each of the 24 SBGs, which will reduce NO_x emissions below 2,000mg/m³, the SCR abatement will be designed to reduce NO_x emissions to meet the MCPD emission limit for NO_x (190mg/m³ @ 15% oxygen). The SBGs are therefore considered to be compliant with BAT.

The resilience configuration of the SBGs providing for the electrical load demand of a site (i.e. the data centre building and installed IT equipment) is referred to using 'N', where 'N' is the specified MWe rate delivered by a SBG unit. The EA Data centre FAQ states that 2N is the exemplar (i.e. twice as many SBGs as required are installed).

The LON1B SBG configuration for the data centre will be in an N+1 arrangement per LON1B data hall with a total of 22 SBGs; the two SBGs provided for the House Systems will be in a 2N, arrangement. The N+1 configuration (i.e. an additional SBG added to support a single SBG failure or required maintenance) and 2N, configuration (i.e. 1 duty & 1 standby SBG in



the event of failure or required maintenance of the other House SBG) allows for a level of redundancy to the SBG system such that, even in a worse case blackout scenario, only the required number of SBGs needed to meet the electrical load demand would be run; the operational capacity of the SBGs at the time of a blackout would be dependent on the extent of blackout. Furthermore, in the event of failure of an SBG, the correct number of remaining SBGs will in an emergency event provide the required load. The N+1 and N+N configurations offer resilience and minimises the risk of disruption in service to the data centre's clients.

As is the case for the existing permitted SBGs, the proposed SBGs will be automated via the BMS. In the event of a reduction in electrical power delivered from the National Grid, the BMS would automatically start-up the required number of SBGs necessary to service the customer suites; this configuration allows for the required number of SBGs to be run dependant on the failure scenario. This results in the reduced consumption of fuel and hence generation of less emissions to air from the SBGs.

4.3.1 SCR Abatement

Each of the proposed 24 SBGs will be supplied with SCR abatement to reduce NO_x emissions generated as a result of the combustion of fuel; the SCR abatement is designed to reduce NO_x emissions to meet the MCPD emission limit for NO_x (190mg/m³ @ 15% oxygen).

The SCR abatement system has yet to be selected; NTT will confirm to the EA the SCR abatement systems once selected.

The SCR abatement system will be located within each of the banded generator rooms in LON1B. Each SCR system will be accompanied by an AdBlue bulk storage tank located in the generator room. NTT will ensure that the storage arrangements for AdBlue will meet BAT.

Each SCR system will be powered by the same Cummins SBG that will be installed within the generator room.

4.4 Reliability Data

The magnitude of risk posed by operation of the SBGs (other than for SBG testing) is strongly linked to the reliability of the provision of electricity from the national transmission network (in addition to the uninterruptable power supply (UPS) arrangements).

LON1B will be designed to provide the maximum reliability of the electrical power supply to the on-site systems that are critical for operation of the site as a data centre. The data centre will be designed to Uptime Institute Tier III standards, ensuring the required level of resilience to ensure maximum uptime for critical IT infrastructure. Note that the building shall not be uptime institute certified.

The electricity supply arrangements for the site remain unchanged to that stated in the initial EP application, in that the arrangements include:

- two 132KV feeds (each being 80MVA) from the National Grid, either of which can serve the 'customer load'.

These supplies are fed direct from a National Grid pylon via a 132KV intake substation; in the event of failure of one feed the remaining feed can provide the required electrical power for the data centre. There have been no black outages at the Dagenham data centre since commencement of operations. In 2023 there have been two outages, both due to voltage spikes, which were very limited in duration and involved the operation of a small number of LON1A SBGs as summarised below:

- 25/11/2023 (duration: 30 minutes (17:37 – 18:07)). The outage resulted in the operation of two SBGs (GEN H-B and GEN 1-2); and



- 19/06/2023 (duration: 14 minutes (07:16 – 07:30)). The outage resulted in the operation of three SBGs (GEN H-A, GEN 6-1 and GEN 6-3).

The UPSs are arrays of batteries that can provide power, almost instantaneously, in the event of a loss of electrical input to the data centre. The LON1B data centre will have battery arrays which will provide sufficient protection to the supply of electrical power for the critical 'customer load' whilst the SBG(s) are started. These arrays provide almost instantaneous power in the event of a loss of electrical input to them, providing sufficient protection to the supply of electrical power to the 'customer load' whilst the SBGs are started.

The site operates its electrical supplies on an automatic basis such that in the event of fluctuations in (or loss of) the electrical supply to the site, where such events could negatively impact operation of the site's data centre function, these are detected and the relevant response (e.g. UPS start-up followed by the start-up of SBGs, if required) is automatically deployed by the data centre BMS.

This infrastructure design provides the required reliability for each customer suite, and the required resilience for the data centre customers. The electricity supply arrangement for the data centre is illustrated in the drawing presented in Appendix B.

4.4.1 Technical Standards

The LON1B data centre will be designed and operated in accordance with the relevant sections of the following key guidance:

- Develop a management system: environmental permits guidance, 03 April 2023;
- Emergency backup diesel engines on installations: best available techniques (BAT), 23 August 2023;
- Best Available Techniques: environmental permits, February 2016; and
- Specified generator: comply with permit conditions, 28 December 2022.

In addition, the LON1B data centre will be operated in accordance with 'Data Centre FAQ, Draft Version 21.0 to TechUK for Discussion 15/11/22' with respect to standby operation. It is noted that this guidance is draft, however, for the purposes of this application, this guidance is considered to represent the current EA position on BAT for data centre back-up generation systems.

Operation of the SBGs (other than for maintenance and testing) will commence in the event that electricity is not available from the national transmission network (e.g. brown- or black-out) or on internal failure of electrical supply (e.g. transformer failure, UPS problem).

The SBGs on-site will also be operated for maintenance and testing purposes. Each SBG will operate for less than 50 hours per annum and will therefore not be subject to the emission limit value (ELV) for NO_x (190mg/kg).

The emissions from the site will be estimated using emissions factors, as discussed in Section 6.0.

4.4.2 Emergency Operation

Emergency operations are taken to include unplanned hours required to come off grid to make emergency repair of electrical infrastructure associated within the data centre itself.

Given the short start-up and shutdown times for diesel engines, the SBGs are regarded, for the purposes of determining operating hours, as commencing operation at the first fuel ignition. This is taken to include the shorter periods of plant 'overlap' when engines provided as redundancy are started as a precautionary measure before final customer load is reached with the optimum/minimum number of SBGs.



The Operator will notify the EA in accordance with the requirements as stated in the EP.

5.0 Operating Regime

5.1 SBG Scheduled Operating Regime

During planned maintenance and testing the proposed LON1B SBGs will each be typically operated for less than 50 hours per year.

The planned testing regime for the SBGs is scheduled to ensure that the impact on air quality as a result of the combustion emissions is minimised. The planned operating regime for the proposed SBGs (i.e. testing regime) at the LON1B data centre is presented in Table 5-1.

Table 5-1 LON1B SBG Testing Regime

Event	Detail	Event Operational Time per LON1B SBG
Monthly on-load testing (60% load)	Each SBG is run for 30 minutes (if the SBG has not run within the month at a minimum of 30% load. Each SBG is tested individually.	30 minutes (per month)
Annual on-load testing (100% load)	Each SBG is run loaded at rated capacity (100%) for minimum of one hour. Each SBG is tested individually.	4 hours (once annually)
Black building testing (75% load)	Each SBG is run loaded at rated capacity (75%) for one hour. All SBGs tested simultaneously.	1 hour (once annually)
Annual UPS Maintenance (75% load)	Each SBG is run loaded at rated capacity (75% load) for 10 hours per UPS with their being 2 UPS's per line up/SBG. Each SBG is tested individually.	20 hours (once annually)
HV maintenance (75% load)	Each SBG is run loaded at rated capacity (75% load). Each SBG is tested individually.	10 hours (once annually)
LON1B operational hours for planned testing per year (per SBG)		41 hours
LON1B operational hours for planned testing per year (all 24 SBGs)		984 hours



The scheduled testing regime for each LON1B SBG will be below the 50-hour testing regime for SBGs which are used purely for a stand-by emergency role as stated in the EA Data centre FAQ.

5.2 Commissioning

5.2.1 SBG Commissioning

The 24 SBGs will following on-site installation, be subject to a period of commissioning.

The commissioning will be undertaken during weekdays between the hours of 08:00-18:00. The commissioning plan has yet to be developed, however it is expected to be very similar to that for the LON1A phase 2 and 3 SBGs, as detailed below; for the purpose of the air emissions modelling, the commissioning model scenario has been based on this commissioning plan.

Testing will be spread out over several days/weeks, but in total will be circa 24 hours. Commissioning times and dates have yet to be decided.

The main commissioning phase will involve the following tests (all at 100% load):

- Initial SBG start-up;
- 12 hour load bank testing; and
- Integrated Systems Test (IST). This phase of commissioning is intended to verify that the emergency and redundant systems will perform appropriately when required.

Generally, one SBG will be tested at a time, however there will also be a building test where up to 5 SBGs at a time will run for a short period of typically no more than 1 hour.

In summary the anticipated commissioning will involve the following for each SBG:

- Temporary load bank: 12 hours;
- Busbars: 5 hours;
- UPS Commissioning: 3 hours;
- SCR Commissioning Programme: 4.5 hours; and
- Integrated systems testing (IST): 2 x 12-hour tests.

A brief overview of the commissioning is provided below.

5.2.1.1 Load bank Testing

A 12-hour load bank test will be performed at a 1.0 Power Factor (PF). The load bank will include the following testing sequences:

- Load Test at 100%.
- Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the SBG.
- Stepped load test with resistive load bank, in immediate succession.
- Verify voltage and frequency steady state operation at 25%, 50%, 75% and 100%.
- Perform all types of generator shutdowns and prove all monitoring points back to the monitoring system.



5.2.1.2 Busbar Testing

- All busbar joints to be torqued.
- At the completion of busduct install ductor test of the whole busbar length.
- Perform infrared scan.

5.2.1.3 UPS Testing

- Perform system heat run on inverter and on static bypass on full rated load.
- Battery discharge test to confirm expected start of life capacity is met.
- Verify input current distortion, output voltage distortion and power factor (50% and 100% loads). UPS efficiency to be verified at 50% and 100% loads only (if not recorded during factory acceptance testing).
- Perform various load steps and record output voltage, current, frequency.
- Perform UPS shutdown at reduced load.
- Perform transfer to maintenance bypass (at 100% load) on both mains and generators.
- Perform all types of UPS shutdowns and prove all monitoring points back to the monitoring system.

5.2.1.4 Integrated Systems Test

The Integrated Systems test will include the following steps:

- Perform data hall loading to 100%– testing at SBG loadings of 0%-25%, 25%-50%, 50%-75%, 75%-100% loads.
- Simulate loss of mains by switching off the upstream medium voltage (MV) circuit breaker(s).
- Fail one generator after cooldown shutdown.
- Simulate further loss of mains by switching off the upstream MV circuit breaker(s).
- Fail redundant cooling units and store once room conditions are stable.
- Perform data hall offloading to 0% in 4 steps (100%-75%-50%-25%-0% loading).

5.2.2 Commissioning of SCR Abatement

On completion of build and all installation works, commissioning procedures will include:

- Testing of all interconnecting control cables between SBGs and mains panels (no SBG running).
- Off load SBG operation proving all signals are correct.
- Testing of SCR system control cables (no SBGs running).
- Off load SBG test to establish SCR communications and readings.
- Heat load SBG run, 0% - 100% loading run for approximately 2.5 hours to test engine and commission SCR system.

It is anticipated the above will take 1 to 2 weeks to complete.



6.0 Emissions

6.1 Emissions to Air

The Air Quality Risk Assessment (SLR Ref: 410.V61547.00001 AERA) predicts for:

- Planned maintenance and testing: for operation of all 52 SBGs for planned maintenance and testing, significant impacts are considered unlikely on the identified sensitive receptors.
- 72-hour emergency outage: operation of all 52 SBGs under a 72-hour emergency (brown- or black-out) scenario, there is a probability of exceedances of the 1 hour mean US AEGL-1 and predicted exceedances of the daily mean critical level at certain receptors. It is however recognised that such a prolonged emergency scenario is highly unlikely and that the reliability of electricity supply from the national network could, conservatively, be expected to be unavailable for <1 hour per year. This is recognised in Data Centre FAQ.
- SBG commissioning: when considering the combined impacts of the planned maintenance and testing regime of the existing SBGs, and the commissioning of the proposed 24 SBGs, significant impacts are considered unlikely on the identified sensitive receptors. Furthermore, commissioning only happens once (i.e. in one year) and is therefore a low occurrence.

Refer to the Environmental Risk Assessment for further information (document reference 410.V61547.00001 AERA).

6.1.1 Emissions Factors

In order to estimate the total annual emissions of NO_x to air from the site, emissions factors have been developed from the peak fuel consumption rate and the resultant emissions of the planned testing and maintenance schedule discussed in the Air Quality Risk Assessment (SLR Ref: 410.V61547.00001 AERA).

The proposed emissions factors for LON1B, calculated based on the emission rates in stated in the AERA and the SBG planned testing and maintenance hours are presented in Table 6-1 (41 hours per SBG).



Table 6-1 NO_x Emissions Factors for Annual Reporting

Generator Model	Emission Rate Details	Emissions Factor (g/s)	NO _x (as NO ₂) per engine (kg/yr)
DS3600	100% load and SCR factored for warm up*	1.54	153.5**
	100% load and SCR full*	1.25	
	75% load and SCR factored for warm up*	1.14	
	75% load and SCR full*	0.96	
DS1650	100% load and SCR factored for warm up*	0.82	81.1**
	100% load and SCR full*	0.65	
	75% load and SCR factored for warm up*	0.61	
	75% load and SCR full*	0.51	
NO _x (as NO ₂) per total number of SBGs (kg/yr)			3,540
* - emission rate sourced from the SLR AERA			
** - based on 41 hours planned maintenance and testing per year for each MTU SBG at respective loads and with SCR warm-up accounted for.			

6.2 Emissions to Sewer

The LON1B data centre will be connected into the existing LON1A drainage system. The data centre site has separate foul and surface water drainage systems. The drainage to foul sewer consists of sanitary foul water (sinks, toilets, cleaning water, etc.); operation of the data centre will not result in the generation of trade effluent. A drainage plan for the data centre site is provided in Appendix C.

There will be no discharges to foul sewer or to surface water drainage within the internal LON1B generator rooms where the SBGs will be located.

The LON1B tanker refuelling points will be located on the external wall of each SBG room; refuelling vehicles will be required to park in the external hard surfaced yard area adjacent to the north of LON1B where connections to the SBG refuelling points will be located (locked refuelling cabinets located on the external wall of the LON1B data centre building; one per SBG room). Surface water run-off from this area will drain to the on-site surface water drainage system, via an interceptor, prior to off-site discharge into the municipal combined sewer system.

Surface water run-off from the external SBG refuelling area will drain via a grated drainage channel to the on-site surface water drainage system via an oil interceptor (Class 1 full retention). The interceptor will be fitted with an automatic closure device and high-level audible alarm system for oil and silt levels. Following the interceptor the surface water drainage will drain into the on-site surface water attenuation system (Tuborsider system).

From this rainwater harvesting system the surface water runoff ultimately discharges into the Thames Water municipal combined sewer, this point of discharge being located on the central southern boundary of the site. The point where the site's surface water drainage leaves the data centre site is indicated as discharge point SW1 on Drawing 002 Site Layout and Emissions Points, as submitted with this EP variation application.



Existing procedures within the site's environmental management system (EMS) for the management of surface water runoff, for the management and maintenance of the interceptor, and for the training of relevant staff, will be updated to include LON1B.

6.3 Emissions to Water

The data centre has no point source emissions to water.

6.4 Emissions to Land

The data centre has no point source emissions to land.

6.5 Fugitive Emissions

Significant fugitive emissions, odours and noise are not anticipated in respect of operation of the LON1B data centre SBGs either during testing or during full emergency operation.

A summary of the storage arrangements for diesel fuel and AdBlue is provided in section 12.7.

NTT maintains a spill procedure (a copy of which was provided for the initial EP application), this will be updated to include LON1B.

Relevant operating personnel have been provided with spill response training; training will be provided to include requirements for ION1B.

The EMS, including associated maintenance procedures, will be updated to include requirements for completing regular inspections of the LON1B data centre site.

6.6 Noise and Vibration

A Noise Assessment has been undertaken in accordance with British Standard 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound*. This is presented in Section 5 of this EP application.

The assessment found that:

- During the daytime, the results of the BS4142 assessment indicate that at worst sound from the SBGs would be 8dB above the background level, which is an indication of an adverse impact, depending on the context.
- During the night-time, the results of the BS4142 assessment indicate that at worst sound from the SBGs would be 11dB above the background level, which is an indication of a significant adverse impact, depending on the context.
- The specific sound level at the remaining receptors is less than 5dB above the background sound level during the night-time, which is an indication of a low impact, depending on the context.

When considering the context, operational sound from the site is expected to be largely unnoticeable, or just perceptible during the most noise sensitive periods. Sound from the site will likely be masked by the existing residual sound, including sources such as road and rail traffic. If the sound is audible, it is not expected to cause any change in behaviour or attitude at the receptor locations, due to the low level of sound from the site.

Furthermore, outside of limited SBG testing and maintenance regime, the SBGs sole purpose is to provide back-up power, and the proposed testing at the data centre involves individual SBGs tested for a limited number of hours per year, with no proposals to undertake testing of the full site at once (i.e. all SBGs operating simultaneously as modelled). Therefore,



the predicted impacts would only occur during an emergency situation such as a brown- or black-out, which is an indication that the predicted impacts can be reduced.

When considering the context of the acoustic environment which the sound occurs, the noise impact of the SBGs is considered to be low and unlikely to cause a significant noise impact at the identified receptors.

7.0 Resource Use and Efficiency

7.1 Types and Amounts of Raw Materials

The key raw materials used at LON1B are:

- HVO fuel (if HVO is not available diesel will be used as a fuel):
 - Each MTU DS3600 SBG will require up to 756 litres of fuel per hour and MTU DS1650 SBG will require up to 378 litres of fuel per hour (at 100% standby load).
- AdBlue (typically c. 32% urea in water) (the quantity used by each SCR System (x24) has yet to be confirmed).
- Lubricating oil: used in the engines and other mechanical equipment. Occasional top up or replacement will be required during scheduled or forced maintenance periods only.
- The lubricating oil for the SBGs is stored within the engine and manually topped up during servicing by the NTT appointed service contractor.
- Transformer oil: transformer oil (free of polychlorinated biphenyls (PCBs)) is used in oil-cooled transformers. Occasional top up or replacement will be required.

Transformers oils are not stored on-site; the oils will be brought to site and topped up/replaced during scheduled or forced maintenance periods only.

The BAT objective with regard to raw materials is achieved by the appropriate design, operation and maintenance of the LON1B SBGs to ensure the lowest possible consumption rate of fuel; by the selection of least hazardous materials; and by the provision of appropriate storage methods.

The SBG engines are designed for the combustion of diesel fuel oil. NTT intends to use HVO 100 as an alternative fuel (if HVO is not available NTT will use diesel).

AdBlue is designed for use in the SCR abatement systems and is accepted as the most appropriate chemical for use in such systems to reduce NO_x emissions.

In addition, the lubricating and transformer oils may have alternatives, however the type of oils used are limited to those recommended/specified by the engine manufacturers (again, with potential for supplier selection).

Cogeneration (Combined Heat and Power)

The provision/implementation of combined heat and power (CHP) is not applicable as the SBGs each operate for substantially less than 500 hours per annum for the provision of emergency power generation only; each engine inherently only operates for a small fraction of the year (in the case of the proposed LON1B Cummins SBGs this will be 7 hours per year for planned testing).



7.2 Fuel Storage

Fuel will be stored in a bunded 'belly' tank for each SBG. The belly tank is integral to the SBG units being located beneath the base of each SBG unit. The belly tank capacity for the MTU SBGs is 36m³ (36,000 litres).

Based on a total of 24 LON1B SBGs, a maximum of approximately 864,000 litres (circa 728 tonnes (based on and 1,187 litres/ton of diesel¹)) of fuel (diesel) can be stored at the LON1B data centre for the SBGs.

There is no other bulk storage of SBG fuel at the data centre.

Further details of the diesel storage arrangements are provided Section 11.0 Best Available Techniques.

7.3 AdBlue Storage

AdBlue will be stored in an external AdBlue bulk tank for each SCR abatement system, within the SBG rooms located internal to the LON1B data centre building (ground floor level). The exact details, including AdBlue storage tank capacity and pollution prevention measures, are not known at this stage. NTT will provide further details when they become available.

7.4 Energy Efficiency

7.4.1 Climate Change Agreement

NTT is a participant to a Climate Change Agreement, (CAA) for the data centre sector. Energy management techniques are implemented to monitor, record and track energy consumption at the data centre. The NTT Dagenham data centre CCA reference is DATC/T00124 (the CCA details can be found via this link [Climate Change Agreements - Reduced Rate Certificates \(RRC\) \(data.gov.uk\)](#)).

Additionally, energy efficiency and reduction are managed via the data centre's environmental management system (EMS).

7.4.2 Energy Efficiency Directive (EED)

The EED exempts "those peak load and back-up electricity generating installations which are planned to operate under 1,500 operating hours per year as a rolling average over a period of five years".

Based on the planned maintenance and testing schedule, in total the SBGs at the LON1B data centre will be operated 168 hours per year as summarised in Table 3. Based on the planned operation of the SBGs in LON1A (a total of 561 hours) plus the total planned operational hours for LON1B (168 hours), the SBGs at the LON1 data centre will operate for less than the 1,500 hour threshold. For the purpose of this EP variation application, the data centre is therefore exempt from the EED requirements and an assessment of energy efficiency in accordance with the Reference Document on Best Available Techniques for Energy Efficiency, February 2009 is not required.

¹ [Greenhouse gas reporting: conversion factors 2023 - GOV.UK \(www.gov.uk\)](#)



7.4.3 Energy Management

The management of energy forms an integral part of the EMS. Energy use forms one of the key environmental aspects and within the EMS measurement and reduction targets will likely be established.

Training aimed at minimising energy use and developing good housekeeping techniques form part of staff training.

7.4.4 Measures for the Improvement of Energy Efficiency

The LON1B SBGs and SCR abatement systems will be subject to regular maintenance and inspection. For the SBGs, this will include ensuring the engines are optimised to minimise the heat rate (energy consumption) whilst maintaining the relevant emissions standards.

Energy recovery is not reasonably practicable for engines with such small anticipated operational hours, however, as part of the EMS, assessment of the data centre's energy usage is undertaken with a view to identifying measures to reduce energy consumption, where possible.

7.4.5 Energy Usage

Operation of the SBGs will be for emergency back-up. The overall efficiencies of the SBGs (under the provision of 'standby' power) at the data centre is summarised below:

- MTU DS3600: 39%
- MTU DS1650: 35%

When taking into account the efficiency of the existing 12 Kohler KD 1800 SBGs in place at the data centre (35.12%), and the proposed LON1A 16 Kohler SBGs (43.3%), the overall efficiency of the site will be approximately 40%.

7.5 Water Minimisation

There is no consumption of water associated with the SBG combustion activities, SCR abatement systems, and SBG fuel use/storage at the LON1B.

7.6 Waste Minimisation

The site inherently does not produce significant amounts of waste. Waste oil is generated at the site as a result of SBG maintenance. SBG, and also SCR abatement system, maintenance are/will be undertaken by appointed third party specialists who are/will be responsible for the off-site disposal of waste. Waste oil is not stored on site. NTT ensures that the contracted companies are a certified waste carrier.

Waste oil is managed off-site. In accordance with the waste hierarchy, NTT ensures that the waste oil is subject to re-use, avoiding the need for disposal.

It is anticipated that waste oils (EWC 13 02) from the LON1B SBGs at the data centre will be less than 5m³(4.5 tonnes) per annum.

8.0 F Gases

Fluorinated gases (F-gases) will be used at the LON1B data centre in the refrigeration systems for chiller units and air conditioning units. The use and management of F gases at LON1B will be the same as that for LON1A.

These units will be subject to regular maintenance and leak testing; these requirements will be included in the site's preventative maintenance system. Maintenance and testing will be



undertaken by an NTT approved external specialist contractor; copies of the certificates of the engineers qualified to install, maintain and service refrigeration equipment will be maintained on file by NTT.

NTT maintains an F-gas register for the data centre. The register details each refrigerant-containing unit, the make, model and serial number, refrigerant type and charge, the global warming potential (GWP), carbon dioxide equivalent (CO₂e kg), maintenance/leak test frequency and refrigerant used per year. This register will be updated to include LON1B.

Leak detection and maintenance records for LON1B will be maintained and will include details of the quantity of refrigerant used to recharge the units, date of recharge and leak re-test for those assets where leaks are identified.

9.0 Management Systems

The data storage services at the data centre site are managed in accordance with the following standards:

- ISO/IEC 27001:2013 that specifies the requirements for establishing, implementing, maintaining and continually improving an information security management system.
- ISO 14001:2015 that specifies the requirements for an environmental management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects.
- ISO9001:2015 that specifies the requirements for establishing, implementing, monitoring, managing and improving quality throughout the organisation.

9.1 Environmental Management System (EMS)

NTT has developed an EMS in line with the requirements of the international standard ISO14001:2015. The EMS includes the policies, management principles, organisational structure, responsibilities, standards/ procedures, process controls and resources in place to manage environmental protection across all aspects of the business.

NTT has established and maintains documented procedures for identifying and recording environmental aspects for all its activities, products and services. Where significant, the environmental aspects are considered in the development, implementation and maintenance of the EMS. These are also considered when introducing new or modified activities and services. NTT also document in the EMS the process for the setting, managing and reviewing of environmental objectives and targets.

The EMS places particular importance on:

- Reducing risks to the environment to a level that is as low as reasonably practicable using best available techniques;
- Integrating EMS responsibilities within line management;
- A commitment to personnel environmental awareness and competence;
- The ongoing monitoring and review of environmental performance; and
- A commitment to working to achieve continuous improvement in environmental performance.

As part of the EMS, NTT has developed systems for managing accidents or incidents. NTT has also developed:



- A Disaster Recovery Plan to counteract potential interruptions to its business activities and to protect critical business processes from the effects of major failures of information systems or disasters. Risk assessments are undertaken to ensure that the Disaster Recovery Plan has appropriate controls in place; and
- A Business Continuity Plan (BCP), which details emergency/accident procedures and incident management responsibilities, including management of significant pollution incidents and fire. The plan includes contact numbers for key company personnel and emergency services.

The EMS will be updated to reflect the addition of the 24 LON1B SBGs.

Environmental training is provided for both general awareness and job-specific training. Each individual's knowledge and skills is assessed and matched against the needs of the job position. Additional experience and/or training requirements necessary to enable an individual to undertake their assigned role is identified, prioritised and planned. Training records are maintained and training needs regularly reviewed.

All contractors and sub-contractors are given appropriate training prior to the commencement of any works or services.

10.0 Monitoring

The LON1B SBGs at the data centre will each be operated for less than 500 hours per annum and will not be subject to emissions limit values (ELV) for the substances listed in Annex V of Directive 2010/75/EU on industrial emissions (Industrial Emissions Directive, IED).

As the SBGs will not be used for the elective generation of electricity they will not be considered 'specified SBGs' in accordance with EPR 2018 and hence will not be subject to the ELV for NO_x (190mg/kg (within 10 minutes of the specified SBG commencing operation)).

The LON1B SBGs at the data centre will be subject to the emissions monitoring requirements as stated in the LON1 EP for NO_x and CO. The initial monitoring will be completed within 4 months of receipt of the varied EP or the date the LON1B SBGs are put into operation, whichever is the soonest.

The operator will record:

- the operating hours of each engine for planned maintenance;
- the operating hours of each engine for emergency operation; and
- the amount of fuel used on an annual basis.

For the purposes of determining operating hours, the SBGs are regarded as having minimal start-up or shut-down times. Operational hours will be counted from the first fuel ignition. This will include the shorter periods of plant 'overlap' when redundant plant is started as a precautionary measure before final load is reached with the optimum/minimum number of SBGs.

10.1 Point Source Emissions to Atmosphere

Point source emissions to air are from the SBGs as a result of fuel combustion. Based on the findings of the air emissions risk assessment (410.V61547.00001 AERA) the products of combustion which are released to air as a result of planned maintenance and testing will not result in an adverse impact on the environment.

For operation of all LON1 SBGs (52 SBGs) under an emergency (brown- or black-out) scenario (72 hours modelled), there is a probability of exceedances of the 1 hour mean US



AEGL-1 and predicted exceedances of the daily mean critical level at certain receptors. However, as stated previously, it is recognised that such a prolonged emergency scenario is highly unlikely.

Operation of the SBGs during commissioning, when considering the combined impacts of the planned maintenance and testing regime of the existing SBGs in combination with the commissioning of the proposed 24 SBGs, there are predicted exceedances of the daily mean critical level at certain receptors, however these are marginal exceedances and given the highly precautionary nature of the air emissions risk assessment it is considered unlikely to result in 'significant pollution'.

The SBGs on-site each operate for less than 500 hours per annum and will not be subject to emissions limit values (ELV) for the substances listed in Annex V of Directive 2010/75/EU on industrial emissions (Industrial Emissions Directive, IED).

The operator will record:

- the operating hours of each engine;
- the amount of fuel used on an annual basis; and
- the estimated total emissions of NO_x based on the emissions factors described in Section 7.0 of this document.

For the purposes of determining operating hours, the SBGs are regarded as having minimal start-up or shut-down times. Operational hours will be counted from the first fuel ignition. This will include the shorter periods of plant 'overlap' when redundant plant is started as a precautionary measure before final customer load is reached with the optimum/minimum number of SBGs.

10.2 Point Source Emissions to Sewer

As stated in the initial EP application, the data centre is connected to the municipal combined sewer system. Discharges to sewer are limited to:

- sanitary effluent (sinks, toilets, cleaning water, etc.). This is not considered to be a trade effluent discharge and monitoring of this discharge is not considered necessary; and
- uncontaminated surface water runoff which is discharged via the on-site surface water drainage system. This runoff passes via an oil interceptor prior to discharge into the Tuborsider system and off site into the municipal combined sewer - refer to Section 6.2 for details.

Monitoring of the surface water discharge from the data centre is not considered necessary.

10.3 Point Source Emissions to Water

There are no point source emissions to water from the LON1B data centre site.

11.0 Best Available Techniques

The assessment for the implementation for Best Available Techniques (BAT) at the data centres is based on the following:

- Data Centre FAQ, Draft Version 21.0 to TechUK for Discussion 15/11/22; and
- with respect to technology selection, Department of Energy & Climate Change, Developing Best Available Techniques for Combustion Plants Operating in the Balancing Market, Final Report, June 2016.



11.1 Data centre BAT - Operating Regime

11.1.1 Planned Maintenance and Testing

During operation for planned testing/maintenance at the data centre, the proposed 24 LON1B SBGs will each operate typically for 41 hours per year; this is below the 50 hour per annum data centre BAT requirement.

In the event that electricity is not available from the national transmission network (e.g. brown- or black-out) the SBGs will be operated to deliver the required data centre customer load.

Whilst emergency operation (if required) would increase the total operational hours of each SBG, it is extremely unlikely that operation of any single SBG would exceed 500 hours per annum (this being the definition of an 'emergency' unit).

The SBG provision includes for a level of redundancy to the SBG system such that, even in a worse case blackout scenario, whilst all SBGs would start up they are not operated at full capacity; the operational capacity of the SBGs at the time of a blackout would be dependent on extent of blackout. Should an SBG fail the engine is covered by the duty standby SBG for that suite and, if required, the remaining engine/s (should the maximum electrical demand for that suite be required).

Emergency operations are taken to include unplanned hours required to come off grid to make emergency repair of electrical infrastructure associated only within the data centre.

The Operator will notify the EA in accordance with the requirements as stated in the EP for the data centre.

11.1.2 Elective Electricity Generation

The SBGs at the data centre will not be operated for elective electricity generation.

11.1.3 Operating Regime Time Limit

The air emissions modelling (410.V61547.00001 AERA) has confirmed that operation of the SBGs for the annual planned maintenance and testing regime per SBG per year, as detailed in Table 5-1, will not result in adverse impacts on air quality. NTT will therefore not operate the SBGs for more than these hours per year for the purpose of planned maintenance and testing.

11.2 Data centre BAT: Engine Selection

Diesel-fired SBGs have been chosen for the provision of emergency back-up energy in the event of a black- or brown out at the facility, however NTT intends to operate these SBGs on HVO fuel (if HVO is not available diesel will be used as an alternative fuel). A BAT assessment has been undertaken which compares diesel SBGs to other available technologies to support the chosen technology.

The following key requirements for the SBGs to provide emergency back-up electricity have been considered for the selected technologies:

- Start-up time;
- Reliability;
- Independence of off-system services; and
- Causing the least environmental impact.



A comparison of these technology types is presented in Table 11-1. Start up, efficiency and emissions data as stated has been obtained from a report prepared by DECC (Department of Energy & Climate Change, Developing Best Available Techniques for Combustion Plants Operating in the Balancing Market, Final Report, June 2016) unless otherwise stated. Figures are reported at oxygen reference values of 15%.



Table 11-1: Comparison of Technologies

	Combined Cycle Gas Turbines (CCGT)	Open Cycle Gas Turbines (OCGT)	Aero Derivative Gas Turbines ²	Gas Engines	Diesel Engines
Process Description	<p>CCGT technology uses a primary gas turbine coupled to a secondary steam turbine.</p> <p>Air is compressed through a rotating compressor, then mixed with fuel and combusted before being expanded through a gas turbine, converting the thermal energy into rotation of the turbine blades. Some of the mechanical energy powers the compressor, with the majority turning a SBG which converts the mechanical energy to electricity.</p> <p>The hot turbine exhaust gases then pass through a boiler to generate steam. The steam is fed to a steam turbine which powers a second SBG, producing further electricity.</p>	<p>OCGT consist of a compressor, combustion chamber and gas turbine. They differ from CCGTs in that they operate without the secondary component to recover heat.</p> <p>Air is fed into the compressor, pressurised and then passed to the combustion chamber where fuel is added and combusted. The hot exhaust gas turns the turbine blades and energy is converted to electricity.</p> <p>OCGTs can provide STOR and peaking services but not fast reserve services as during start-up thermal stresses need to be managed through a slow heating up process.</p>	<p>Aero Derivative Gas Turbines are similar to open cycle gas turbines, but have been derived from turbines used for aeronautical applications.</p> <p>As a result of the different requirements for use of gas turbines in aircraft, they are more flexible than OCGT plant, and are able to operate under wider ranges of load and start up and shut down quicker than other turbines.</p>	<p>A gas engine consists of a bank of fixed cylinders inside which pistons move, injecting air and fuel, compressing the mixture, igniting the mixture and then expanding the hot gas produced converting the thermal energy into rotation of a crank shaft.</p> <p>The engine load is adjusted by controlling the amount of gas and air injected into the cylinder, which is controlled by an automated system.</p> <p>A SBG connected to the crank shaft of the engine converts the mechanical energy into electricity.</p>	<p>Diesel engines work in a similar fashion to gas engines with the key difference being that diesel fuel is injected into the cylinder after compression of the air has taken place, and automatically ignites as a result of the high temperature of the compressed air.</p> <p>Engines are generally rated for a continuous power output, but can exceed this by stated amounts for shorter periods of time in modes named Standby (1hr maximum) and Prime (12hr maximum). These higher power outputs come at the cost of higher emissions and greater equipment stress.</p>
Start-Up Time³	1 – >3.5 hours	15 -30 minutes	As low as 1 minute	1-10 minutes	<10 minutes

² GE Power Systems, Aero Derivative Gas Turbines – Design and Operating Features

³ Note that this is based on typical industrial facilities.



	Combined Cycle Gas Turbines (CCGT)	Open Cycle Gas Turbines (OCGT)	Aero Derivative Gas Turbines ²	Gas Engines	Diesel Engines
Thermal Efficiency (LHV%)	58.8-60.7	38.3-39.9	35-39	35.0-45.0	35.0-37.0
Notes	<p>The secondary steam turbine increases the start-up time of the facility, as it requires slow warming.</p> <p>The complexity and footprint of a combined cycle, combined with the efficiency of steam cycles only being high at relatively large capacities means that CCGT systems are only suitable for large facilities (c.100MW+)</p>	<p>The significant amount of heat lost in the exhaust gas makes open cycle gas turbines significantly less efficient than combined cycle systems.</p>	<p>As with the open-cycle gas turbine, heat loss in exhaust gases means these systems are not as efficient as other options. Certain enhancements can be added, e.g. steam injection, but these are relatively novel and difficult to apply in a non-continuous scenario.</p>	<p>Gas engines are proven, reliable technology and are known to perform well and emit relatively low amounts of NO_x, SO_x and particulates when compared to diesel fired engines.</p>	<p>Diesel engines, unabated, emit relatively high amounts of SO₂ and particulate matter as well as NO_x. The use of low sulphur fuel, catalysts and particle filters can reduce this but diesel engine emissions are considerably higher than other options.</p>



11.2.1 Technology Selection

Gas Turbines

As per Table 11.1, CCGTs are not considered BAT for the provision of emergency/standby power. This is due to their lengthy start up times and their size limitations; the efficiency of steam cycles being relatively low at small capacity and the overall system complexity being more appropriate to larger size installations.

OCGTs have relatively high capital investment, operating and maintenance costs and lower thermal efficiencies than can be achieved by CCGTs and gas engines.

Aero derivative gas turbines can achieve suitably short start-up times of as low as one minute, however they suffer from relatively low efficiencies compared to engines and the enhancements which have recently become available to improve these are relatively novel and unproven. This is especially applicable for non-continuous operation, where steam or water injection may become a problem as a result of potential condensation within turbine sections.

Reciprocating Engines

Reciprocating engines perform well in terms of their thermal efficiencies. At the upper end of their efficiency range, gas engines have higher thermal efficiencies than diesel engines and OCGTs.

Reciprocating engines also have shorter start up times and are thus more suitable for the provision of emergency/standby power. Under standby conditions, higher emissions are produced, including NO_x, SO₂ and particulate matter as soot.

Gas engines benefit from lower NO_x emissions than diesel engines and can utilise gas delivered by the national gas grid, avoiding the additional transport and fuel storage issues associated with diesel systems.

Reciprocating engines fired on diesel fuel oil have a high response (i.e. low start-up duration) and good independent performance reliability due to the on-site storage of diesel fuel in sufficient quantities, which is managed and controlled by the facility, with the option for fuel oil to be sourced from more than one supplier for delivery to the site. Diesel-fired engines do have a large number of moving parts which can be subject to failure and require regular ongoing maintenance to ensure reliability, however these moving parts can be readily obtained and replaced and are typically included as part of the service agreement with the generator vendor. Due to the number of moving parts, diesel generators when operated can be noisy and generate vibration.

When compared to gas-fired generators diesel engines produce polluting emissions to air, most notably NO_x and particulate matter, which can impact local air quality if operated for prolonged periods of time.

Final Choice of Engine

From the above options, and considering all the aspects required of the plant to provide emergency/standby power for the data centre, diesel engines have been determined as BAT on the basis that:

- These engines provide a fast response speed to the required load; as stated previously, fast start-up of standby generators for data centre is fundamental as an almost instantaneous supply of electricity is required in the event of power loss to the site.



- The need for a reliable supply of fuel is essential to ensure reliance, the on-site storage of sufficient quantities of diesel fuel provides the required level of independent performance reliability.
- Diesel engines have low maintenance costs and replacement parts are readily available.

11.3 Data centre BAT: Emissions

The *Data Centre FAQ* specifies the BAT emissions specification for new diesel-fired reciprocating engines as 2g TA-Luft or EPA Tier 2 with guaranteed emissions compliant (or equivalent standard).

The LON1B SBGs will be MTU DS3600 and DS1650 engines, the manufacturer specifications for which state that these engines are EPA Tier 2 compliant. As stated in the Data Centre FAQ, Tier II US EPA is the minimum appropriate for new SBGs. SCR abatement systems will be installed on each of the 24 proposed SBGs to reduce NO_x emissions to ensure that they meet the MCPD emission limit of 190mg/m³. The SBGs are therefore considered to be compliant.

With respect to emissions management options, the air/fuel mix of each SBG will be automatically optimised via an electronic fuel management system to ensure combustion efficiency. Additionally, the SBGs will be subject to regular planned maintenance in accordance with manufacturer requirements to ensure optimal performance and efficient combustion. Regular maintenance ensures that the products of combustion emitted to air are minimised. Furthermore, NTT staff, and the NTT appointed maintenance subcontractor, are suitably experienced and trained in the operation of and the maintenance and testing requirements for the SBGs.

The SBGs in an emergency event will be operated automatically by the Building Management System (BMS). In the event of a reduction in electrical power delivered from the National Grid, the BMS would automatically start-up the minimum number of SBGs necessary to service the customer suites; this configuration allows for the minimum number of SBGs to be run dependant on the failure scenario. This will result in the reduced consumption of diesel fuel and hence generation of less emissions to air from the SBGs.

Given the short start-up and shutdown times for diesel engines, the SBGs are regarded, for the purposes of determining operating hours, as commencing operation at the first fuel ignition. This is taken to include the shorter periods of plant 'overlap' when engines provided as redundancy are started as a precautionary measure before final load is reached with the optimum/minimum number of SBGs.

The emissions from the site will be estimated using emissions factors, as discussed in Section 6.0.

11.4 Data centre BAT: Stacks

The *Data Centre FAQ* states that data centres usually have very low profile sites and as such can have short, below roof level emission stacks and that this can impact on the efficiency of dispersion of emissions and BAT is that release stacks are vertical to aid the dispersion of emissions from the SBGs.

By elevating stack heights it is possible to increase the dispersion of exhaust gases as a result of mixing with the surrounding air once the plume of exhaust gases leaves the stack. Whilst this will not reduce the concentration of pollutants leaving the stack, it will result in a lower concentration at ground level – i.e. a lesser impact on the receptor. Increasing the stack height also avoids the effects of building wake and entrainment of the emissions in the locality of the emission source. The use of taller stacks does have an impact on the



operation of the engine(s) as it will marginally increase the back pressure on the engine.

By bringing together the exhaust streams for multiple engines, it is possible to improve the mixing of flue gases with the surrounding air. This aggregation does not decrease the absolute quantities of NO_x emitted but does lead to a lower concentration at ground level – i.e. a lesser impact on the receptor.

The reduction in ground level concentration is achieved through improved mixing with the surrounding air once the plume of exhaust gases leaves the stack. A higher mass flowrate of gases will result in a greater momentum that increases the final height of the plume after it has left the aggregated stack. This increased mixing leads to a lower concentration of pollutants at receptors.

Each LON1B SBG will have a dedicated stack to aid the dispersion of the engine flue gases, each LON1B SBG will have one flue which will discharge via one SBG exhaust air duct (i.e. riser) (for further details, please see the Air Emissions Risk Assessment (410.V61547.00001 AERA)):

- The SBG vertical flues will extend to 3m below the terminal height of each riser. The release height of each of the risers for the 24 proposed SBGs at the LON1B data centre will be 20.6m above ground level (agl).

The risers, which will be vertical and unimpeded, will terminate 5m from the roof level, but at the same height as roof plant.

The AERA has taken into account the profiles and heights of all the stacks and building downwash impacts at the data centre and has concluded that:

- For planned maintenance and testing there will not be significant impacts on air quality;
- For a 72 hour 'electrical grid outage', NO_x emissions will result in impacts on air quality and as such on certain local sensitive receptors (as identified in the AERA); and
- For SBG commissioning, when considering the combined impacts of the planned maintenance and testing regime of the LON1A SBGs and with the commissioning of the proposed 24 LON1B SBGs, there will be impacts on air quality which will impact certain receptors (as identified in the AERA), however these are marginal exceedances and given the highly precautionary nature of the air emissions risk assessment it is considered unlikely to result in 'significant pollution'.

Further air emissions controls are not considered necessary as, given the very low probability of emergency operation at the site, and with regard to commissioning that this is a one-off event, the overall environmental risk is not considered to be significant⁴.

11.5 Data centre BAT: Electrical System Reliability

Section 4.4 provides a description of the on-site electricity supply system for the data centre which has been implemented to service the 'customer load' that, in addition to the SBGs, incorporates physical connections to the national transmission network (to allow for the failure of any single connection).

⁴ See Air Emissions Risk Assessment (SLR Ref: 410.V61547.00001 AERA) and Environmental Risk Assessment (SLR Ref: 410.V61547.00001 ERA)



The electrical system for the data centre provides significant protection against the failure of (or fluctuation in) the electrical supply to the site, before it would become necessary to start the SBGs.

NTT will seek certification to ISO/IEC 27001:2013 that specifies the requirements for establishing, implementing, maintaining and continually improving an information security management system.

Operation of the LON1B SBGs will in the main be limited to maintenance and testing. NTT will implement a programme of planned maintenance and testing of the SBGs in accordance with manufacturer requirements, to limit unplanned maintenance/testing of the SBGs and thus avoiding the unnecessary use of diesel and the generation of emissions to air.

11.6 Data centre BAT: Air Quality Emergency Action Plan

NTT will develop an update to the LON1 Air Quality Emergency Action Plan (AQEAP) to include the LON1B SBGs. The AQEAP will detail the management actions to be taken in the event of an emergency outage of the national electricity transmission system that could result in the prolonged usage of the SBGs which could potentially result in adverse impacts on local air quality.

NTT will liaise with the Local Authority and the Environment Agency to agree actions to be taken in the event of a prolonged outage situation (>18 hours) and a finalised plan will be incorporated into the site's environmental management system.

NTT will maintain open lines of communication with the Local Authority, particularly to manage any risks that may be identified in the future as becoming significant threats to the local air quality, for example Identification of new emissions sources (cumulative impacts) or potential for future site expansion.

11.7 Data centre BAT: Fuel Storage

HVO/diesel for LON1B SBGs and associated SCR systems will be stored at the LON1B data centre building in belly tanks which will sit below the individual SBGs within the internal SBG rooms. There will be no bulk tank storage of diesel at the LON1B data centre.

The fuel storage arrangements for the LON1B SBGs are summarised below.

11.7.1 Belly Tanks

The LON1B SBGs at the data centre will be sited within dedicated generator rooms to be located on the ground floor of the LON1B data centre building. The belly tank will be located underneath each SBG, and will automatically supply fuel to the SBG. Each generator room will be bunded to provide 110% containment of the maximum volume of SBG fuel stored within the belly tank within these rooms; each bund will be fitted with a leak detection alarm which will alarm to the BMS. A drawing of the LON1B generator room design is presented in Appendix D.

The LON1B SBGs will be filled directly from refuelling vehicles (the fuel being delivered by an NTT appointed fuel supplier and in accordance with fuel delivery procedures which are part of the EMS for the data centre). Fuel will be delivered directly to the belly tanks via fill points which will be located on the external northern wall of the LON1B data centre building; these fill points will be positioned in lockable cabinets with integral drip trays; the tank fill point cabinets will remain locked when not in use. Other than the pipework connecting the belly tanks to the SBGs, there is no oil distribution pipework located within the Installation boundary.

The SBG belly tanks will have the following protection measures:



- Tank level gauge.
- High and low level alarms connected to the BMS.
- A pressure delivery over-fill prevention valve.
- Leak detection alarms connected to the BMS. The generator tank fuel monitoring system will alarm, via the data centre BMS to the on-site control room, in the event of a diesel tank volume decrease when the generators are not operating. In addition, the generator room bunds will have a monitoring system to detect any leaks from the fuel tanks, this will alarm to the PMS.
- To minimise the risk of corrosion all pipework will be painted or constructed of corrosion resistant material.

Refuelling vehicles will be required to park in a dedicated hard surfaced refuelling area located externally adjacent to the northern facade of the LON1B data centre building; the delivery tanker will connect to the SBG fill points located on this wall, as described above, to enable delivery of fuel to individual belly tanks. Diesel deliveries will be fully supervised by NTT personnel from the point at which the vehicle arrives at site and during delivery of diesel to the belly tanks.

Runoff from the area where fuel deliveries will be made will flow to a drain gully which is connected to the surface water drainage system on site; in the unlikely event of any unplanned release of fuel from fuel delivery activities then these would drain to this gully. Drainage from this area will be directed via an oil interceptor (Class 1 interceptor fitted with an automatic closure device and high-level audible alarm system for oil and silt levels).

The bulk delivery of fuel at the NTT data centre is highly controlled. Bulk deliveries of diesel from NTT approved suppliers is undertaken in accordance with procedure *HS12-P02 Diesel oil delivery procedure*. This procedure requires an NTT engineer (CFM Engineer) to escort the fuel tanker to the relevant delivery tank, to unlock and open the tank fill point and to test the tank's high-level alarm is working, only then will the fuel delivery driver be allowed to connect the tanker delivery hose and deliver the fuel. Following delivery of the fuel the tanker driver is required to ensure that the delivery hose is 'blown down' to remove any residual diesel in the hose and thus avoid fuel spillage on disconnection. The fuel supplier is required to ensure that a fuel spill kit is available on the fuel delivery vehicle. In addition, NTT has on-site spill kits. In the event of spillage when offloading diesel from dedicated refuelling vehicles, spill procedures *HS12-P01 Spillage Procedure* and *HS04-TT44 Spillage Response* would be put into action. Operating personnel are provided with spill response training.

11.7.1.1 Preventative and Predictive Maintenance (PPM)

NTT has developed a preventative maintenance system. The PPM is managed and completed by the facilities management personnel and appointed approved third party specialists, as required. The PPM system is used to inform facility management (FM) personnel of plant status and any system issues.

The LON1B SBG planned testing schedule will be managed via NTT's PPM CAFM software. To minimise the number of SBGs tested at the LON1 data centre at any one time, the PPM software system is used to schedule this maintenance and testing.

There is a central Control Room at the data centre; Control Room personnel responsibilities include the following:

- Issue of all permits for plant modification and repair (the permit issuers will also control and approve Risk Analysis and Method Statements (RAMS)).
- Monitoring of all fuel deliveries.



- Monitoring tank levels, flow rates, tank level alarms and leak alarms.

The PPM system includes the requirement for checks, which are formally recorded, of storage tanks and associated infrastructure.

NTT, in accordance with the EMS, has procedures in place for diesel deliveries and for the actions to be taken in the event of an unplanned release of diesel. Relevant staff are trained in these procedures and processes. NTT will provide spill kits at relevant locations at the site. The EMS will be updated to include any specific requirements for LON1B.

The datacentre site has CCTV and 24 hour manned security, additionally the LON1B SBG plant area will be subject to regular inspections by NTT staff. In the unlikely event of an unplanned release of fuel this would be readily identified and measures put in place to minimise potential adverse impacts.

It is considered that diesel delivery and storage arrangements are BAT.

12.0 Conclusion

Based on the above discussions, it is considered that NTT will operate the SBGs, SCR abatement systems and associated fuel storage arrangements at the data centre in accordance with all relevant BAT.





Appendix A MTU SBG Specification

LON1 Phase B Environmental Permit Variation Application

Best Available Techniques and Operating Techniques Assessment, LON1 Phase B

NTT Global Data Centers EMEA Limited

SLR Project No.: 410.V61547.00001

26 July 2024



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

1.0 – Technical Submission Front Page

Trade Contractor:	AVK-SEG (UK) Ltd	From:	J. Moeller-Schwartz
Trade Contractor Sub No:	TS-01	Date:	22/02/2024
Revision:	0		
Reason for Revision:	First Issue		

Approval for the following equipment is required:

Equipment:	Diesel Generating Set	Make:	AVK
Equipment Reference:	DS3600 Generating Set	Areas Used:	
Description:	Supply and installation of 12 no. <i>mtu</i> 20V4000 DS3600 Standby Rated with UTI Letter Diesel Generating Set Comprising of: <ul style="list-style-type: none"> • <i>mtu</i> 20V4000G94F NEA (ORDE) Emissions Optimised Diesel Engine • Leroy Somer LSA54.2 ZL17 / 4p Brushless Synchronous Alternator • Mechanically Driven Cooling Package • ComAp IntelliSys Generator Controller 		
Planned on Site Date:			

Attached detail documents:

(Tick if included and insert references within boxes identifying supporting documentation included within this submission)

Section	Description	Tick	Section	Description	Tick
1.0	Technical Submission Front Page	✓	6.0	Interfaces and Dependencies Schedule	✓
2.0	Equipment Description	✓	7.0	Builders Work Requirements	X
3.0	List of Exceptions & Clarifications	✓	8.0	Schedule of Comments	✓
4.0	Manufacturers Documents	✓	9.0	Appendices	✓
5.0	Certified Drawings	X			

Signed by:	J. Moeller-Schwartz
Date:	22/02/2024

Approval:

Company	Name	Date	Status	Comments

Note: If client sign off and/or comments have not been received within 2 weeks of the date stated on this technical submission then the products and/or services detailed in the technical submission are deemed to be acceptable and final technical submission from AVK Projects will be based upon the scope covered within this document.



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

2.0 – Equipment Description

2.1 Requirements

We are required to provide 12 no. 3500kVA/2800kW net, NEA (ORDE) emissions optimised, standby rated with UTI letter, LV diesel generating set. Complete with mechanically driven cooling package and generator mounted controller.

2.2 Generator

mtu DS3600 diesel generating set with *mtu* 20V4000G94F NEA (ORDE) emissions optimised turbocharged diesel engine and Leroy Somer LSA 54.2 ZL17 / 4p brushless synchronous alternator.

Generating set sized to support a standby rated load of 3500kVA/2800kW net, at 400V, 3-phase, 50Hz, 1500 rev/min, for an unlimited number of operating hours per year with varying load conditions (average load factor <100%), as stated in the UTI letter, in accordance with ISO 8528-1 and ISO 3046-1. No overload capability for this rating.

Generating set designed to performance class G3.

Generating set supplied with:

- Integrated digital automatic voltage regulator (AVR)
- Dual 24V electrical starter motor with battery charging alternator (redundant operation)
- Dual 24V low maintenance lead acid starting batteries.
- 24V battery chargers
- Air, fuel, and lube oil filters
- Electronic engine management
- Common rail electronic injection system
- Low lube oil pressure protection switch
- High water temperature protection switch
- Low coolant level alarm
- Common skid frame with rubber type anti-vibration pads between engine/alternator and skid to give approximately 80-85% isolation.
- Thermostatically controlled water jacket heater and circulating pump.
- Flanged exhaust bellows
- CE label

See the following appendices for further details:

[Appendix 9.01 – Generator Datasheet](#)

[Appendix 9.02 – Engine Datasheet](#)

[Appendix 9.03 – Alternator Datasheet](#)



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

2.2.1 Engine

In-line, liquid-cooled, four-stroke mtu 20V4000G94F NEA (ORDE) emissions optimised turbocharged diesel engine. Electronically controlled common rail fuel injection system with low and high-pressure fuel pumps, fuel pressure accumulator, high pressure fuel lines, duplex fuel filter and fuel priming pump for initial system filling and venting.

Forced-feed lubrication system with piston cooling, lube oil circulation pump with safety valve, automatic lube oil make-up system, lube oil multi-stage filter, lube oil heat exchanger, oil filler neck and oil dipstick for measurement on non-running engine and closed crankcase venting system. Hand pump included for manual lube oil extraction.

Thermostatically controlled water jacket heater with coolant circulation pump and coolant thermostat for charge air cooling circuit.

Engine warranted to operate using the fluids and lubricants specified in Appendix 04 – MTU Fluids and Lubricants.

See the following appendices for further details:

[Appendix 9.02 – Engine Datasheet](#)

[Appendix 9.04 – MTU Fluids and Lubricants](#)

[Appendix 9.05 – Emissions Datasheet](#)

2.2.2 Alternator

Leroy Somer LSA 54.2 ZL17 / 4p brushless self-excited, self-regulating, double bearing, IP23 drip proof, class H alternator sized to support a standby rated load of 3500kVA/2800kW net, at 400V, 3-phase, 50Hz, 1500 rev/min, for an unlimited number of operating hours per year with varying load conditions (average load factor <100%), as stated in UTI letter, in accordance with ISO 8528-1 and ISO 3046-1. No overload capability for this rating.

Integrated digital type automatic voltage regulator (AVR) included to maintain alternator output voltage of 400V \pm 5% from no load to full load, unity to 0.8 lagging power factor, 3-phase, 50 Hz, 400V, 1500 rev/min and a total harmonic distortion (THD) of < 5%.

See the following appendices for further details:

[Appendix 9.03 – Alternator Datasheet](#)

[Appendix 9.06 – AVR Datasheet](#)



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

2.2.3 Cooling System

The generating set is supplied with a mechanically driven cooling package.

Specifications:

- Cooling ambient design: 42°C
- Cooling altitude design (A.S.L): 115m
- Maximum external restriction 200 Pa
- Engine coolant capacity: 260 litres
- Intercooler coolant capacity: 50 litres
- Thermostat: 79-92°C

2.2.4 Starting System

The generating set starting system comprises:

- 24V 15kW electrical starter motor and redundant starter motor.
- 24V dual set low maintenance lead acid starting batteries (each sized for maximum 3 x genset starting attempts, 6 total crank cycles of 10 seconds with redundant operation).
- Battery charging alternator.
- Dual battery chargers fed from auxiliary supply.

See the following appendices for further details:

[Appendix 9.07 – Battery Datasheet](#)



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

2.2.5 Earthing

Earthing points are provided on the generator base frame.

2.2.6 Generator Controller

The generating sets are controlled via ComAp IntelliSys controllers located within the generator control panel mounted on the bedframe of the generator set. The ComAp controller provides individual set control and monitoring. The control panel is fed from the 24V DC battery backed generator supply and is operated with an 8-inch ergonomic touch screen.

The ComAp control panel provides:

- Control of the genset in both automatic and manual mode
- Testing of the generating set both on/off load
- Display of genset measurement values (electrical and mechanical)
- Status of generating set (both current and historical)
- Time-stamped event display with log for up to defined amount of events
- Adjustment of genset parameters with appropriate user level (i.e. timer settings)
- Automatic cooldown periods with user defined time settings
- Engine oil pressure
- Engine water temperature
- Engine oil temperature
- Engine speed
- Hours run
- Number of start attempts
- Battery voltage

Event-based history (up to 1000 records) with customer-selectable list of stored values; RTC; statistic values.

See the following appendices for further details:

[Appendix 08 – ComAp Datasheet](#)

[Appendix 09 – ComAp HMI Datasheet](#)



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

3.0 - List of Exceptions & Clarifications

Please see CDE document.

4.0 - Manufacturers Documents

Please see appendices.

5.0 - Certified Drawings

N/A

6.0 - Interfaces and Dependencies Schedule

Auxiliary Supply Required	Detail	Quantity Required	Provided By	Final Connection By
TBC	Maintained Generator Auxiliary Supply	1 per generating set	Others	Others
High Level Interface	Generator alarm monitoring (Modbus)	1 per generating set	Others	Others
Low Level Interface	Generator alarm monitoring (VFC's)	TBC	Others	Others

Note: The above list is based on initial design information and may be subject to change as the project progresses.

7.0 - Builders Work Requirements

N/A



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

8.0 – Schedule of Comments

The following table provides a schedule of all comments required against this document and details the AVK response and status of each comment.

Item	Client Comment	AVK Response	Status

Note: Client to advise status of comment from the following list:

- Accepted (no further action)
- Rejected (refer to comments)



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

9.0 – Appendices

Item	Document Name
9.01	Generator Datasheet
9.02	Engine Datasheet
9.03	Alternator Datasheet
9.04	MTU Fluids and Lubricants
9.05	Emissions Datasheet
9.06	AVR Datasheet
9.07	Battery Datasheet
9.08	ComAp Datasheet
9.09	ComAp HMI Datasheet
9.10	UTI Letter



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

APPENDIX 9.01

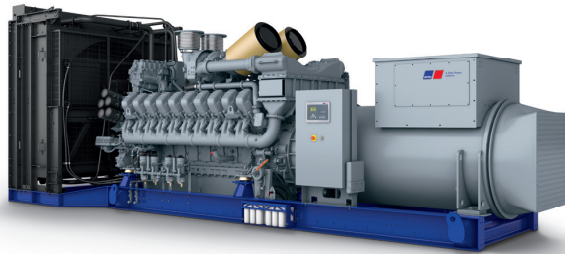
Generator Datasheet



Diesel Generator Set

mtu 20V4000 DS3600

400 V - 11 kV/50 Hz/standby power/NEA (ORDE) + Tier 2 optimized
20V4000G94F/water charge air cooling



Optional equipment and finishing shown. Standard may vary.

Project Specific Datasheet - NTT LON1B

Product highlights

Benefits

- Low fuel consumption
- Optimized system integration ability
- High reliability
- High availability of power
- Long maintenance intervals

Support

- Global product support offered

Standards

- Engine-generator set is designed and manufactured in facilities certified to standards ISO 2008:9001 and ISO 2004:14001
- Generator set complies to ISO 8528
- Generator meets NEMA MG1, BS 5000, ISO, DIN EN and IEC standards
- NFPA 110

Power rating

- System ratings: 3580 kVA - 3730 kVA
- Accepts rated load in one step per NFPA 110*
- Generator set complies to G3 according to ISO 8528-5
- Generator set exceeds load steps according to ISO 8528-5*

Performance assurance certification (PAC)

- Engine-generator set tested to ISO 8528-5 for transient response
- 85% load factor
- Verified product design, quality and performance integrity
- All engine systems are prototype and factory tested

Complete range of accessories available

- Control panel
- Power panel
- Fuel system
- Fuel connections with shut-off valve mounted to base frame
- Starting/charging system
- Exhaust system
- Electrical driven radiators
- Medium and oversized voltage alternators
- Low voltage alternator

Emissions

- Tier 2 optimized engine
- NEA (ORDE) optimized

Certifications

- CE certification option
- Unit certificate acc. to VDE-AR-N 4110

* Changes to the standard parameter sets (alternator-regulator and genset-controller) are necessary



A Rolls-Royce
solution

Application data ¹⁾

Engine

Manufacturer	mtu
Model	20V4000G94F
Type	4-cycle
Arrangement	20V
Displacement: l	95.4
Bore: mm	170
Stroke: mm	210
Compression ratio	16.4
Rated speed: rpm	1500
Engine governor	ECU 9
Max power: kWm	3088
Air cleaner	dry

Fuel system

Maximum fuel lift: m	5
Total fuel flow: l/min	27

Fuel consumption ²⁾

	l/hr	g/kwh
At 100% of power rating:	756	203
At 75% of power rating:	578	207
At 50% of power rating:	402	216

Liquid capacity (lubrication)

Total oil system capacity: l	390
Engine jacket water capacity: l	260
Intercooler coolant capacity: l	50

Combustion air requirements

Combustion air volume: m ³ /s	4.5
Max. air intake restriction: mbar	30

Cooling/radiator system

Coolant flow rate (HT circuit): m ³ /hr	80
Coolant flow rate (LT circuit): m ³ /hr	44
Heat rejection to coolant: kW	1140
Heat radiated to charge air cooling: kW	890
Heat radiated to ambient: kW	105
Fan power for electr. radiator (40°C): kW	105

Exhaust system

Exhaust gas temp. (after engine, max.): °C	550
Exhaust gas temp. (before turbocharger): °C	642
Exhaust gas volume: m ³ /s	11.1
Maximum allowable back pressure: mbar	50
Minimum allowable back pressure: mbar	-

Standard and optional features

System ratings (kW/kVA)

Generator model	Voltage	NEA (ORDE) optimized		
		without radiator		
		kWel	kVA*	AMPS
Leroy Somer LSA54.2 ZL17 (LV Leroy Somer standard)	400 V	2960	3700	5340
Leroy Somer LSA54.2 XL11 (Med. volt. Leroy Somer)	11 kV	2864	3580	188
Marathon 1040FDH7103 (Medium-volt. marathon)	11 kV	2976	3720	195
Leroy Somer LSA54.2 ZL12 (MV Leroy Somer oversized)	11 kV	2864	3580	188
Marathon 1040FDH7105 (MV marathon oversized)	11 kV	2976	3720	195
Leroy Somer LSA54.2 ZL12 (Engine output optimized)	11 kV	2984	3730	196

* cos phi = 0.8

1 All data refers only to the engine and is based on ISO standard conditions (25°C and 100m above sea level).

2 Values referenced are in accordance with ISO 3046-1. Conversion calculated with fuel density of 0.83 g/ml. All fuel consumption values refer to rated engine power.

Standard and optional features

Engine

- 4-cycle
- Standard single stage air filter
- Oil drain extension & shut-off valve
- Closed crankcase ventilation
- Governor-electronic isochronous
- Common rail fuel injection
- Tier 2 optimized engine
- NEA (ORDE) optimized engine

Generator

- 4 pole three-phase synchronous generator
- Brushless, self-excited, self-regulating, self-ventilated
- Digital voltage regulator
- Anti condensation heater
- Stator winding Y-connected, accessible neutral (brought out)
- Protection IP23
- Insulation class H, utilization acc. to H
- Radio suppression EN 55011, group 1, cl. B
- Short circuit capability 3xIn for 10sec
- Winding and bearing RTDs (without monitoring)
- Excitation by AREP + PMI
- Mounting of CT's: 3x 1 core CT's
- Winding pitch: 127° pitch
- Voltage setpoint adjustment ± 5%
- Meets NEMA MG-1, BS 5000, IEC 60034-1, VDE 0530, DIN EN 12601, AS 1359 and ISO 8528-3 requirements
- Leroy Somer low voltage generator
- Leroy Somer medium voltage generator
- Marathon medium voltage generator
- Oversized generator

Cooling system

- Jacket water pump
- Thermostat(s)
- Water charge air cooling
- Electrical driven front-end cooler
- Jacket water heater
- Pulley for fan drive

Control panel

- Unit cabling with coded plugs for easy connection of customer-specific controls (V0)
- Pre-wired control cabinet for easy application of customized controller (V1+)
- Island operation (V2)
- Automatic mains failure operation with ATS (V3a)
- Automatic mains failure operation incl. control of generator and mains breaker (V3b)
- Island parallel operation of multiple gensets (V4)
- Automatic mains failure operation with short (< 10s) mains parallel overlap synchronization (V5)
- Mains parallel operation of a single genset (V6)
- Mains parallel operation of multiple gensets (V7)
- Basler controller
- Deif controller
- Complete system metering
- Digital metering
- Engine parameters
- Generator protection functions
- Engine protection
- SAE J1939 engine ECU communications
- Parametrization software
- Multilingual capability
- Multiple programmable contact inputs
- Multiple contact outputs
- Event recording
- IP 54 front panel rating with integrated gasket
- Remote annunciator
- Daytank control
- Generator winding- and bearing temperature monitoring
- Modbus TCP-IP

Connectivity

The engine system automatically collects and transfers engine data to the manufacturer from time to time. The data is used by the manufacturer for the purposes of product

development and improvement as well as service optimization. Users can log in or register via <https://mtu-go.com> and also gain insight into the data.

- Represents standard features
- Represents optional features

Standard and optional features

Power panel

- Supply electrical driven radiator from 45kW – 75kW

Fuel system

- Flexible fuel connectors mounted to base frame
- Fuel filter with water separator
- Fuel filter with water separator heavy-duty
- Switchable fuel filter with water separator
- Switchable fuel filter with water separator heavy-duty
- Separate fuel cooler
- Fuel cooler integrated into cooling equipment

Starting/charging system

- 24V starter
- Redundant starting system
- Starter batteries, cables, rack, disconnect switch (lockable)
- Battery charger
- Alternator

Mounting system

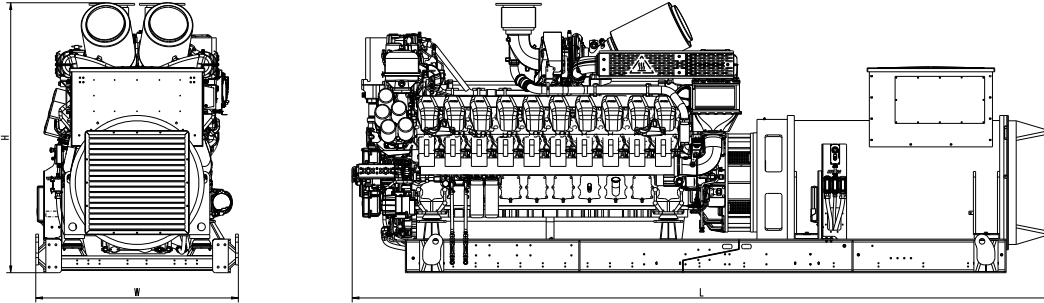
- Welded base frame
- Resilient engine and generator mounting
- Modular base frame design
- Base frame mounting on foundation/base plate with using clamping brackets

Exhaust system

- Exhaust bellows with connection flange
- Exhaust silencer with 10 dB(A) sound attenuation
- Exhaust silencer with 30 dB(A) sound attenuation
- Exhaust silencer with 40 dB(A) sound attenuation
- Y-connection-pipe

- Represents standard features
- Represents optional features

Weights and dimensions



Drawing above for illustration purposes only, based on a standard open power 400 Volt engine-generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (LxWxH)	Weight (dry/less tank)
Open power unit (OPU)	6343 x 1810 x 2421 mm	20810 kg

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific engine-generator set.

Sound data

– Consult your local **mtu** distributor for sound data.

Emissions data

– Consult your local **mtu** distributor for emissions data.

Rating definitions and conditions

- Standby ratings apply to installations served by a reliable utility source. The standby rating is applicable to varying loads for the duration of a power outage. No overload capability for this rating. Ratings are in accordance with ISO 8528-1, ISO-3046-1, BS 5514 and AS 2789. Average load factor: $\leq 85\%$. Operating hours/year: max. 500.
- Consult your local **mtu** distributor for derating information.



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

APPENDIX 9.02

Engine Datasheet



Name	20V4000G94F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

Reference conditions

No.	Description	Index	Value	Unit
6	Intake air temperature		25	°C
7	Charge-air coolant temperature		45	°C
8	Barometric pressure		1000	mbar
9	Site altitude above sea level		100	m

BL Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

DL Reference value: continuous power
Engine power that can be run continuously under standard conditions

> Actual value must be greater than specified value
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X Applicable
The module is valid for this product type

□ Non-applicable
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A Design value
Value required for the design of an external system (plant)

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Typical average value as information – only suitable for design purposes to a limited extent

L Limit value
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Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

0. Data-relevant engine design configuration

No.	Description	Index	Value	Unit
13	Engine without sequential turbocharging (turbochargers without cut-in/cut-out control)		X	-

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Engine power that can be run continuously under standard conditions

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWel]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

1. Power-related data

No.	Description	Index	Value	Unit
1	Engine rated speed	A	1500	rpm
3	Mean piston speed		10.5	m/s
5	Fuel stop power ISO 3046	A	3088	kW
9	Mean effective pressure (MEP) (Fuel stop power ISO 3046)		25.9	bar

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

2. General Conditions (for maximum power)

No.	Description	Index	Value	Unit
46	Individual power calculation (ESCM) required for maximum power		X	-
3726	Site altitude above sea level, max. (special hardware required for altitudes > site altitude)	L	1300	m
3727	Special hardware for altitude > site altitude needed (see chapter 2, item No. 3726)		X	-
1	Intake air depression (new filter)	A	15	mbar
3332	Intake air depression for new system	A	15	mbar
2	Intake air depression, max.	L	30	mbar
3	Exhaust back pressure	A	30	mbar
51	Exhaust overpressure (total pressure against atmosphere)	A	30	mbar
52	Exhaust overpressure, max. (total pressure against atmosphere)	L	50	mbar
5	Fuel temperature at fuel feed connection	R	25	°C
6	Fuel temperature at fuel feed connection, max.	L	55	°C
9	Fuel temperature at fuel feed connection, max. (w/o power reduction)	L	55	°C
10	Fuel temperature at fuel feed connection, max.	L	-	°C
18	Fuel temperature at fuel feed connection, min.	L	-	°C

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Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWel]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

3. Consumption

No.	Description	Index	Value	Unit
56	Specific fuel consumption (be) - 100 % FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	203	g/kWh
57	Specific fuel consumption (be) - 75 % FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	207	g/kWh
58	Specific fuel consumption (be) - 50 % FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	216	g/kWh
59	Specific fuel consumption (be) - 25 % FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	234	g/kWh
73	No-load fuel consumption	R	50	kg/h
92	Lube oil consumption after 100 h of operation (B = fuel consumption per hour) Guideline value does not apply for the design of EGAT systems. Please consult the Applications Center with regard to the layout of EGA systems.	R	0.2	% of B
62	Lube oil consumption after 100 h of operation, max. (B = fuel consumption per hour)	L	0.5	% of B

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some applications (stabilization reserve)

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

4. Model-related data (basic design)

No.	Description	Index	Value	Unit
3	Engine with exhaust turbocharger (ETC) and intercooler		X	-
4	Exhaust piping, non-cooled		X	-
33	Working method: four-cycle, diesel, single-acting		X	-
34	Combustion method: direct injection		X	-
36	Cooling system: conditioned water		X	-
37	Direction of rotation: c.c.w. (facing driving end)		X	-
6	Number of cylinders		20	-
7	Cylinder configuration: V angle		90	degrees (°)
10	Bore		170	mm
11	Stroke		210	mm
12	Displacement, cylinder		4.77	liter
13	Displacement, total		95.4	liter
14	Compression ratio		16.4	-
40	Cylinder heads: single-cylinder		X	-
41	Cylinder liners: wet, replaceable		X	-
49	Piston design: solid-skirt piston		X	-
21	Number of piston compression rings		2	-
22	Number of piston oil control rings		1	-
24	Number of inlet valves, per cylinder		2	-
25	Number of exhaust valves, per cylinder		2	-
15	Number of turbochargers		2	-
16	Number of L.P. turbochargers		2	-
18	Number of intercoolers		1	-

[BL] Reference value: fuel stop power
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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

19	Number of L.P. intercoolers		1	-
28	Standard flywheel housing flange (engine main PTO)		00	SAE
50	Static bending moment at standard flywheel housing flange, max.	L	15	kNm
51	Dynamic bending moment at standard flywheel housing flange, max.	L	75	kNm
43	Flywheel interface (DISC)		21	-

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Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

5. Combustion air / exhaust gas

No.	Description	Index	Value	Unit
27	Charge-air pressure before cylinder - FSP	R	4.05	bar abs
10	Combustion air volume flow - FSP	R	4.5	m ³ /s
12	Exhaust volume flow (at exhaust temperature) - FSP	R	11.1	m ³ /s
14	Exhaust temperature before turbocharger - FSP	R	642	°C
4083	Exhaust temperature after engine - FSP (Position of interface according to installation drawing)	R	457	°C
4085	Exhaust temperature after engine, max. - FSP (Position of interface according to installation drawing)	L	550	°C

BL Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

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Name	20V4000G94F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

6. Heat dissipation

No.	Description	Index	Value	Unit
16	Heat dissipated by engine coolant - FSP with oil heat, without charge-air heat	R	1140	kW
27	Charge-air heat dissipation - FSP	R	890	kW
32	Heat dissipated by return fuel flow - FSP	R	7.5	kW
34	Radiation and convection heat, engine - FSP	R	105	kW

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

7. Coolant system (high-temperature circuit)

No.	Description	Index	Value	Unit
17	Coolant temperature (at engine outlet to cooling equipment)	A	100.0	°C
57	Coolant temperature differential after/before engine, from	R	10.0	K
58	Coolant temperature differential after/before engine, to	R	12.0	K
23	Coolant temperature differential after/before engine	L	14.0	K
20	Coolant temperature after engine, limit 1	L	102.0	°C
21	Coolant temperature after engine, limit 2	L	104.0	°C
25	Coolant antifreeze content, max.	L	50	%
127	Cooling equipment: coolant flow rate at max. pressure loss in off-engine cooling System (see chapter 7, item No. 41)	A	75	m³/h
128	Cooling equipment: coolant flow rate at min. pressure loss in off-engine cooling System (see chapter 7, item No. 72)	A	80	m³/h
31	Coolant pump: pressure differential	R	2.25	bar
35	Coolant pump: inlet pressure, min.	L	0.50	bar
36	Coolant pump: inlet pressure, max.	L	2.50	bar
39	Engine: coolant pressure differential with thermostat	R	1.70	bar
41	Pressure loss in off-engine cooling system, max.	L	0.70	bar
72	Pressure loss in off-engine cooling system, min.	L	0.3	bar
43	Pressure loss in off-engine cooling system, max. without thermostat	L	0.70	bar
70	Pressure loss in off-engine cooling system, min. without thermostat	L	0.3	bar
47	Breather valve (expansion tank) opening pressure (excess pressure)	R	1.00	bar

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

54	Cooling equipment: height above engine, max.	L	15	m
53	Cooling equipment: operating pressure	A	2.50	bar
74	Coolant level in expansion tank, below min. shutdown	L	X	-
50	Thermostat, starts to open	R	79.0	°C
51	Thermostat, bypass closed	R	92.0	°C
52	Thermostat, fully open	R	92.0	°C
48	Breather valve (expansion tank) opening pressure (depression)	R	-0.1	bar
49	Pressure in cooling system, max.	L	5.00	bar

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

8. Coolant system (low-temperature circuit)

No.	Description	Index	Value	Unit
53	Coolant temperature (at engine outlet to cooling equipment)	R	70.0	°C
9	Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	45.0	°C
14	Coolant temperature before intercooler, limit 1	L	75.0	°C
15	Coolant temperature before intercooler, limit 2	L	78.0	°C
54	Coolant temperature differential after/before intercooler, min.	L	18.0 *	K
55	Coolant temperature differential after/before intercooler, max.	L	30.0 *	K
13	Coolant antifreeze content, max.	L	50	%
17	Charge-air temperature after intercooler, max.	L	80.0	°C
76	Temperature differential between intake air and charge-air coolant before intercooler	A	20.0	K
75	Temperature differential between intake air and charge-air coolant before intercooler, max.	L	22.0	K
18	Coolant pump: flow rate ($\pm 5\%$)	R	44.0	m ³ /h
80	Cooling equipment: coolant flow rate at max. pressure loss in off-engine cooling system	A	43	m ³ /h
81	Cooling equipment: coolant flow rate at min. pressure loss in off-engine cooling system	A	50	m ³ /h
24	Coolant pump: inlet pressure, min.	L	0.5	bar
25	Coolant pump: inlet pressure, max.	L	2.5	bar
29	Pressure loss in off-engine cooling system, max.	L	1.0	bar
62	Pressure loss in off-engine cooling system, min.	L	0.3	bar
31	Pressure loss in off-engine cooling system, max. without thermostat	L	1.0	bar

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on
some applications (stabilization reserve)

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Engine power that can be run continuously under standard
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Name	20V4000G94F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

63	Pressure loss in off-engine cooling system, min. without thermostat	L	0.3	bar
43	Cooling equipment: height above engine, max.	L	15	m
36	Breather valve (expansion tank) opening pressure (excess pressure)	R	1.00	bar
37	Breather valve (expansion tank) opening pressure (depression)	R	-0.10	bar
42	Cooling equipment: operating pressure	A	2.50	bar
68	Coolant level in expansion tank, below min. shutdown	L	X	-
39	Thermostat, starts to open	R	38.0	°C
40	Thermostat, bypass closed	R	51.0	°C
41	Thermostat, fully open	R	51.0	°C

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

10. Lube oil system

No.	Description	Index	Value	Unit
1	Lube oil operating temp. before engine, from	R	85	°C
2	Lube oil operating temp. before engine, to	R	98	°C
3	Lube oil operating temp. after engine, from	R	98	°C
4	Lube oil operating temp. after engine, to	R	108	°C
5	Lube oil temperature before engine, limit 1	L	99	°C
6	Lube oil temperature before engine, limit 2	L	101	°C
7	Lube oil operating pressure before engine (measuring block)	R	5.1	bar
8	Lube oil operating press. bef. engine, from	R	4.3	bar
9	Lube oil operating press. bef. engine, to	R	7.1	bar
33	Lube oil pressure before engine, limit 1 (speed-related value, consult Rolls-Royce Solutions GmbH)	L	3.5	bar
34	Lube oil pressure before engine, limit 2 (speed-related value, consult Rolls-Royce Solutions GmbH)	L	3.2	bar
17	Lube oil pump(s): oil flow, total	R	835	liter/min
19	Lube oil fine filter (main circuit): number of units		1	-
20	Lube oil fine filter (main circuit): number of elements per unit		5	-
21	Lube oil fine filter (main circuit): particle retention	R	0.012	mm
32	Lube oil fine filter (main circuit): pressure differential, max.	L	1.5	bar
35	Lube oil fine filter (main circuit): make (standard): MANN & HUMMEL		X	-

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

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		Nominal power [kVA]	-
		Nominal power [kWel]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

11. Fuel system

No.	Description	Index	Value	Unit
1	Fuel pressure at engine fuel feed connection, min. (when engine is starting)	L	-0.1	bar
2	Fuel pressure at engine fuel feed connection, max. (when engine is starting)	L	1.5	bar
57	Fuel pressure at engine fuel feed connection, min. (when engine is running)	L	-0.3	bar
65	Fuel pressure at engine fuel feed connection, max. (when engine is running)	L	0.5	bar
37	Fuel supply flow, max.	A	*	liter/min
4211	Max. fuel supply volume Normal mode	A	20.1	liter/min
4212	Fuel supply volume, max. Fault mode	A	22.6	liter/min
4	Fuel pressure before injection pump, from (high-pressure pump)	R	7.0	bar
5	Fuel pressure before injection pump, to (high-pressure pump)	R	9.0	bar
6	Fuel pressure before injection pump, min. (high-pressure pump)	L	5.0	bar
7	Fuel pressure before injection pump with engine not running, max. (high-pressure pump)	L	1.5	bar
4213	Max. fuel return volume Normal mode	A	5.5	liter/min
4214	Fuel return volume, max. Fault mode	A	21.8	liter/min
10	Fuel pressure at return connection on engine, max.	L	0.5	bar
18	Fuel fine filter (main circuit): number of units	A	1	-
19	Fuel fine filter (main circuit): number of elements per unit	A	2	-

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- Product Data -

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Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

21	Fuel fine filter (main circuit): pressure differential, max.	L	2.0	bar
----	--	---	-----	-----

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

12. General operating data

No.	Description	Index	Value	Unit
1	Cold start capability: air temperature (w/o starting aid, w/o preheating) - (case A)	R	10	°C
2	Additional condition (to case A): engine coolant temperature	R	10	°C
3	Additional condition (to case A): lube oil temperature	R	10	°C
4	Additional condition (to case A): lube oil viscosity	R	15W40	SAE
9	Cold start capability: air temperature (w/o starting aid, w/ preheating) - (case C)	R	0	°C
10	Additional condition (to case C): engine coolant temperature	R	40	°C
11	Additional condition (to case C): lube oil temperature	R	-10	°C
12	Additional condition (to case C): lube oil viscosity	R	15W40	SAE
21	Coolant preheating, heater performance (standard)	R	9.0	kW
22	Coolant preheating, preheating temperature, min.	L	32	°C
3506	Coolant preheating, preheating temperature, max.	L	55	°C
28	Breakaway torque (without driven machinery) coolant temperature +5°C	R	2600	Nm
30	Breakaway torque (without driven machinery) coolant temperature +40°C	R	2200	Nm
29	Cranking torque at firing speed (without driven machinery) coolant temperature +5°C	R	1400	Nm
31	Cranking torque at firing speed (without driven machinery) coolant temperature +40°C	R	1100	Nm
37	High idling speed, max. (static)	L	1613	rpm
38	Limit speed for overspeed alarm / emergency shutdown	L	1950	rpm
39	Limit speed for overspeed alarm	L	1950	rpm

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		Nominal power [kVA]	-
		Nominal power [kWel]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

42	Firing speed, from	R	80	rpm
43	Firing speed, to	R	120	rpm
44	Engine coolant temperature before starting full-load operation, recommended min. (for emergency/standby sets with coolant preheating the minimum preheating temperature referred to extended property No.22 is sufficient)	R	60	°C
3515	Minimum continuous load (operation > 10h)	R	30	kW/cyl
50	Engine mass moment of inertia (without flywheel)	R	24.6	kgm ²
52	Standard flywheel mass moment of inertia	R	10.2	kgm ²
51	Engine mass moment of inertia (with standard flywheel)	R	34.8	kgm ²
69	Speed droop (with electronic governor) adjustable, from	R	0	%
70	Speed droop (with electronic governor) adjustable, to	R	7	%
95	Number of starter ring-gear teeth on engine flywheel		182	-

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
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Exhaust Regulations NEA Singapore for ORDE;

13. Starting (electric)

No.	Description	Index	Value	Unit
2309	Manufacturer		Delco	-
4101	Type		50MT	-
2310	Number of starter		2	-
2312	Starter electrically redundant		-	-
2313	Rated power per starter	R	9	kW
2314	Starter, rated voltage	R	24	VDC
2315	Rated short-circuit current per starter	L	1900	A
2316	Power consumption per starter (at an engine speed of 100 rpm)	R	580	A
2317	Internal resistance of power supply + line resistance per starter	A	0.008	Ω
2318	Manufacturer		Bosch	-
4118	Type		HEP	-
2319	Number of starter		2	-
2320	Starter electrically redundant		-	-
2321	Rated power per starter	R	11.3	kW
2322	Starter, rated voltage	R	24	VDC
2323	Rated short-circuit current per starter	L	2190	A
2324	Power consumption per starter (at an engine speed of 100 rpm)	R	750	A
2325	Internal resistance of power supply + line resistance per starter	A	0.0047	Ω
2326	Manufacturer		Prestolite	-
4119	Type		S-152	-
2327	Number of starter		1	-
2328	Starter electrically redundant		-	-

BL Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
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		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

2329	Rated power per starter	R	15	kW
2330	Starter, rated voltage	R	24	VDC
2331	Rated short-circuit current per starter	L	3000	A
2332	Power consumption per starter (at an engine speed of 100 rpm)	R	1400	A
2333	Internal resistance of power supply + line resistance per starter	A	0.0049	Ω
2334	Manufacturer		Prestolite	-
4120	Type		S-152	-
2335	Number of starter		2	-
2336	Starter electrically redundant		X	-
2337	Rated power per starter	R	15	kW
2338	Starter, rated voltage	R	24	VDC
2339	Rated short-circuit current per starter	L	3000	A
2340	Power consumption per starter (at an engine speed of 100 rpm)	R	1400	A
2341	Internal resistance of power supply + line resistance per starter	A	0.0049	Ω
4104	Manufacturer		Prestolite	-
4105	Type		M128R	-
4106	Number of starter		2	-
4107	Starter electrically redundant		-	-
4108	Rated power per starter	R	9.4	kW
4109	Starter, rated voltage	R	24	VDC
4110	Rated short-circuit current per starter	L	2000	A
4111	Power consumption per starter (at an engine speed of 100 rpm)	R	600	A
4112	Power consumption per starter (at an engine speed of 100 rpm, SAE0)	R	-	A
4113	Power consumption per starter (at an engine speed of 100 rpm, SAE1)	R	-	A

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		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

4114	Internal resistance of power supply + line resistance per starter	A	0.008	Ω
2347	Generally valid data for starter		X	-
2342	Rated starting-attempt Duration (at +20°C ambient temperature with battery full)	R	5	s
2343	Interval between starts (at rated starting-attempt duration), min.	L	20	s
2345	Maximum acceptable starting-attempt duration	L	15	s
2344	Interval between starts (when starting-attempt duration > rated starting-attempt duration)	R	60	s
2346	Starting attempts within 30 minutes (at +20°C ambient temperature with battery full), max.	L	6	-
3565	Disengagement of starter pinion at engine Speed Note: Exceeding the guideline value of the disengagement speed will reduce the life cycle of the starter depending on how often and how much the speed has been exceeded	R	400	rpm
3566	Disengagement of starter pinion at engine speed, max.	L	500	rpm

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

15. Starting (pneumatic/oil pressure starter)

No.	Description	Index	Value	Unit
36	Pneumatic starter: make TDI		X	-
5	Starting air pressure before starter motor, min.	R	8	bar
6	Starting air pressure before starter motor, max.	R	9	bar
7	Starting air pressure before starter motor, min.	L	8	bar
8	Starting air pressure before starter motor, max.	L	9	bar
18	Start attempt duration (engine preheated)	R	3	s
19	Start attempt duration (engine not preheated)	R	5	s
114	Air consumption/start attempt (engine preheated) Engine without generator Control with engine controller	R	1.4	m ³ n
116	Air consumption with external control for air-starter (per second)	R	0.5	m ³ n
29	Starting air tank for 3 start attempts (max. 40 bar) (engine not preheated)	R	N	liter
30	Starting air tank for 3 start attempts (max. 30 bar) (engine not preheated)	R	N	liter
31	Starting air tank for 6 start attempts (max. 40 bar) (engine not preheated)	R	N	liter
32	Starting air tank for 6 start attempts (max. 30 bar) (engine not preheated)	R	N	liter
33	Starting air tank for 10 start attempts (max. 40 bar) (engine not preheated)	R	N	liter
34	Starting air tank for 10 start attempts (max. 30 bar) (engine not preheated)	R	N	liter
103	Starting oil pressure before starter motor, max.	R	207	bar
105	Starting oil pressure before starter motor, max.	L	207	bar
106	Start attempt duration (engine preheated)	R	2.5	s

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

108	Start attempt duration, max.	L	15	s
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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

16. Inclinations - standard oil system (ref.: waterline)

No.	Description	Index	Value	Unit
15	Longitudinal inclination, continuous max. driving end down (Option: max. operating inclinations)	L	5	degrees (°)
17	Longitudinal inclination, continuous max. driving end up (Option: max. operating inclinations)	L	5	degrees (°)
19	Transverse inclination, continuous max. (Option: max. operating inclinations)	L	10	degrees (°)

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[X] Applicable
The module is valid for this product type

[] Non-applicable
The module is not valid for this product type

[N] Value not named
The value has not yet been named or will not be named

[*] Adequate verification not yet available (tolerance +/- 10%)
[] Adequate verification not yet available (tolerance +/- 5%)**

[A] Design value
Value required for the design of an external system (plant)

[R] Guideline value
Typical average value as information – only suitable for design purposes to a limited extent

[L] Limit value
A value representing the lower limit/minimum value or upper limit/maximum value that may not be exceeded. Not suitable for design purposes



Name	20V4000G94F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

18. Capacities

No.	Description	Index	Value	Unit
1	Engine coolant capacity (without cooling equipment)	R	260	liter
10	Intercooler coolant capacity	R	50	liter
11	On-engine fuel capacity	R	9	liter
14	Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	390	liter
20	Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	340	liter
28	Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	270	liter
29	Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	315	liter

BL Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

DL Reference value: continuous power
Engine power that can be run continuously under standard conditions

≥ Actual value must be greater than specified value
≤ Actual value must be less than specified value

X Applicable
The module is valid for this product type

□ Non-applicable
The module is not valid for this product type

N Value not named
The value has not yet been named or will not be named

□ Adequate verification not yet available (tolerance +/- 10%)
□ Adequate verification not yet available (tolerance +/- 5%)

A Design value
Value required for the design of an external system (plant)

R Guideline value
Typical average value as information – only suitable for design purposes to a limited extent

L Limit value
A value representing the lower limit/minimum value or upper limit/maximum value that may not be exceeded. Not suitable for design purposes



Name	20V4000G94F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

19. Masses / dimensions

No.	Description	Index	Value	Unit
1	Engine dry mass (standard scope of supply)	R	9650	kg
2	Engine dry mass (with engine-mounted standard accessories incl. coupling)	R	10050	kg
4	Engine length (standard scope of supply)	R	3479	mm
5	Engine width (standard scope of supply)	R	1700	mm
6	Engine height (standard scope of supply)	R	2252	mm

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

[DL] Reference value: continuous power
Engine power that can be run continuously under standard conditions

[>] Actual value must be greater than specified value
[<] Actual value must be less than specified value

[X] Applicable
The module is valid for this product type

[] Non-applicable
The module is not valid for this product type

[N] Value not named
The value has not yet been named or will not be named

[*] Adequate verification not yet available (tolerance +/- 10%)
[] Adequate verification not yet available (tolerance +/- 5%)**

[A] Design value
Value required for the design of an external system (plant)

[R] Guideline value
Typical average value as information – only suitable for design purposes to a limited extent

[L] Limit value
A value representing the lower limit/minimum value or upper limit/maximum value that may not be exceeded. Not suitable for design purposes



Name	20V4000G94F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

21. Exhaust emissions

No.	Description	Index	Value	Unit
2005	Emissions data sheet: NEA Singapore for ORDE		X	-

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

[DL] Reference value: continuous power
Engine power that can be run continuously under standard conditions

[>] Actual value must be greater than specified value
[<] Actual value must be less than specified value

[X] Applicable
The module is valid for this product type

[] Non-applicable
The module is not valid for this product type

[N] Value not named
The value has not yet been named or will not be named

[*] Adequate verification not yet available (tolerance +/-10%)
[] Adequate verification not yet available (tolerance +/-5%)**

[A] Design value
Value required for the design of an external system (plant)

[R] Guideline value
Typical average value as information – only suitable for design purposes to a limited extent

[L] Limit value
A value representing the lower limit/minimum value or upper limit/maximum value that may not be exceeded. Not suitable for design purposes



Name	20V4000G94F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	3088
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	4141
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

22. Acoustics

No.	Description	Index	Value	Unit
102	Exhaust noise, unsilenced - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	121	dB(A)
202	Exhaust noise, unsilenced - FSP (sound power level LW, ISO 6798, +3dB(A) tolerance)	R	134	dB(A)
104	Exhaust noise, unsilenced - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	737214e	-
110	Engine surface noise with attenuated intake noise (filter) - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	111	dB(A)
210	Engine surface noise with attenuated intake noise (filter) - FSP (sound power level LW, ISO 6798, +2dB(A) tolerance)	R	130	dB(A)
112	Engine surface noise with attenuated intake noise (filter) - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	737188e	-
126	Structure borne noise at engine mounting brackets in vertical direction above resilient engine mounts - FSP Spectrum No.	R	737201e	-

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on
some applications (stabilization reserve)

[DL] Reference value: continuous power
Engine power that can be run continuously under standard
conditions

[>] Actual value must be greater than specified value
[<] Actual value must be less than specified value

[X] Applicable
The module is valid for this product type

[] Non-applicable
The module is not valid for this product type

[N] Value not named
The value has not yet been named or will not be named

[*] Adequate verification not yet available (tolerance +/-10%)
[] Adequate verification not yet available (tolerance +/-5%)**

[A] Design value
Value required for the design of an external system
(plant)

[R] Guideline value
Typical average value as information – only suitable
for design purposes to a limited extent

[L] Limit value
A value representing the lower limit/minimum value or
upper limit/maximum value that may not be
exceeded. Not suitable for design purposes



AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

APPENDIX 9.03

Alternator Datasheet

ALTERNATOR TECHNICAL DESCRIPTION
LSA 54.2 ZL17 / 4p

LS Reference: **MB260-04-2022-1** 1

Date: 08.04.2022 V6.09b - 01/2022 1
1

Nidec ACIM Germany GmbH
Electric Power Generation
Eschborner Landstrasse 166 - 60489 Frankfurt am Main MB

Main data C 1

Generator type: **LSA 54.2 ZL17 / 4p** 1
Power: 3 737 kVA 2 990 kWe 3 088 kWm 1
Voltage: 400 V Star serial 1
Rated voltage range: +5/-5% 1
Power factor - Lagging: 0,8 1
Frequency: 50 Hz 1
Speed: 1 500 rpm 1
Nominal current: 5 394 A 1
Winding type: p2/3 1
Classes (Insulation / Temperature Rise): H / H (Std-by) 1
Ambient temperature: 40 °C 1
Altitude: 1 000 m 1
-

Installation IEC Quantity 1 + x 1

Client: Rolls-Royce Solutions GmbH 1
Project: MTU 20V4000 DS3600 1
Site: XS596340.00179 / X59434400823/C45 1
Prime mover: Reciprocating engine 1
Manufacturer: MTU 1
Type: 20V4000G94F 1
Duty: Peak Rating 1
Industry: Construction 1
-

Mechanical construction IM1101 1

Type of construction: Two bearing 1
Mounting arrangement: Horizontal Axis 1
Direction of rotation: Clockwise (seen when facing the drive end - DE) 1
Bearing type: Anti-friction 1
Bearing Lubrication: Regreasable 1
Bearing insulation: Not insulated 1
Shaft end type: Cylindrical with keyway 1
Balancing - Class (ISO 1940/1): Half key - G2,5 (std) 1
Flange: None / without 1
Shaft height: 500 mm 1
Width: 1 150 mm 1
-

Additional specificities 1

Stabilized Runaway speed: 1 800 rpm - 2 min. 1

ALTERNATOR TECHNICAL DESCRIPTION
LSA 54.2 ZL17 / 4p

LS Reference: MB260-04-2022-1 1

Cooling Method

IC01

Degree of protection:	IP23	1
Coolant:	Air / Temperature: 40 °C	1
Air quality:	Clean	1
Ventilation (internal):	Self-ventilated	1
Filters:	Without	1
Ducting for air inlet:	No	1
Ducting for air outlet:	No	1

Connection, Excitation & Regulation

Parallel operation:	With mains (3F) - From measuring CT	1
Excitation:	Self-excited - Brushless - Type: AREP + PMI	1
Sustained 3-phase Isc:	> 3 x FLC for 10s.	1
AVR type:	Leroy Somer - D550 - Digital	1
AVR location:	In terminal box	1
Alternator Voltage sensing:	In terminal box	1
Additional features:	Three-phase sensing	1
	Diode failure detector	1

Terminal box

Power connection:	4 connectors (brought out neutral)	1
Main terminal box location:	1 terminal box on the top	1
Line side outlet:	Left hand side (seen when facing the drive end - D)	1
Gland plate:	Non magnetic, Undrilled	1
Auxiliaries	In main terminal box	1

Protection and measurement accessories

Temperature detection

Stator windings:	6 x 3-wire PT100 RTDs	1
Combined guide and thrust bearing - DE:	1 x 3-wire PT100 RTD	1
Guide bearing - NDE:	1 x 3-wire PT100 RTD	1

Anti-condensation heating

Voltage: 230 V - 1Ph / Power: 500 W

Transformers (Client use)

LS Supply		1
Set of 3 x CTs (measuring and/or protection):	I Primary / I Secondary / Power / Class	
<i>Preliminary</i> Neutral side	S1 6000 / 1A / 10VA / Cl. 0,5FS5	1

Various items

Paint:	C3M-P - Polyurethane - RAL defined by RRS	1
Documentation:	PDF manual	1
Documentation Language:	English	1

ALTERNATOR TECHNICAL DESCRIPTION
LSA 54.2 ZL17 / 4p

LS Reference: MB260-04-2022-1 1

Controls

QUAL/INES/006 001	Measurement of winding resistance	1
QUAL/INES/006 021	Insulation check on sensors (when fitted)	1
QUAL/INES/006 002	Voltage balance and phase order check	1
QUAL/INES/006 007	Overspeed test (according to test bench limitation)	1
QUAL/INES/006 009	High potential test	1
QUAL/INES/006 010	Insulation resistance measurement	1

Example

ALTERNATOR ELECTRICAL DATA
LSA 54.2 ZL17 / 4P

LS Reference: MB260-04-2022-1

Date: 08.04.2022

V6.09b - 01/2022

Main data:

Power:	3 737 kVA	2 990 kW _e	3 088 kW _m	1
Voltage:	400 V	Frequency:	50 Hz	1
Rated voltage range:	+5% / -5%	Speed:	1500 rpm	1
Power factor - Lagging:	0,8	Phases	3	1
Nominal current:	5 394 A	Connexion	Star serial	1
Insulation / Temperature rise:	H / H (Std-by)	Winding type:	p2/3	1
Cooling:	IC01	Winding:	- 6 Wires	1
Ambient temperature:	40 °C	Overspeed (rpm)	1800	1
Altitude:	1000 m	Total Harmonic Distortion (THD) < 3,5%		1
Duty: Peak Rating				

Efficiency (Base 2989,6 kW_e)

	25%	50%	75%	100%	110%	IEC
Power factor - Lagging: 0,8	92,3	95,6	96,5	96,8		1
Power factor - Lagging: 1	92,7	96,0	97,0	97,4		1

Reactances (%) - (Base 3737 kVA)

Unitary impedance (1 per unit) = 0,042815 ohms

		Unsaturated		Saturated	
		Direct axis	Quadrature axis	Direct axis	Quadrature axis
Synchronous reactance	X _d	173	114	X _q	88 / 58
Transient reactance	X' _d	19,8	16,8	X' _q	88 / 58
Subtransient reactance	X'' _d	11,7	9,9	X'' _q	13,0 / 11,0
Negative sequence reactance	X ₂	12,3	10,5		

X ₀	2,2	Zero sequence reactance	1
X _l	5,8	Stator leakage reactance	1
X _r	15,2	Rotor leakage reactance	1
K _c	0,88	Short-circuit ratio	1

Time constants (s)

	Direct axis	Quadrature axis
Open circuit transient time constant	T' _{do} 4,35	T' _{qo} NA
Short-circuit transient time constant	T' _d 0,498	T' _q NA
Open circuit subtransient time constant	T'' _{do} 0,071	T'' _{qo} 0,257
Subtransient time constant	T'' _d 0,042	T'' _q 0,038
T _a 0,067	Armature time constant	

Resistances (%)

R _a 0,6	Armature resistance	R ₀ 0,7	Zero sequence resistance	1
X/R 16,9	X/R ratio (without unit)	R ₂ 2,5	Negative sequence resistance	

Voltage accuracy: 0,25%

Maximum inrush current for a voltage dip of 15%: 3699 kVA

when starting an AC motor having a starting power factor between 0 and 0.4

Rating is provided for the specified temperature rise, by resistance measurement according to IEC60034-1

According to: I.E.C. 60034.1 - 60034.2 - NEMA MG 1-32

Products and materials shown in this catalogue may, at any time, be modified in order to follow the latest technological developments.

ALTERNATOR MAIN CURVES
LSA 54.2 ZL17 / 4P

LS Reference: MB260-04-2022-1

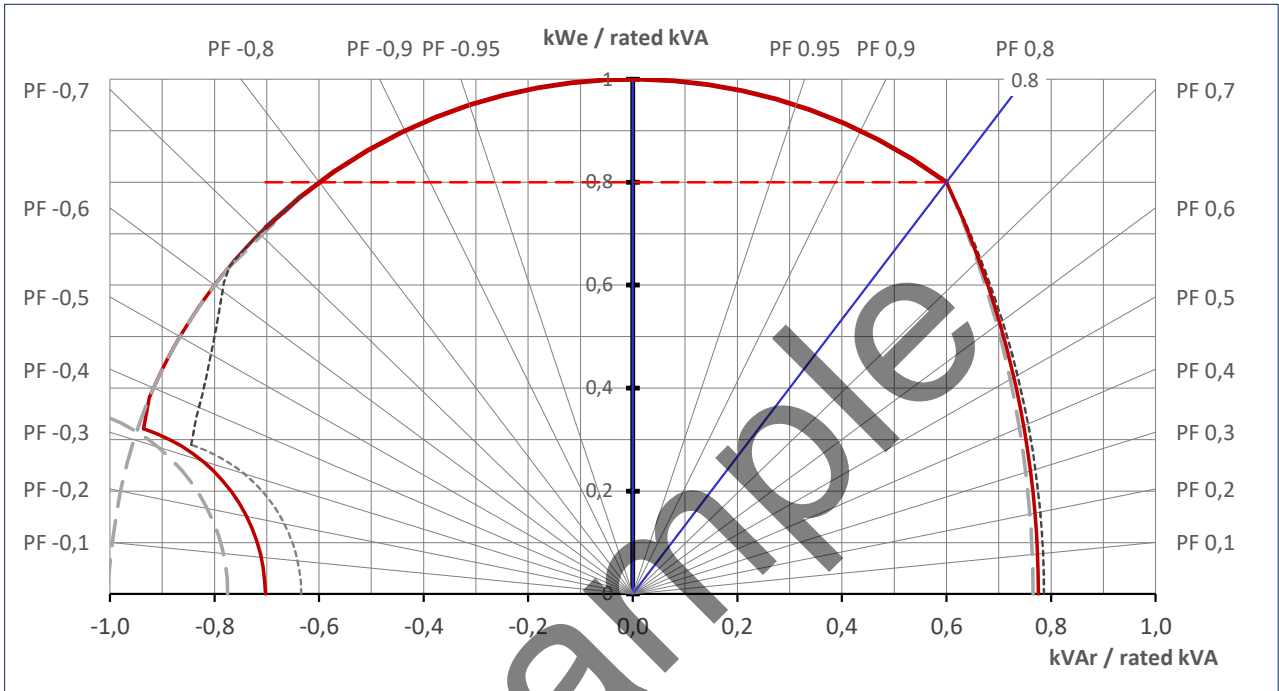
Date: 08.04.2022

3737kVA - 400V - 50 Hz

V6.09b - 01/2022

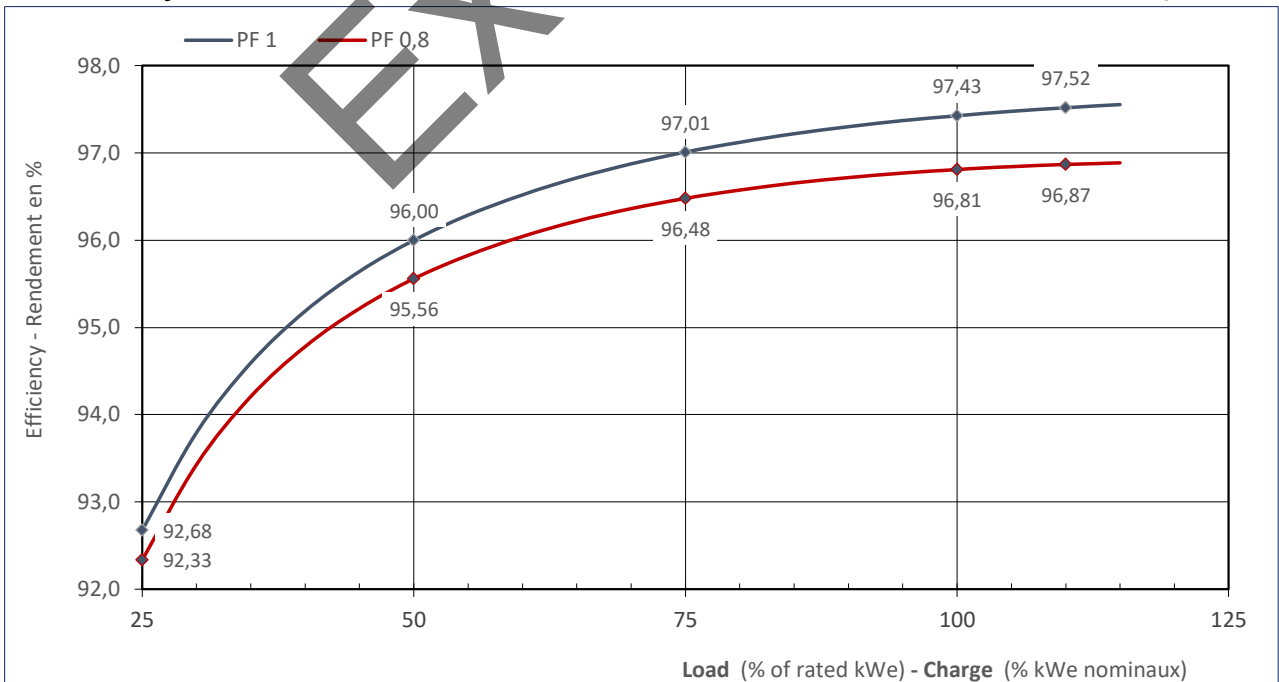
Capability Curve

---	Umax	+ 5%	420	V
—	Un		400	V
- - -	Umin	- 5%	380	V



Efficiency Curves

According to: IEC

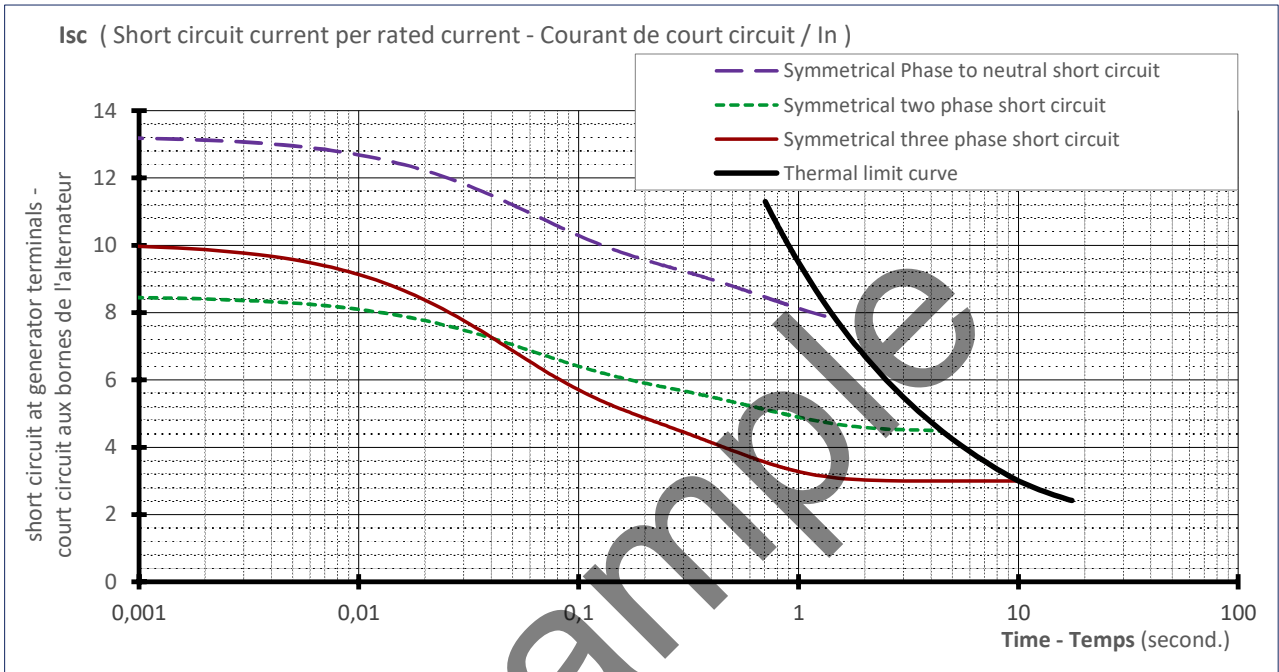


ALTERNATOR MAIN CURVES
LSA 54.2 ZL17 / 4P

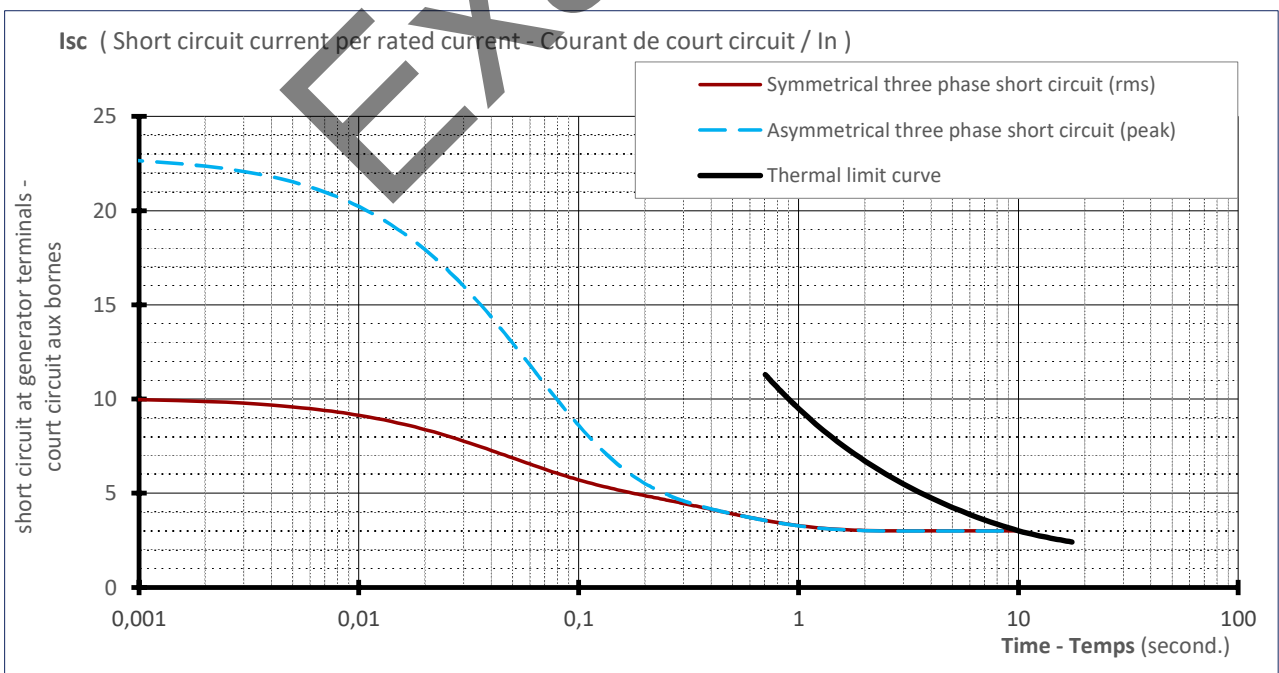
LS Reference: MB260-04-2022-1

Stator Current decrement curves

Symmetrical phase to neutral short-circuit	—	initial	71 109	A	13,2 x In	
Symmetrical two phase short-circuit	- - -	max	45 557	A	8,4 x In	In = 5394 A
Symmetrical three phase short-circuit	—	value	53 778	A	10 x In	
Thermal Limit	—					



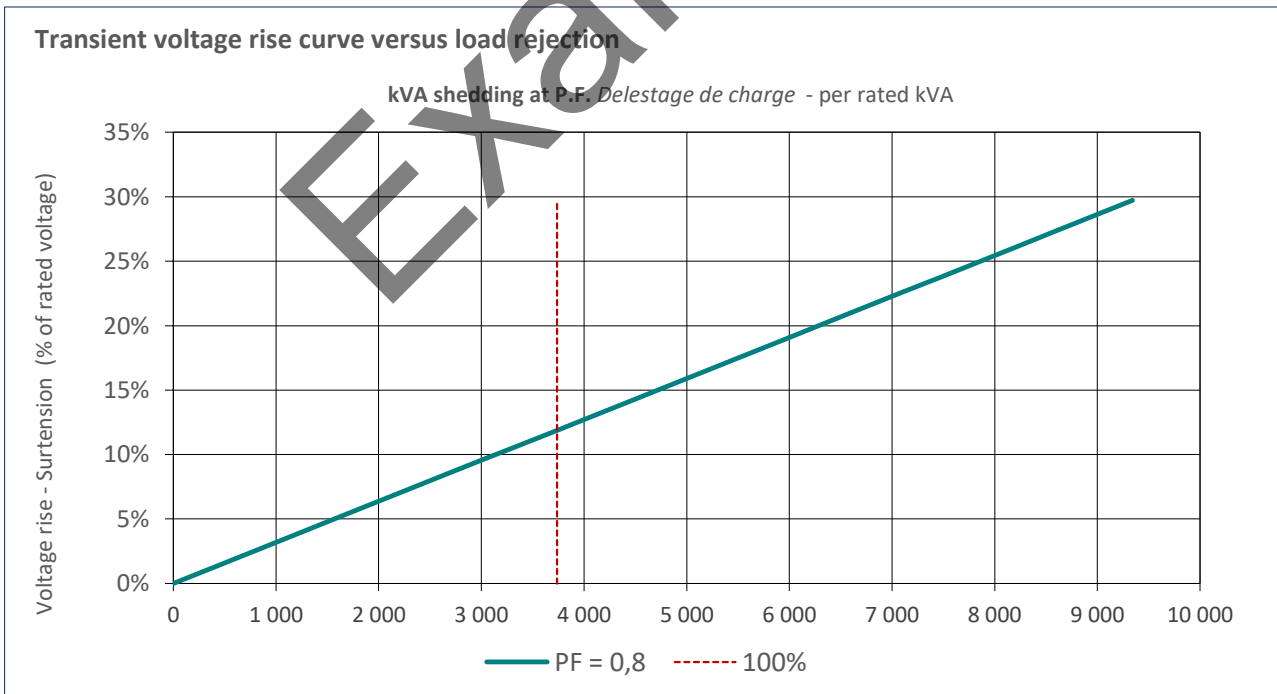
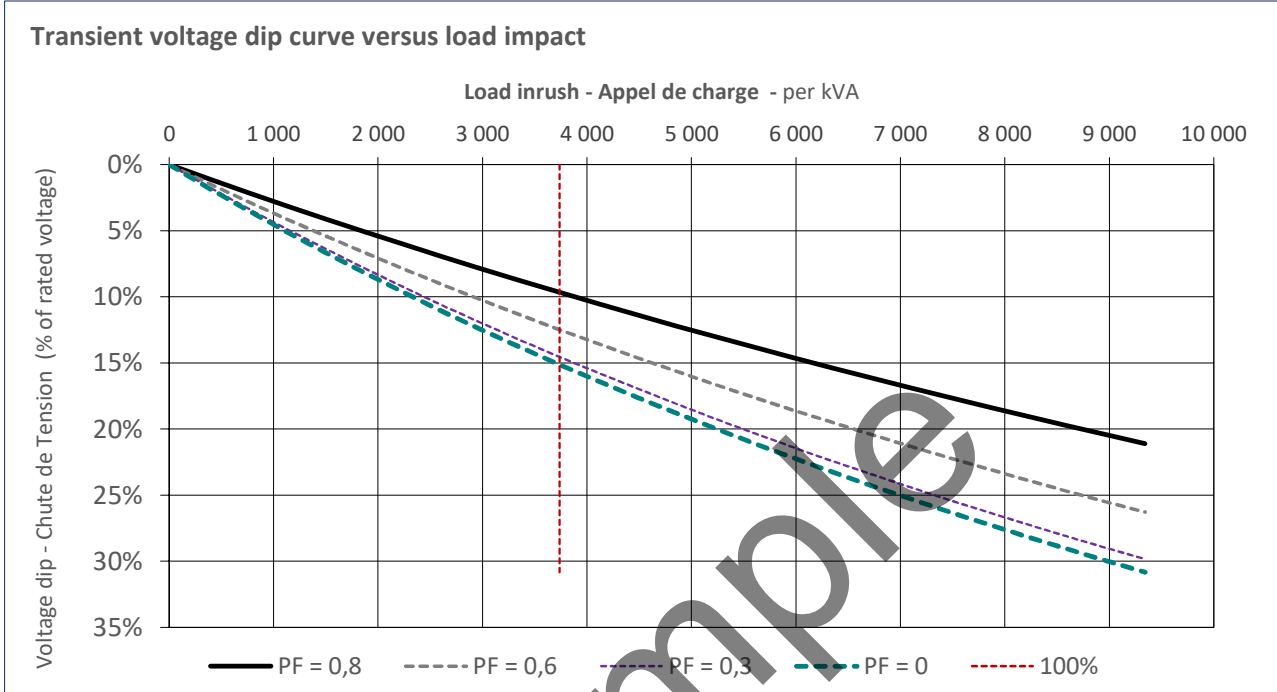
Asymmetrical three phase short-circuit	—	IP	121 233	A	22,5 x In
--	---	----	---------	---	-----------



ALTERNATOR MAIN CURVES
LSA 54.2 ZL17 / 4P

LS Reference: MB260-04-2022-1

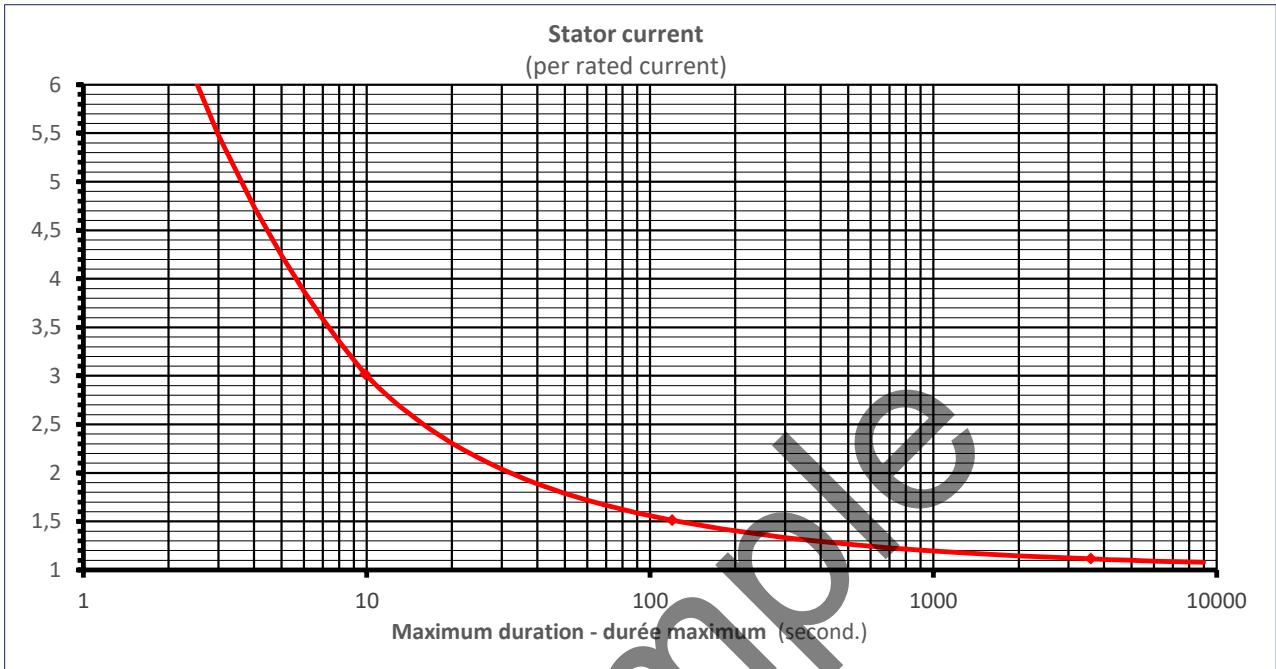
Transient Voltage Variation



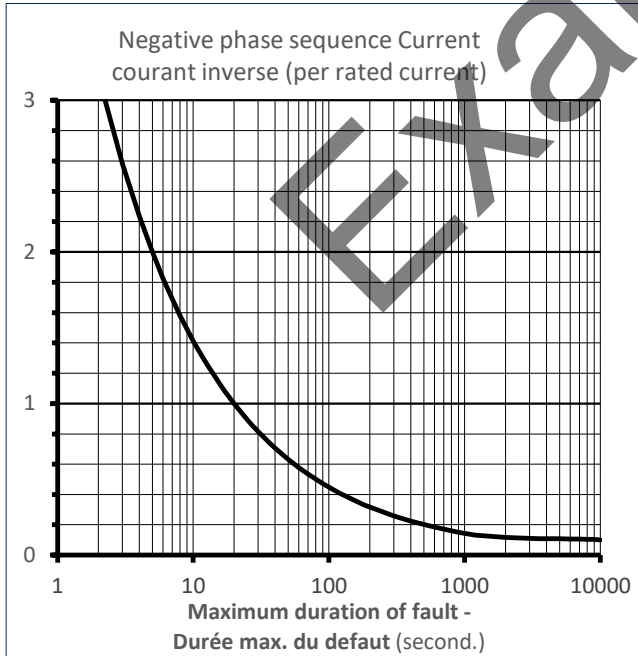
**ALTERNATOR MAIN CURVES
LSA 54.2 ZL17 / 4P**

LS Reference: MB260-04-2022-1

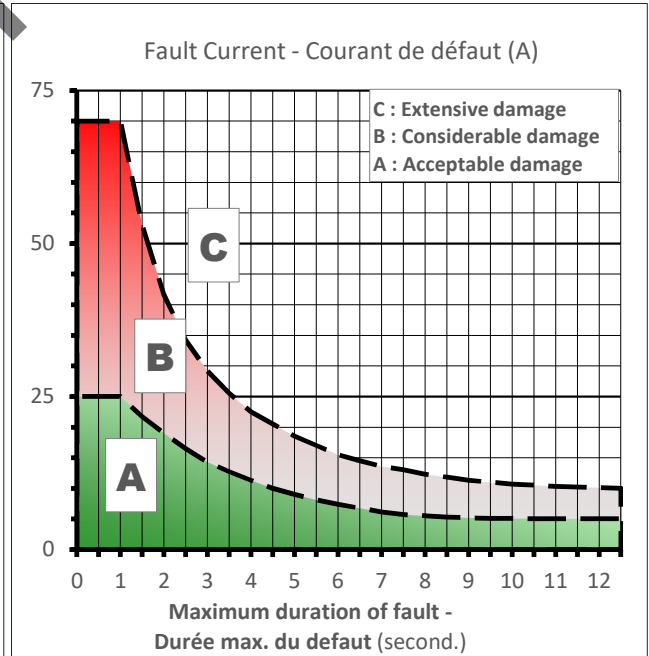
Thermal Damage Curve



Unbalance Load Curve



Stator Earth Fault Current





AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

APPENDIX 9.04

MTU Fluids and Lubricants



Fluids and Lubricants Specifications

Diesel engine-generator sets
with **Series 2000 and 4000 MTU engines**

A001064/09E

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1 Preface

1.1 General information

Used symbols and means of representation

The following instructions are highlighted in the text and must be observed:

Important

This field contains product information which is important or useful for the user. It refers to instructions, work and activities that have to be observed to prevent damage or destruction to the material.

Note:

A note provides special instructions that must be observed when performing a task.

Fluids and lubricants

The service life, operational reliability and function of the drive systems are largely dependent on the fluids and lubricants employed. The correct selection and treatment of these fluids and lubricants are therefore extremely important.

Test standard	Designation
DIN	Federal German Standards Institute
EN	European Standards
ISO	International Standards Organization
ASTM	American Society for Testing and Materials
IP	Institute of Petroleum

Applicability of this document

These Fluids and Lubricants Specifications define the fluids and lubricants for diesel engine-generator sets from MTU Onsite Energy with the following MTU engines:

- Series 2000Gx5
- Series 2000Gx6
- Series 4000Gx3, application groups 3B, 3D, 3E, 3F, 3G
- Series 4000Gx4

Note: Please ignore references to other series in this document.

Up-to-dateness of this document

The Fluids and Lubricants Specifications are revised or supplemented as required. Before using them, make sure you have the latest version (publication number A001064/..). The latest version is available at: www.mtuonsiteenergy.com in the area "Parts and Service" under "MTU ValueCare for Diesel Generator Sets" > "Technical Documentation".

Warranty

Use of the approved fluids and lubricants, either under the brand name or in accordance with the specifications given in this publication, constitutes part of the warranty conditions.

The supplier of the fluids and lubricants is responsible for the worldwide standard quality of the named products.

Important

Fluids and lubricants for diesel engine-generator sets can be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturers' instructions, legal requirements and technical guidelines valid in the individual countries. Great differences can apply from country to country and a generally valid guide to applicable regulations for fluids and lubricants is therefore not possible within this publication.

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants which it has approved.

MTU Onsite Energy recommends consultation with the suppliers of all fluids and lubricants to request the relevant safety data sheets prior to storing, handling and using these fluids and lubricants.

Safe disposal

Important

To prevent environmental pollution and infringements of statutory requirements, used fluids and lubricants must be disposed of in accordance with local regulations.
Never dispose of or burn the used oil in the fuel tank.

The regulations for the disposal of fluids and lubricants differs from place to place. Environmental protection is one of the fundamental corporate objectives of MTU Onsite Energy. We therefore recommend the recycling of fluids and lubricants wherever possible. If recycling is not possible, MTU Onsite Energy recommends consulting the local waste-disposal authorities before disposing of fluids and lubricants to determine the best option. Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants which it has approved.

Registered trademarks

All brand names are registered trademarks of the manufacturer concerned.

Preservation

The document "Preservation and Re-preservation Specifications" (publication number A001070/..) contains all information on:

- Preservation
- Re-preservation and de-preservation
- Permissible preservatives

The latest version is available at: www.mtuonsiteenergy.com in the area "Parts and Service" under "MTU ValueCare for Diesel Generator Sets" > "Technical Documentation".

2 Lubricants

2.1 Engine oils – General information

Important

Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the combustion engine!

Requirements of the engine oils for MTU approval

MTU conditions for the approval of engine oils for diesel engines are defined in the MTU standards and available under these numbers:

- MTL 5044: Engine oils for diesel engines; Requirements
- MTL 5051: Initial operation and corrosion inhibitor oil for internal preservation of engines

Manufacturers of engine oils are notified in writing if their product is approved.

Approved engine oils are divided into the following MTU quality groups:

- Oil category 1: Standard quality / Single and multigrade oils
- Oil category 2: Higher quality / Single and multigrade oils
- Oil category 2.1: Multigrade oils with a low ash-forming additive content (low SAPS oils)
- Oil category 3: Highest quality / Multigrade oils
- Oil category 3.1: Multigrade oils with a low ash-forming additive content (low SAPS oils)

Low SAPS oils are oils with a low sulfur and phosphor content and an ash-forming additive content of $\leq 1\%$.

They are only approved if the sulfur content in the fuel does not exceed 50 mg/kg. When using diesel particulate filters, it is advisable to use these oils to avoid fast coating of the filter with ash particles.

Selection of a suitable engine oil is based on fuel quality, projected oil drain interval and on-site climatic conditions. At present there is no international industrial standard which alone takes into account all these criteria.

Important

The use of engine oils not approved by MTU can mean that statutory emission limits can no longer be observed. This can be a punishable offense.

Important

Mixing different engine oils is strictly prohibited!

Changing to another oil grade can be done together with an oil change. The remaining oil quantity in the engine oil system is not critical in this regard.

This procedure also applies to MTU's own engine oils in the regions Europe, Middle East, Africa, America and Asia.

Important

When changing to an engine oil in Category 3, note that the improved cleaning effect of these engine oils can result in the loosening of engine contaminants (e.g. carbon deposits).

It may be necessary therefore to reduce the oil change interval and oil filter service life (one time during change).

Special features

MTU engine oils for diesel engines

At MTU, the following single and multigrade oils are available in the individual regions:

Manufacturer & sales region	Product name	SAE grade	Oil category	Part No.
MTU Friedrichshafen Europe Middle East Africa	Diesel Engine Oil DEO SAE 15W-40	15W-40	2	20 l canister: X00070830 210 l barrel: X00070832 IBC: X00070833 Loose items: X00070835 (only on request)
	Power Guard® DEO SAE 40	40	2	20 l canister: X00062816 210 l barrel: X00062817 IBC: X00064829
MTU America America	Power Guard® SAE 15W-40 Off Highway Heavy Duty	15W-40	2.1	5 gallons: 800133 55 gallons: 800134 IBC: 800135
	Power Guard® SAE 40 Off Highway Heavy Duty	40	2	5 gallons: 23532941 55 gallons: 23532942
MTU Asia Asia	Diesel Engine Oil DEO SAE 15-W40	15W-40	2	18 l canister: 64247/P 200 l barrel: 65151/D
MTU Asia China	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 64242/P 205 l barrel: 65151/D
	Diesel Engine Oil - DEO 10W-40	10W-40	2	20 l canister: 60606/P
	Diesel Engine Oil - DEO 5W-30	5W-30	3	20 l canister: 60808/P
MTU Asia Indonesia	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 64242/P 205 l barrel: 65151/D
MTU India Pvt. Ltd. India	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 63333/P 205 l barrel: 65151/P
	Diesel Engine Oil - DEO 40	40	2	20 l canister: 73333/P 205 l barrel: 75151/D

Restrictions for certain applications

- Series 2000 Gx6
- Series 4000 Gx3, application groups 3F, 3G

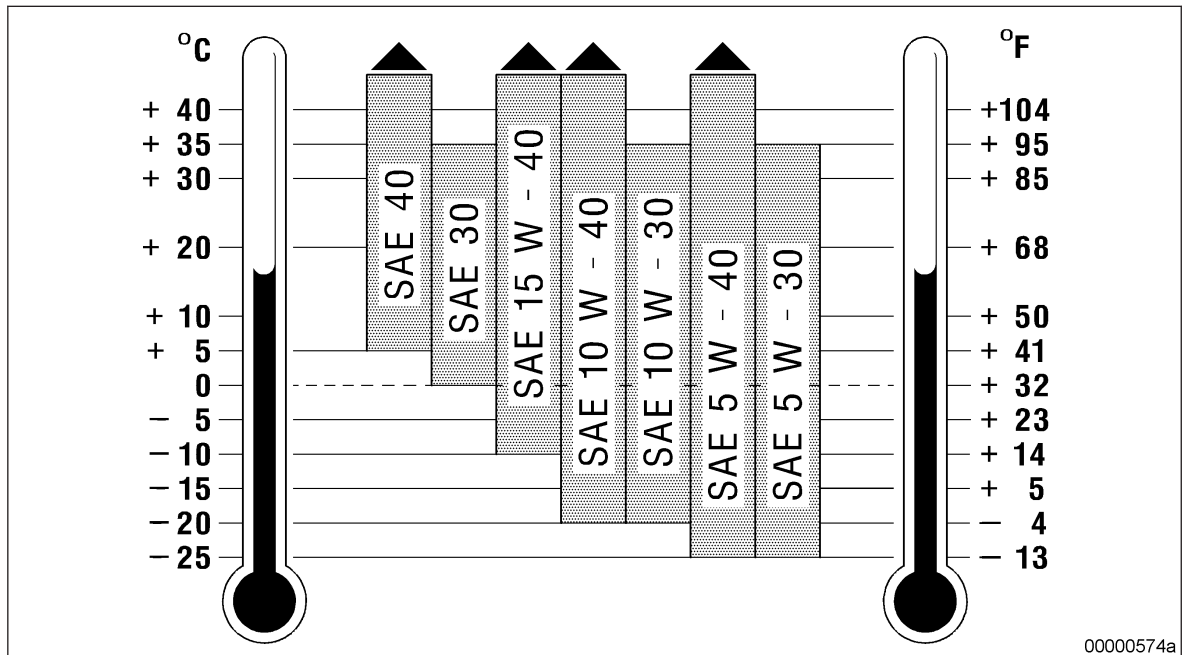
Important

Oils in oil category 1 must not be used!

Selection of viscosity grades

Selection of the viscosity grade is based primarily on the ambient temperature at which the engine is to be started and operated. If the relevant performance criteria are observed the engines can be operated both with single grade and multigrade oils, depending on the application. Guide values for the temperature limits of the individual viscosity classes, see (→ Figure 1).

If the prevailing temperature is too low, the engine oil must be preheated.



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Figure 1: Viscosity grade chart

Oil drain intervals for diesel engines

Engine oil drain intervals depend on the engine-oil quality, its conditioning, the operating conditions and the fuel used.

The intervals quoted (Table) are guide values based on operational experience and are valid for applications with a standard load profile.

Transmission fluid change intervals

Oil category	Without centrifugal oil filter	With centrifugal oil filter or by-pass filter
1	250 operating hours	500 operating hours
2	500 operating hours	1000 operating hours
2.1 ¹⁾	500 operating hours	1000 operating hours
3	750 operating hours	1500 operating hours
3.1 ¹⁾	750 operating hours	1500 operating hours

Table 1:

¹⁾ = To be used in conjunction with fuels with max. 50 mg/kg sulfur content.

Important

The oil drain intervals in the table (→ Table 1) are recommended guide values when using diesel fuels with < 0.5 % sulfur content. The defined limit values for the used oil (→ Table 2) must be observed. The numbers of operating hours quoted for oils must be confirmed by means of oil analysis.

The oil drain intervals must be determined by oil analysis if one or more of the following difficult operating conditions are encountered:

- Extreme climatic conditions
- High engine startup frequency
- Frequent and prolonged idling or low-load operation
- High fuel sulfur content of 0.5 to 1.5% by weight (see "Use of High-Sulfur Fuel")

For applications involving low runtimes, the engine oil must be changed every two years at the latest irrespective of its category.

Where engine oils with higher-grade corrosion-inhibiting characteristics are in use (→ Page 13), a change must be carried out every 3 years at the latest.

In individual cases the service life of the engine oil can be optimized by regular laboratory analysis and appropriate engine inspections in consultation with the MTU service point responsible:

- The first oil sample should be taken from the engine as a “basic sample” after the engine has run for approximately 1 hour after being filled with fresh oil.
- Further samples are to be analyzed at specific intervals (see "Laboratory Analysis").
- The appropriate engine inspections are to be carried out before and after the oil analyses.
- After completion of all analyses, and depending on the findings, special agreements can be reached for individual cases.
- Oil samples must always be taken under the same conditions and at the point provided for that purpose (see Operating Instructions).

Special additives

Engine oils approved have been specially developed for diesel engines and have all necessary properties. Further additives are therefore superfluous and may even be harmful.

Laboratory analysis

Spectrometric oil analysis

Analysis of the engine oil's additive-metal content is carried out by the MTU laboratory to determine the brand of oil.

MTU does not generally analyze the oil's wear-metal contents in order to determine the degree of engine wear. These content levels are very much dependent on the following factors, among others:

- Individual engine equipment status
- Tolerance scatter
- Operating conditions
- Duty profile
- Fluids and lubricants
- Miscellaneous assembly materials

Unambiguous conclusions as to the wear status of the engine components involved are therefore not possible. This means that no limit values can be given for wear-metal contents.

Used-oil analysis

In order to check the used oil, it is recommended that regular oil analyses be carried out. Oil samples should be taken and analyzed at least once per year and during each oil change and under certain conditions, depending on application and the engine's operating conditions, sampling / analysis should take place more frequently.

The specified test methods and limit values (Analytical Limit Values for Used Diesel Engine Oils) (→ Table 2) indicate when the results of an individual oil sample analysis are to be regarded as abnormal.

An abnormal result requires immediate investigation and remedy of the abnormality.

The limit values relate to individual oil samples. When these limit values are reached or exceeded, an immediate oil change is necessary. The results of the oil analysis do not necessarily give an indication of the wear status of particular components.

In addition to the analytical limit values, the engine condition, its operating condition and any operational faults are decisive factors with regard to oil changes.

Some of the signs of oil deterioration are:

- Abnormally heavy deposits or precipitates in the engine or engine-mounted parts such as oil filters, centrifugal oil filters or separators, especially in comparison with the previous analysis
- Abnormal discoloration of components

Analytical limit values for used diesel engine oils

Characteristics of the engine oil	Test method	Limit values	
Viscosity at 100 °C max. mm ² /s	ASTM D445 DIN 51562	SAE 30 SAE 5W-30 SAE 10W-30	15.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	19.0
SAE 30 SAE 5W-30 SAE 10W-30		9.0	
SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40		10.5	
min. mm ² /s			
Flashpoint °C (COC)	ASTM D92 DIN EN ISO 2592	Min. 190	
Flashpoint °C (PM)	ASTM D93 ISO 2719	min. 140	
Soot content (by weight %)	DIN 51452 CEC-L-82-A-97	Max. 3.0 (Oil category 1) Max. 3.5 (Oil category 2, 2.1, 3 and 3.1)	
Total base number (mg KOH/g)	ASTM D2896 ISO 3771 DIN 51639	Min. 50% of new-oil value	
Proportion of water (vol. %)	ASTM D6304 EN 12937 ISO 6296	max. 0.2	
Oxidation (A/cm) ¹⁾	DIN 51453 ¹⁾	Max. 25	
Ethylene glycol (mg/kg)	ASTM D2982	max. 100	

Table 2:

¹⁾ = only possible if there are no ester compounds

Use of high-sulfur diesel fuel

The following measures must be taken in the case of diesel fuels with a sulfur content above 0.5%:

- Use of an engine oil with a total base number (TBN) of more than 8 mgKOH/g
- Shorten oil draining intervals (see oil change intervals)
- Series 4000: TBO (Time Between Overhaul) for cylinder head: Shorten time between overhauls (→ Page 36)

Figure (→ Figure 2) shows the recommended minimum total base numbers for new and used oils depending on the sulfur content of the diesel fuel.

For the total base numbers (TBN) of the approved engine oil, see (→ Page 13).

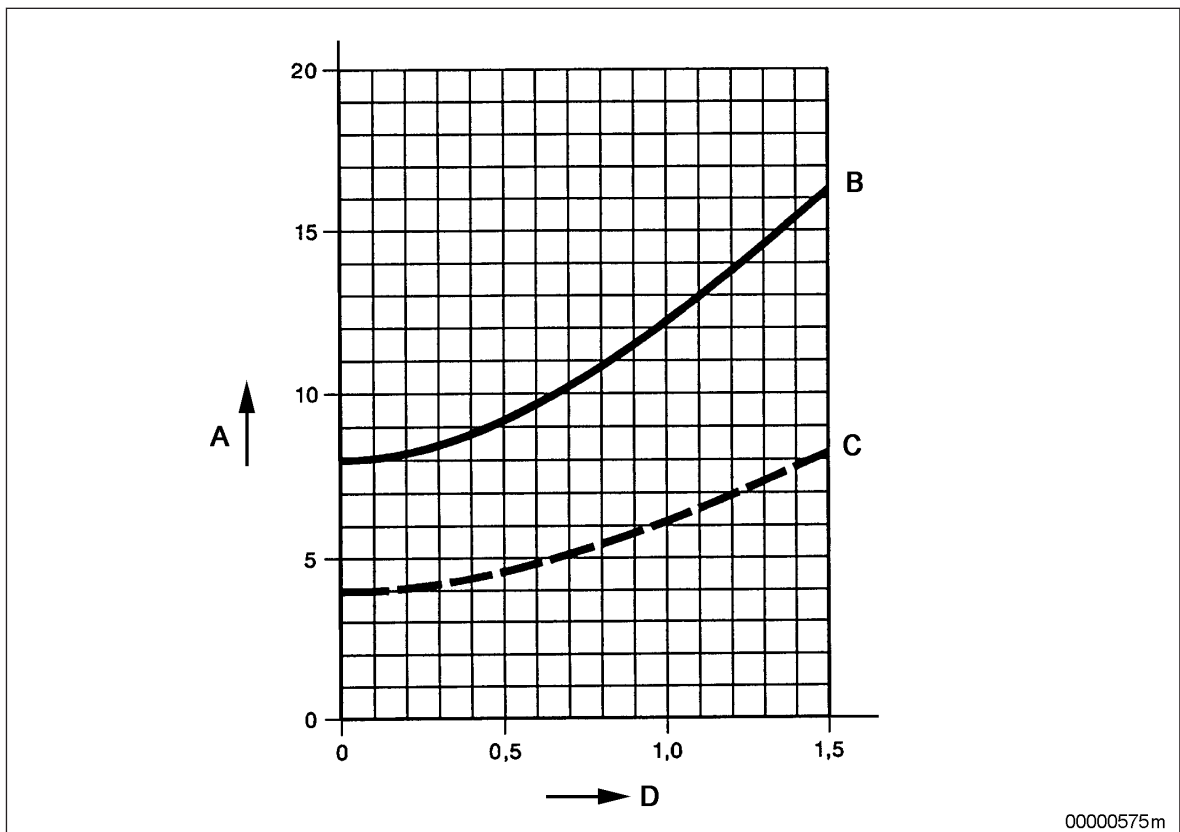


Figure 2: Engine oil Total Base Numbers depending on the Diesel Fuel's Sulfur Content

- | | |
|---|--|
| A Total base number in mgKOH/g, ISO 3771 | C Minimum total base number for used oil |
| B Recommended minimum total base number for fresh oil | D Sulfur content of fuel in % weight |

Use of low-sulfur diesel fuel

The use of diesel fuels with low sulfur content (< 0.5%) does not influence the oil drain intervals.

Minimum requirements for operational checks

Oil analyses can be carried out using the MTU Test Kit. The Test Kit contains all the equipment required as well as instructions for use.

The following checks can be performed:

- Determination of oil dispersing capacity (spot test)
- Determination of diesel fuel content in oil
- Determination of water content in oil

Test Package for North America

The MTU Advanced Fluid Management System is available in North America, which contributes to preventive maintenance through innovative diagnostics.

MTU Advanced Fluid Management System for engine oils, see (→ Page 16).

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2.2 Series-based usability for engine oils

Series-based usability of engine oils in MTU oil categories

Series	Approved engine oils		
	MTU oil category 1	MTU oil category 2 and 2.1 (Low Saps)	MTU oil category 3 and 3.1 (Low Saps)
2000Gx5	<ul style="list-style-type: none"> • Single-grade oils (→ Page 67) • Multigrade oils (→ Page 69) 	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)
2000Gx6	Not approved	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)
4000Gx3, application groups 3B, 3D, 3E	<ul style="list-style-type: none"> • Single-grade oils (→ Page 67) • Multigrade oils (→ Page 69) 	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)
4000Gx3, application groups 3F, 3G	Not approved	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)
4000Gx4	<ul style="list-style-type: none"> • Single-grade oils (→ Page 67) • Multigrade oils (→ Page 69) 	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)

2.3 Fluorescent dyestuffs for detecting leaks in the lube oil circuit

The fluorescent dyestuffs listed below are approved for detection of leaks in the lube oil circuit.

Manufacturer	Product name	Concentration for use	Part No.	Container size	Storage stability ¹⁾
Chromatech Europe B.V.	D5 1000A Chromatint Fluorescent Yellow 175	0.04 % - 0.07 %	X00067084	16 kg	2 years
Cimcool, Cincinnati	Producto YFD-100	0.5 % - 1.0 %		5 gallons (canister) 55 gallons (barrel)	6 months

Table 3:

¹⁾ = ex works delivery, based on original and hermetically sealed containers in frost-free storage (> 5 °C).

The fluorescence (light-yellow color tone) of both dyestuffs is made visible with a UV lamp (365 nm).

2.4 Lubricating greases

Requirements

The MTU conditions for lubricating-grease approval are specified in the MTU Factory Standard MTL 5050, which can be ordered under this reference number.

Grease manufacturers are notified in writing if their product is approved by MTU.

Lubricating greases for general applications

Lithium-saponified greases are to be used for all lubrication points with the exception of:

- Emergency-air shutoff flaps fitted between turbocharger and charge-air cooler (see Special-purpose lubricants)
- Coupling internal centering

Lubricating greases for applications at high temperatures

High-temperature grease (up to 250 °C) must be used for emergency-air shutoff flaps located between turbocharger and intercooler:

- Aero Shell Grease 15
- Optimol Inertox Medium

General purpose greases suffice for emergency-air shutoff flaps located before the turbocharger or after the intercooler.

Greases for internal centerings of couplings

Greases for internal centerings:

- Esso Unirex N3 (stable up to approx. 160 °C)

Special-purpose lubricants

Oil for turbochargers

Exhaust turbochargers with integrated oil supply are generally connected to the engine oil system.

For ABB turbochargers which are not connected to the engine lube oil system, mineral-based turbine oils with viscosity grade ISO-VG 68 must be used.

Lubricating greases for curved tooth couplings

Depending on the application, the following lubricants have been approved for curved tooth couplings:

- - Klüber: Structovis BHD MF (highly viscous lubricating oil)
- - Klüber: Klüberplex GE11-680 (adhesive transmission lubricant)

Guidelines on use and service life are contained in the relevant Operating Instructions and Maintenance Schedules.

2.5 MTU Advanced Fluid Management System for engine oils – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following:

- Optimized oil change intervals
- Extended engine service life
- Detection of minor problems before they become major problems
- Maximization of diesel engine-generator set's reliability
- Higher resale value of diesel engine-generator set

For full information on the MTU Advanced Fluid Management System available in North America, please contact an authorized MTU Onsite Energy service partner.

The following test packages from MTU Advanced Fluid Management System can be ordered from authorized MTU Onsite Energy service partners in North America:

- BMP32
Extended test – monitoring of wear and contamination
- AMP51R
Extended Test Plus – extension of the oil change intervals

The following engine oil parameters can be determined:

Engine oil parameters	BMP32	AMP51R
24 elementary metals *	✓	✓
percent water *	✓	✓
Viscosity at 40 °C for ISO engine oils	✓	✓
Viscosity at 100 °C for SAE engine oils	✓	✓
Percent fuel dilution **	✓	✓
Percent soot **	✓	✓
Oxidation/nitration	-	✓
Total base number **	-	✓
Total acid number	-	✓

* Samples of non-engine oils submitted with Order No. BMP32, are only examined spectrometrically for metals and the proportion of water and viscosity are determined.

** Samples of non-engine oils submitted with Order No. AMP51R are not examined for fuel dilution, soot content and base number.

The MTU Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Samples must be taken:

- While the engine is operating under normal conditions or immediately after stopping the engine while the engine is still at operating temperature
- Every 250 hours at the same point
- By means of suction pump via dipstick tube or sampling cock in filter return

Note: The software offered by MTU for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The MTU Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

3 Coolants

3.1 Coolants – General information

Coolant

Definition

Coolant = coolant additive (concentrate) + fresh water to predefined mixing ratio
Ready for use in engine

The corrosion-inhibiting effect of coolant is only ensured with the coolant circuit fully filled.

Apart from that, only the corrosion inhibitors approved for internal preservation of the coolant circuit provide proper corrosion protection when the medium was drained. This means that after draining the coolant the cooling circuit must be preserved if no more coolant is to be filled. The procedure is described in the Preservation and Represervation Specifications for MTU Onsite Energy (publication number A001070/..).

Coolants must be prepared from suitable fresh water and an MTU-approved coolant additive. Conditioning of the coolant takes place outside the engine.

Important

Mixtures of various coolant additives and supplementary additives (also in coolant filters and filters downstream of plant components) are not permitted!

The conditions for the approval of coolant additives are specified in the following MTU works standards (MTL):

- MTL 5048: Corrosion inhibiting antifreeze
- MTL 5049: Water-soluble corrosion inhibitor

Coolant manufacturers are informed in writing if their product is approved by MTU.

To prevent cooling system damage:

- When topping up (following loss of coolant) it must be ensured that not only water but also concentrate is added. The specified antifreeze and/or corrosion inhibitor concentration must be maintained.
- Flushing with water is required at every change to a different coolant product. For flushing and cleaning specifications for engine coolant circuits, see (→ Page 117).
- The corrosion inhibitor concentration must not exceed 55 % by volume (max. antifreeze) corrosion inhibitor. Concentrations in excess of this reduce antifreeze protection and heat dissipation. Only exception: BASF G206 (special application)
- The coolant must not contain any oil or copper residue (in solid or dissolved form).
- The majority of corrosion inhibitors currently approved for internal coolant circuit preservation are water-soluble and do not provide antifreeze protection. Make sure that the engine is stored safe from frost, because a certain amount of coolant remains in the engine after draining.
- A coolant circuit can not usually be drained completely, i.e. residual quantities of used coolant or fresh water from a flushing procedure remain in the engine. These residual quantities can result in the dilution of a coolant to be filled (mixed from a concentrate or use of a ready mixture). This dilution effect is higher the more add-on components there are on the engine. Check the coolant concentration in the coolant circuit and adapt it if necessary.

Important

All coolants approved in these Fluids and Lubricants Specifications generally relate only to the coolant circuit of MTU engines. In the case of complete propulsion plants, the operating fluids approvals of the component manufacturer must be observed!

Important

For corrosion-related reasons, it is not permissible to operate an engine with pure water without the addition of an approved corrosion inhibitor!

Special features

MTU coolants

The following coolant additives are available from MTU:

Manufacturer & sales region	Product name	Type
MTU Friedrichshafen and MTU Asia Europe Middle East Africa Asia	Antifreeze	
	Coolant AH 100 Antifreeze Concentrate	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l)
	Coolant AH 50/50 Antifreeze Premix	X00070528 (20 l) X00070530 (210 l) X00700527 (1000 l) (sales region: England)
	Coolant AH 40/60 Antifreeze Premix	X00070533 (20 l) X00070531 (210 l) X00700532 (1000 l) (sales region: England, Spain)
	Coolant RM 30 Readmix Coolant 40/60	X00073922 (20 l) X00073916 (205 l) X00073923 (1000 l)
	Coolant AH 35/65 Antifreeze Premix	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant without antifreeze	
	Coolant CS 100 Corrosion Inhibitor Concentrate	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l)
	Coolant CS 10/90 Corrosion Inhibitor Premix	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)

Manufacturer & sales region	Product name	Type
MTU America America	Antifreeze	
	Power Cool [®] Off-Highway Coolant 50/50 Premix	23533531 (5 gallons) 23533532 (55 gallons)
	Power Cool [®] Universal 50/50 mix	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
	Power Cool [®] Universal 35/65 mix	800085 (5 gallons) 800086 (55 gallons)
	Power Cool [®] 3 149 Concentrate	23528572 (55 gallons) 23528571 (1000 l)
	Coolant without antifreeze	
	Power Cool [®] Plus 6000 Concentrate	23533526 (1 gallon) 23533527 (5 gallons) colored green

Note

For ready mixtures, the proportion of coolant additive (concentrate) is always named first.

Example:

- Coolant AH 40/60 Antifreeze Premix = 40 % coolant additive by volume / 60 % fresh water by volume

3.2 Operational monitoring

Inspection of the fresh water and continuous monitoring of the coolant are essential for trouble-free engine operation. Fresh water and coolant should be inspected at least once per year and with each fill-up. Inspections can be carried out using the MTU Test Kit which contains the necessary equipment, chemicals and instructions for use.

The following tests can be conducted with the MTU Test Kit:

- Determination of total hardness (°d)
- pH value
- Chloride content of fresh water
- Corrosion-inhibiting oil content
- Determination of antifreeze content
- Determination of the concentration of coolant without antifreeze

Orders for fresh water and coolant analysis may be placed with MTU. Samples of min. 0.25 l must be supplied.

Important information

In the 4000-04-05 Series, an additional exhaust gas cooler is installed and the cooling system reacts more sensitively. A regular check of the coolant is therefore very important to ensure trouble-free engine operation. This check must be carried out annually or after 3000 operating hours and every time the coolant is filled.

The concentration, pH value and silicon content (only with coolant that contain Si) must be within the values specified in the MTU Fluids and Lubricants Specifications.

Important information

Due to thermal stress of the coolant in plants with preheating, a semi-annual analysis of the coolant is recommended.

Permissible concentrations

	Minimum				Maximum
Emulsifiable corrosion inhibitor oils without antifreeze	1% by volume	-	-	-	2% by volume
Antifreeze on ethylene glycol basis	35% by volume	40% by volume	45% by volume	50% by volume	55% by volume
with antifreeze protection up to*	-20 °C	-25 °C	-31 °C	-37 °C	-45 °C
Antifreeze on propylene glycol-basis	35% by volume	-	-	-	50% by volume
with antifreeze protection up to*	-18 °C	-	-	-	-32 °C
BASF G206	65% by volume for application at outside temperatures of up to -65 °C in arctic regions				

Table 4:

* = antifreeze specifications determined as per ASTM D 1177

Operational monitoring for permissible concentrations, coolant without antifreeze

Permissible concentration range	Manufacturer	Brand name vol%	Reading on hand refractometer ¹ at 20 °C (= degrees Brix)					
			7	8	9	10	11	12
9 to 11% by volume	MTU Friedrichshafen	Coolant CS 100 Corrosion Inhibitor Concentrate	3.5	4.0	4.5	5.0	5.5	6.0
		Coolant CS 10/90 Corrosion Inhibitor Premix	3.5	4.0	4.5	5.0	5.5	6.0
	MTU America	Power Cool® Plus 6000	3.5	4.0	4.5	5.0	5.5	6.0
	Arteco	Freecor NBI	Please use test kit of manufacturer					
	BASF SE	Glysacorr G93 green	3.5	4.0	4.5	5.0	5.5	6.0
	BP Lubricants	Castrol Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Manufacturing IL Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	Chevron	Texcool A -200	Please use test kit of manufacturer					
	Detroit Diesel Corporation	Power Cool Plus 6000	4.9	5.6	6.3	7.0	7.7	8.4
	Drew Marine	Drewgard XTA	3.5	4.0	4.5	5.0	5.5	6.0
	ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	Ginouves	York 719	3.5	4.0	4.5	5.0	5.5	6.0
	Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	4.9	5.6	6.3	7.0	7.7	8.4
	Valvoline	Zerex G-93	3.5	4.0	4.5	5.0	5.5	6.0
7 to 11% by volume	Arteco	Havoline Extended Life Corrosion Inhibitor XLI [EU 32765]	2.6	3.0	3.4	3.7	4.1	4.4
	Nalco	Alfloc (Maxitreat) 3443	1.75	2.0	2.25	2.5	2.75	3.0
		Alfloc (Maxitreat) 3477	1.75	2.0	2.25	2.5	2.75	3.0
	PrixMax Australia Pty. Ltd.	PrixMax RCP	2.6	3.0	3.4	3.7	4.1	4.4
Total	WT Supra	2.6	3.0	3.4	3.7	4.1	4.4	
5 to 6% by volume	Fleetguard	DCA-4L	Please use test kit of manufacturer					
	Detroit Diesel Corporation	Power Cool 3000						
	Penray	Pencool 3000						

Permissible concentration range	Manufacturer	Brand name vol%	Reading on hand refractometer ¹⁾ at 20 °C (= degrees Brix)					
			7	8	9	10	11	12
3 to 4% by volume	Detroit Diesel Corporation	Power Cool 2000	Please use test kit of manufacturer					
	Nalco	Alfloc 2000						
		Nalco 2000						
		Nalcool 2000						
		Trac 102						
Penray	Pencool 2000							

Table 5:

¹⁾ = concentration determination by means of suitable hand refractometer

Calibrate the hand refractometer with clean water at coolant temperature. The coolant temperature should be 20 °C. Observe the specifications of the manufacturer.

Operational monitoring of permissible concentrations, antifreeze on ethylene glycol basis

The concentration is determined using a suitable glycol refractometer and direct reading of the scale value in % by vol.

Calibration table for antifreeze for special applications

Reading on hand refractometer at 20 °C (= degrees Brix)		Corresponds to a concentration of
I. Propylene glycol antifreeze	II. BASF G206	
26.3	24.8	35% by volume
26.9	25.5	36% by volume
27.5	26.1	37% by volume
28.2	26.7	38% by volume
28.8	27.4	39% by volume
29.5	28.0	40% by volume
30.1	28.6	41% by volume
30.8	29.2	42% by volume
31.3	29.8	43% by volume
31.9	30.4	44% by volume
32.5	30.9	45% by volume
33.1	31.5	46% by volume
33.7	32.1	47% by volume
34.2	32.6	48% by volume
34.8	33.2	49% by volume
35.3	33.8	50% by volume
	34.4	51% by volume

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Reading on hand refractometer at 20 °C (= degrees Brix)		Corresponds to a concentration of
I. Propylene glycol antifreeze	II. BASF G206	
	34.9	52% by volume
	35.5	53% by volume
	36.1	54% by volume
	36.7	55% by volume
	37.2	56% by volume
	37.8	57% by volume
	38.3	58% by volume
	38.9	59% by volume
	39.4	60% by volume
	39.9	61% by volume
	40.5	62% by volume
	41.0	63% by volume
	41.5	64% by volume
	42.0	65% by volume

Table 6:

3.3 Series-based usability of coolant additives

All details are based on the coolant circuit on the engine side, no allowance is made for external add-on components.

Important

In the case of an engine coolant circuit with no light metal elements but with external add-on components containing light metal (e.g. cooling system or preheater), the coolant approvals for cooling systems containing light metal shall apply. If you have any doubts about a coolant application, consult your contact person at MTU.

For details and special information, see section “Coolants” (→ Page 17)

Any deviating special agreements between the customer and MTU-Friedrichshafen shall remain valid.

Series	Cooling system containing light metals	Coolant without antifreeze
2000Gx5 2000Gx6	Yes	<ul style="list-style-type: none"> Concentrates for cooling systems containing light metal, see (→ Page 96) Ready mixtures for cooling systems containing light metal, see (→ Page 98)
4000Gx3 4000Gx4	No *	<ul style="list-style-type: none"> Concentrates for cooling systems containing light metal, see (→ Page 99) Ready mixtures for cooling systems containing light metal, see (→ Page 101)

Series	Cooling system containing light metals	Antifreeze	
2000Gx5 2000Gx6	Yes	<ul style="list-style-type: none"> Concentrates for cooling systems containing light metal, see (→ Page 102) Concentrates for special applications, see (→ Page 105) Ready mixtures for cooling systems containing light metal, see (→ Page 106) 	<ul style="list-style-type: none"> Concentrates based on ethylene glycol (suitable for series with and without light metal), see (→ Page 115)
4000Gx3 4000Gx4	No *	<ul style="list-style-type: none"> Concentrates for cooling systems containing light metal, see (→ Page 108) Concentrates for special applications, see (→ Page 111) Ready mixtures for cooling systems containing light metal, see (→ Page 112) 	<ul style="list-style-type: none"> Ready mixture based on propylene glycol for series free of light metal, see (→ Page 116)

* In the case of an engine coolant circuit with no light metal elements but with external add-on components containing light metal (e.g. cooling system or preheater), the coolant approvals for cooling systems containing light metal shall apply.

3.4 Unsuitable materials in the coolant circuit

Components made of copper, zinc and brass materials

Unless various preconditions are observed, components made of copper, zinc and brass materials in the coolant circuit can cause an electrochemical reaction in conjunction with base metals (e.g. aluminum). As a result, components made of base metals are subject to corrosion or even corrosive pitting. The coolant circuit becomes leaky at these points.

Requirements

Based on current knowledge, the following materials and coatings must not be used in an engine coolant circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- No galvanized surfaces
The entire cooling system must be free of zinc components. This also applies to coolant supply and drain lines as well as to storage containers.
- No copper-based alloys as material with the use of coolant containing nitrite, with the exception of the following two alloys:
 - CuNi10Fe1Mn corresponds to CW-352-H
 - CuNi30Mn1Fe corresponds to CW-354-H
- Do not use components containing brass in the coolant circuit (e.g. coolers made of CuZn30) if exposed to ammoniacal solutions (e.g. amines, ammonium, ...) and solutions containing nitrite or sulfide. Stress-corrosion cracking is possible in the presence of tensile stress and a critical potential area. "Solutions" refer to cleaning agents, coolants and similar substances.

Non-metallic materials

- Do not use EPDM or silicone elastomers if emulsifiable corrosion inhibitor oils are used or other oils are introduced to the coolant circuit.

Coolant filter / filter downstream of plant components

- If such filters are used, only products that do not contain additives may be used.
Supplementary additives such as silicates, nitrites etc. can diminish the protective effect or service life of a coolant and, possibly, attack the materials installed in the coolant circuit.

Information:

In case of doubt about the use of materials on the engine and add-on components / components in coolant circuits, consultation with the respective MTU specialist department must be held.

3.5 Fresh water requirements

For preparation of coolant without antifreeze protection

Only clean, clear water with values in accordance with those in the following table must be used for preparing the coolant. If the limit values for the water are exceeded, de-mineralized water can be added to reduce the hardness or mineral content.

Parameters	Minimum	Maximum
Sum of alkaline earth metals *) (Water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH value at 20 °C	5.5	8,0
Chloride ions		100 mg/l
Sulphate ions		100 mg/l
Anions total		200 mg/l
Bacteria		10 ³ CFU (colony forming unit)/ml
Fungi, yeasts	are not permitted!	

*) Common designations for water hardness in various countries:

1 mmol/l = 5.6°d = 100 mg/kg CaCO₃

- 1°d = 17.9 mg/kg CaCO₃, USA hardness
- 1°d = 1.79° French hardness
- 1°d = 1.25° English hardness

3.6 Antifreeze

The preceding MTU Fluids and Lubricants Specifications used the designation "Corrosion inhibiting anti-freeze". This designation will be replaced with immediate effect to "Antifreeze".

Antifreezes are necessary for engines without heating facilities and operating in areas where below-freezing temperatures may occur.

Most of the antifreezes approved at MTU are based on ethylene glycol.

Exceptions:

- Ready mixture Fleetguard PG XL based on propylene glycol (→ Page 116)
- Concentrate BASF G206 as a mixture of ethylene glycol and propylene glycol

Provided that they are used in approved concentrations, antifreezes approved by MTU provide effective protection against corrosion, see section "Operational monitoring" (→ Page 20).

The antifreeze concentration must be determined not only in accordance with the minimum anticipated temperatures but also with the corrosion protection requirements.

Important

For the coolant additives approved for the individual series, see (→ Page 24).

Special approvals presently in effect remain valid.

Important

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Note:

- Propylene glycol-based antifreezes are stipulated for use in some types of applications. These products have a lower thermal conductivity than the usual ethylene glycol products. This brings about a higher temperature level in the engine.
- The product BASF G206 is available for use at extremely low temperatures (< -40 °C).
- Flushing with water is required at every change to a different coolant product. For flushing and cleaning specifications for engine coolant circuits, see (→ Page 117).

3.7 Coolant without antifreeze

The preceding MTU Fluids and Lubricants Specifications used the designation "water-soluble corrosion inhibiting antifreeze". This designation will be replaced with immediate effect with "coolant without antifreeze".

Engine coolant without antifreeze is required in the case of higher coolant temperatures or larger temperature gradients in heat exchangers, e.g. in TB systems (with plate-core heat exchanger) and TE systems.

Provided that they are used in adequate concentration, coolants without antifreeze approved by MTU provide effective corrosion protection. The relevant concentration range for use is listed in the section on operational monitoring.

Important

For approved coolant additives for the individual engine series, refer to section "Approved coolants" (→ Page 24).

Special arrangements presently in effect remain valid.

Important

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Flushing with water is required at every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant if the engines were preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the section "Flushing and cleaning specifications for engine coolant circuits" (→ Page 117).

3.8 Emulsifiable corrosion-inhibiting oils

Emulsifiable corrosion-inhibiting oils must not be used with the following Series:

- Series 2000
- Series 4000

Special approval presently in effect remain valid.

3.9 Limit values for coolants

pH value when using:		
- Emulsifiable corrosion inhibiting oil	Min. 7.5	Max. 9.5
- Antifreeze	Min. 7.5	Max. 9.0
- Coolant without antifreeze for engines containing light metal	Min. 7.5	Max. 9.0
- Coolant without antifreeze for engines free of light metal	Min. 7.5	Max. 11.0
Silicon (valid for coolants containing Si)	Min. 25 mg/l	

Table 7:

The coolant must be changed in case of non-compliance with the above specifications.

Note:

For a holistic appraisal of a coolant function, apart from the above-mentioned limit values the respective coolant-specific characteristic data and the fresh water quality used must be taken into consideration.

3.10 Storage capability of coolant concentrates

The storage capability specifications refer to coolant concentrates in original, hermetically sealed packing with storage temperatures up to max. 30 °C.

The instructions of the manufacturer must also be observed.

Coolant concentrate	Limit value	Brand name / Comments
Emulsifiable corrosion-inhibiting oil	6 months	
Antifreeze	Approx. 3 years	Observe manufacturer's specifications
Products containing propylene glycol	3 years	BASF G206
Coolant without antifreeze	6 months	Nalco Trac 102
	1 year	Detroit Diesel Corp. Power Cool 3000 Penray Pencool 3000
	2 years	Arteco Freecor NBI Chevron Texcool A-200 – Nalco Alfloc 2000 Nalco Nalcool 2000 Nalco Nalco 2000 Detroit Diesel Corp. Power Cool 2000 Penray Pencool 2000 PrixMax RCP
	3 years	BASF Glyscorr G93 green Drew Marine Drewgard XTA Ginouves York 719 MTU Friedrichshafen Coolant C150 MTU America Power Cool® Plus 6000 Nalco Alfloc (Maxitreat) 3477 Valvoline ZEREX G-93
	5 years	Arteco Havoline Extended Life Corrosion Inhibitor XLI [EU 032765] BP Castrol Extended Life Corrosion Inhibitor CCI Corporation A216 CCI Manufacturing IL A216 Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free [US 236514] Detroit Diesel Corp. Power Cool Plus 6000 ExxonMobil Mobil Delvac Extended Life Corrosion Inhibitor Fleetguard DCA-4L Old World Industries Final Charge Extended Life Corrosion Inhibitor (A216) Total WT Supra

Table 8:

Note:

For reasons of corrosion protection, do not store in galvanized bins. Take this requirement into account when coolant must be transferred.

Containers must be hermetically sealed and stored in a cool, dry place. Frost protection must be provided in winter.

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Further information can be obtained from the product and safety data sheets for the individual coolants.

3.11 Color additives for detection of leaks in the coolant circuit

The following listed fluorescent dyes are approved as additives for coolant without antifreeze for the detection of leaks.

Manufacturer	Product name	Part No.	Container size	Storage stability ¹⁾
Chromatech Inc. Chromatech Europe B.V.	D11014 Chromatint Uranine Conc	X00066947	20 kg	2 years

Table 9: Approved dye additives

¹⁾ = based on original and hermetically sealed containers in frost-free storage (> 5 °C)

Application:

Approx. 40 g dye must be added to 180 l coolant.

This dye quantity is already very generous and must not be exceeded.

The fluorescence (yellow color tone) is easily recognizable in daylight. In dark rooms, UV light can be used with a wave length of 365 nm.

3.12 MTU Advanced Fluid Management System for coolant – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following:

- Optimization of the coolant change intervals
- Evaluation of metal migration
- Evaluation of the coolant's corrosive properties
- Detection of the causes of problems in the cooling system in connection with blown cylinder-head gaskets, electrical ground problems, localized overheating and contaminants within and outside the system

For full information on the MTU Advanced Fluid Management System available in North America, please contact an authorized MTU Onsite Energy service partner.

The following test packages from MTU advanced Fluid Management System can be ordered from authorized MTU Onsite Energy service partners in North America:

- C-P92
Basic test – For monitoring the corrosivity of the coolant and for detecting metal migration
- C-P94
Extended test – Identification of the causes of leaks in the combustion system, grounding problems and contamination in the plant
- C-P93
Extended Test Plus – Monitoring of corrosivity and metal migration plus HPLC analysis and IC analysis for confirmation of the determined contamination of the corrosion inhibitor

The following coolant parameters can be determined:

Coolant parameters	C-P92	C-P94	C-P93
15 elementary metals	✓	✓	✓
Glycol percentage	✓	✓	✓
Freezing point	✓	✓	✓
Boiling point	✓	✓	✓
pH value	✓	✓	✓
Total hardness	✓	✓	✓
SCA number	✓	✓	✓
Nitrite	✓	✓	✓
Specific conductivity	✓	✓	✓
Carboxylic acid	✓	✓	✓
Sensory parameters (color, oil, fuel, magnetic precipitation, amagnetic precipitation, odor and foam)	✓	✓	✓
Contamination and corrosion inhibitor through IC (chloride, sulfate, nitrite, nitrate, phosphate and glycolate)	-	✓	✓
HPLC	-	-	✓

The MTU Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Samples must be taken:

- While the engine is operating under normal conditions or immediately after stopping the engine while the engine is still at operating temperature
- Every 250 hours at the same point

Note: The software offered by MTU for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The MTU Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

4 Liquid Fuels

4.1 Diesel fuels – General information

Important
 Dispose of used fluids and lubricants in accordance with local regulations.
 Used oil must never be disposed of via the combustion engine!

Selection of a suitable diesel fuel

The quality of the fuel is very important for satisfactory engine performance, long engine service life and acceptable exhaust emission levels.

Important
 Diesel fuels are not available worldwide in the quality required according to (→ Table 10).
 The fuel properties depend on many factors, in particular, region, time of year and storage.

Unsuitable fuel usually leads to a reduced service life of engine components and can also cause engine damage.

Further details on fuel qualities, tank care and filtration are available in the publication "Useful information on fuels, tank systems and filtration" (publication number A060631/..).

Characteristics of the fuel		Test method		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorine compounds.
Total contamination (= elements insoluble in fuel)	max.	D6217	EN 12662	24 mg/kg
Density at 15 °C	min.	D1298	EN ISO 3675	0.820 g/ml
	max.	D4052	EN ISO 12185	0.860 g/ml
API gravity at 60 °F	min.	D287		41
	max.			33
Viscosity at 40 °C	min.	D445	EN ISO 3104	1.5 mm ² /s
	max.			4.5 mm ² /s
Flashpoint (closed crucible)	min.	D93	EN ISO 2719	55 °C
Boiling curve:		D86	EN ISO 3405	
- Initial boiling point				160 to 220 °C
- Volume share at 250 °C	max.			65% by volume
Recovery at 350 °C	min.			85% by volume
- Residue and loss	max.			3% by volume

¹⁾ Filter plugging point or Cold Filter Plugging Point (CFPP) denotes the temperature at which a test filter is blocked under defined conditions by precipitated paraffins. This characteristic is used for diesel fuels as per DIN EN 590 to describe the climatic requirements (e.g. summer and winter diesel).
²⁾ The cloud point is the temperature at which a liquid product becomes turbid in the test glass due to precipitation of paraffin. This must not be higher than the ambient temperature.
 Note: 1% by weight = 10000 mg/kg = 10000 ppm

Characteristics of the fuel		Test method		Limit values
		ASTM		
Fatty acid methyl ester content (FAME) ("Biodiesel")	max.		EN 14078 Internal MTU procedure	7.0% by volume
Proportion of water: (absolute, no free water)	max.	D6304	EN ISO 12937	200 mg/kg
Carbon residue from 10% distillation residue	max.	D189	EN ISO 10370	0.30% by weight
Oxide ash:	max.	D482	EN ISO 6245	0.01% by weight (100 mg/kg)
Sulfur content: 2000Gx5, 4000Gx3, 4000Gx4	max.	D5453, D2622	EN ISO 20846, EN ISO 20884	0.5% by weight (5000 mg/kg)
Sulfur content: 2000Gx6				0.05% by weight (500 mg/kg)
Cetane number	min.	D613	EN ISO 5165, EN ISO 15195	45
Cetane index	min.	D976	EN ISO 4264	42
Copper corrosion 3 hrs at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1 a
Oxidation stability(Rancimat)	min.		EN 15751	20 hours
Oxidation stability	max.	D2274	EN ISO 12205	25 g/m ³
Lubricity at 60 °C (HFRR value)	max.	D6079	EN ISO 12156-1	520 µm
Filter plugging point (CFPP)		D6371	DIN EN 116	See ¹
Cloud Point		D2500	DIN EN 23015	See ²
Neutralization number	max.	D974		0.2 mg KOH/g

¹) Filter plugging point or Cold Filter Plugging Point (CFPP) denotes the temperature at which a test filter is blocked under defined conditions by precipitated paraffins. This characteristic is used for diesel fuels as per DIN EN 590 to describe the climatic requirements (e.g. summer and winter diesel).

²) The cloud point is the temperature at which a liquid product becomes turbid in the test glass due to precipitation of paraffin. This must not be higher than the ambient temperature.

Note: 1% by weight = 10000 mg/kg = 10000 ppm

Table 10:

The fuel supplier must ensure that the fuel can still be used at extremely low temperatures and correct engine operation can be guaranteed. Extremely low temperatures must be noted, which can be expected under the given geographical and other local conditions.

The operator must ensure that fuel necessary for the corresponding climatic requirements is used.

Note:

The engines are certified for operation with the fuels approved in the MTU Fluids and Lubricants Specifications.

The component TBO specified in the maintenance schedule relates to operation of the engine with diesel fuel as per DIN EN 590.

For operation with a high sulfur content in the fuel, the following must be observed:

Series 4000

When a fuel with sulfur content > 1500 mg/kg is used, the times specified in the maintenance schedule for component TBO of the cylinder head may be reduced, see following table (→ Page 38)

TBO cylinder head as a function of sulfur content in the fuel

Sulfur content in fuel (mg/kg)	TBO cylinder head (h)
<1500	According to maintenance schedule
1500 to 3000	12000 ¹⁾
3000 to 4000	7000 ¹⁾
4000 to 5000	5000 ¹⁾

Table 11:

¹⁾= If the TBO cylinder head specified in the maintenance schedule is shorter, the shorter TBO shall always apply.

Important

If the sulfur content in the fuel is > 0.5% by weight (> 5000 ppm), please consult with the MTU-Friedrichshafen (application engineering).

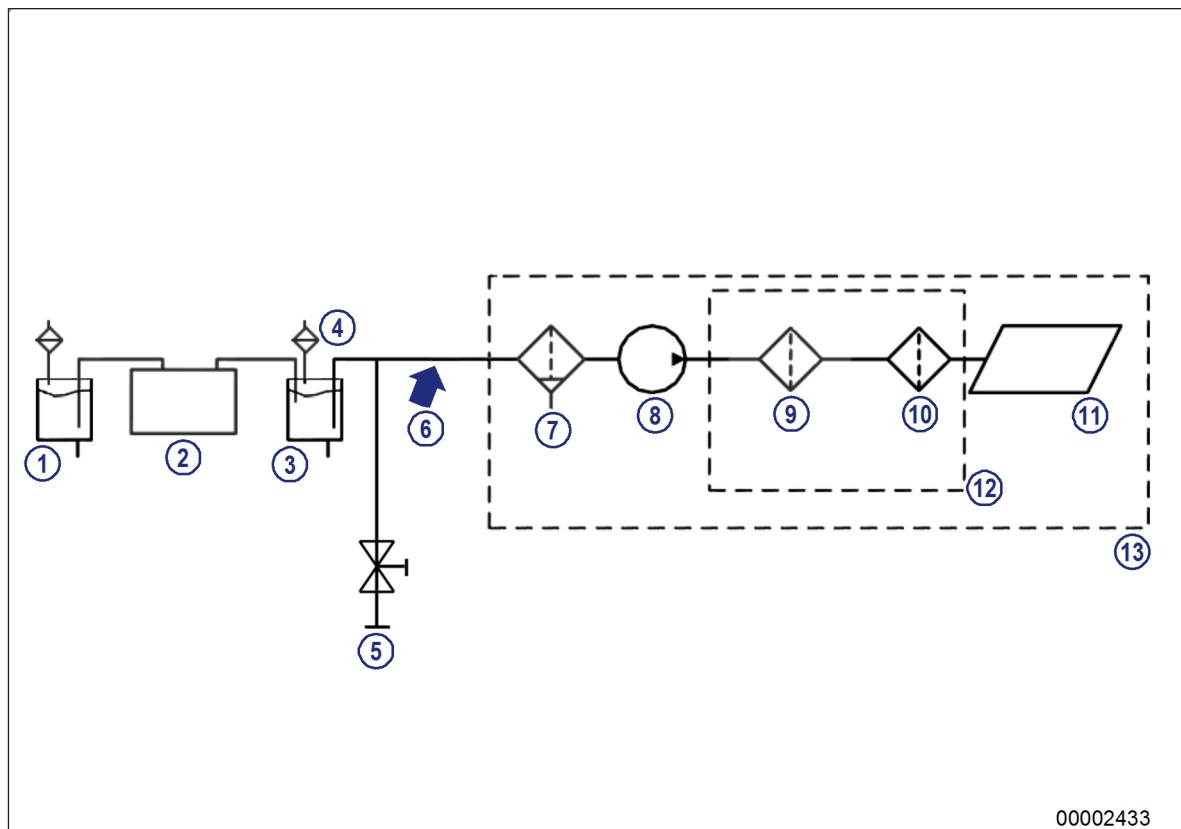


Figure 3: Fuel system

- | | | |
|------------------------------|--|---------------------|
| 1 Fuel tank | 6 Interface for fuel specification | 11 Injection system |
| 2 Fuel conditioning (option) | 7 Fuel prefilter with water separator (option) | 12 Engine filter |
| 3 Last tank before engine | 8 Fuel low-pressure pump | 13 Engine scope |
| 4 Tank ventilation filter | 9 Intermediate filter (option) | |
| 5 Sample extraction | 10 Main filter | |

Note:

The limit values named in the table (→ Table 10) must be observed at the interface [(→ Figure 3), item 6] at the latest to guarantee safe and efficient engine operation. This applies in particular to water and total contamination.

Important
In addition to the limit values listed in the table (→ Table 10), a particle distribution in the fuel in acc. with ISO 4406 must be observed, see (→ Table 12).

Particle distribution for fuels

Particle distribution	Test method ASTM		Limit values	
			Series 2000 Gx6, Series 4000 Gx3, Series 4000 Gx4	Series 2000 Gx5
Particle distribution for fuel between last tank before engine and prefilter [(→ Figure 3), item 6]	D7619 D7647	Coding of number of particles as per ISO 4406	max. ISO Code 18/17/14 for 4/6/14 µm particle size	max. ISO Code 21/20/17 for 4/6/14 µm particle size

Table 12:

Important
The limit values named in the table (→ Table 12) must already be observed in the feed between the last tank before the engine and the prefilter (if necessary, with water separator).

For plants without a prefilter, this refers to the feed between the last tank and the MTU equipment. For the analysis of the fuel quality, an interface (sample extraction cock) must be provided for sample extraction during operation.

For existing plants without an accessible feed, a sample extraction point in the last tank before the MTU equipment is permissible.

Note:

With poorer particle distribution, it is necessary to integrate further / more-optimized filter stages in the fuel system to achieve the operational life of fuel filters and components of the injection system.

For the limit values named for the interface, it has been validated that MTU-approved prefilters provide sufficient filtration.

MTU Friedrichshafen GmbH shall not provide warranty cover for damage and impairment to engine caused by the following usage:

- Fuel grades not approved by MTU (see (→ Table 10), (→ Table 12), (→ Page 41))
- Prefilters not approved by MTU

Laboratory analysis

An order for fuel analysis can be placed with MTU.

The following data is required:

- Fuel specifications
- Sampling point
- Serial number of engine from which fuel sample was taken

Submit the following:

- 0.5 liters of fuel
- 1.5 liters of fuel (with additional determination of cetane number)

Test Package for North America

The MTU Advanced Fluid Management System is available in North America, which contributes to preventive maintenance through innovative diagnostics.

MTU Advanced Fluid Management System for fuels, see (→ Page 65).

4.2 Series-dependent approval of fuel grades for MTU engines

4.2.1 Distillate fuels according to DIN EN 590 and ASTM D975

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
DIN EN 590: 2014-4 <ul style="list-style-type: none"> • Summer and winter quality • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Approved
ASTM D975-16 <ul style="list-style-type: none"> • Grade 1-D • S 15, S 500, S 5000 • Density: 0.820 to 0.860 g/ml • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity min. 1.5 mm²/s • Cetane number min. 45 or centane index min. 42 • Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> • Viscosity min. 1.5 mm²/s • Cetane number min. 45 or centane index min. 42 • Sulfur content max. 500 mg/kg
ASTM D975-16 <ul style="list-style-type: none"> • Grade 2-D • S 15, S 500, S 5000 • Density: 0.820 to 0.860 g/ml • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Sulfur content max. 500 mg/kg

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
DIN EN 590: 2014-4 <ul style="list-style-type: none"> • Summer and winter quality • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Approved
ASTM D975-16 <ul style="list-style-type: none"> • Grade 1-D • S 15, S 500, S 5000 • Density: 0.820 to 0.860 g/ml • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity min. 1.5 mm²/s • Cetane number min. 45 or centane index min. 42 	Approval issued if: <ul style="list-style-type: none"> • Viscosity min. 1.5 mm²/s • Cetane number min. 45 or centane index min. 42
ASTM D975-16 <ul style="list-style-type: none"> • Grade 2-D • S 15, S 500, S 5000 • Density: 0.820 to 0.860 g/ml • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42

4.2.2 British Standard 2869

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
BS 2869:2010 <ul style="list-style-type: none"> Part 1 Class A2 Density: max. 860 kg/m³ Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
BS 2869:2010 <ul style="list-style-type: none"> Part 2 Class D Density: max. 860 kg/m³ Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
BS 2869:2010 <ul style="list-style-type: none"> Part 1 Class A2 Density: max. 860 kg/m³ Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
BS 2869:2010 <ul style="list-style-type: none"> Part 2 Class D Density: max. 860 kg/m³ Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved

4.2.3 Chinese distillate fuels as per GB 19147-2013

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
GB 19147-2013 <ul style="list-style-type: none"> • Grade 0 • III: S max. 350 mg/kg • IV: S max. 50 mg/kg • V: S max. 10 mg/kg • Density: 0.820 to 0.860 g/ml* * deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power re-adjustment, it is possible that the engine operational values change • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) • Neutralization number: Max 0.2 mgKOH/g • Viscosity at 40 °C: 1.5 to 4.5 mm²/s 	Approved	Approved
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
GB 19147-2013 <ul style="list-style-type: none"> • Grade 0 • III: S max. 350 mg/kg • IV: S max. 50 mg/kg • V: S max. 10 mg/kg • Density: 0.820 to 0.860 g/ml* * deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power re-adjustment, it is possible that the engine operational values change • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) • Neutralization number: Max 0.2 mgKOH/g • Viscosity at 40 °C: 1.5 to 4.5 mm²/s 	Approved	Not approved

4.2.4 Heating oil

Commercially available diesel fuels meeting the following specifications are approved for use:

Heating oil

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
DIN 51603-1:2011-09, heating oil EL Standard <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Lubricity max. 520 µm • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Density at 15 °C min. 0.820 g/ml • Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> • Sulfur content max. 500 mg/kg
DIN 51603-1:2011-09, heating oil EL low-sulfur <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Lubricity max. 520 µm • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Approved
DIN 51603-6:2011-09, heating oil EL alternative	Not approved	Not approved
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
DIN 51603-1:2011-09, heating oil EL Standard <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Lubricity max. 520 µm • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
DIN 51603-1:2011-09, heating oil EL low-sulfur <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Lubricity max. 520 µm • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
DIN 51603-6:2011-09, heating oil EL alternative	Not approved	Not approved

4.2.5 Marine distillate fuels in accordance with ISO 8217:2013-12

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
DMX <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
DMZ <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
DMA <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
DMB	Not approved	Not approved
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
DMX <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity > 4.5 mm²/s: Preheating required 	Not approved
DMZ <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity 1.5 to 4.5 mm²/s • Outside the limit range between 1.5 and 4.5 mm²/s: Approval following co-ordination with MTU possible • Density 0.820 to 0.870 g/ml • Cetane number min. 45 or cetane index min. 42 	Not approved

TIM-ID: 0000080026 - 001

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
DMA <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity 1.5 to 4.5 mm²/s • Outside the limit range between 1.5 and 4.5 mm²/s: Approval following co-ordination with MTU possible • Density 0.820 to 0.870 g/ml • Cetane number min. 45 or centane index min. 42 	Not approved
DMB	Not approved	Not approved

4.2.6 Aviation turbine fuels

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
F-34 / F-35 • JP-8	Generally not approved, approval upon request	Generally not approved, approval upon request
F-44 • JP-5	Generally not approved, approval upon request	Generally not approved, approval upon request
F-63 • In accordance with DCSEA 108/A	Generally not approved, approval upon request	Generally not approved, approval upon request

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
F-34 / F-35 • JP-8	Generally not approved, approval upon request	Generally not approved, approval upon request
F-44 • JP-5	Generally not approved, approval upon request	Generally not approved, approval upon request
F-63 • In accordance with DCSEA 108/A	Approved	Generally not approved, approval upon request

4.2.7 NATO diesel fuels

Commercially available diesel fuels meeting the following specifications are approved for use:

Diesel fuel NATO Code F-54

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
NATO Code F-54 in accordance with TL 9140-0001 Edition 8 <ul style="list-style-type: none"> Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 Total contamination: Max. 24 mg/kg Lubricity: Max. 520 µm Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> Sulfur content max. 500 mg/kg
NATO Code F-54 in accordance with STANAG 7090 Edition 4 <ul style="list-style-type: none"> Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 Density: min. 0.820 g/ml Total contamination: Max. 24 mg/kg Lubricity: Max. 520 µm Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> Sulfur content max. 500 mg/kg

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
NATO Code F-54 in accordance with TL 9140-0001 Edition 8 <ul style="list-style-type: none"> Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 Total contamination: Max. 24 mg/kg Lubricity: Max. 520 µm Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
NATO Code F-54 in accordance with STANAG 7090 Edition 4 <ul style="list-style-type: none"> Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 Density: min. 0.820 g/ml Total contamination: Max. 24 mg/kg Lubricity: Max. 520 µm Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved

Diesel fuel NATO Code F-75

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
NATO-Code F-75 in accordance with TL 9140-0003 <ul style="list-style-type: none"> Reduced power possible due to min. density of 0.815 g/ml Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
NATO-Code F-75 in accordance with STANAG 1385 <ul style="list-style-type: none"> Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml max. sulfur content 1.0 % Adapt oil and oil change interval Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
NATO-Code F-75 in accordance with TL 9140-0003 <ul style="list-style-type: none"> Reduced power possible due to min. density of 0.815 g/ml Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
NATO-Code F-75 in accordance with STANAG 1385 <ul style="list-style-type: none"> Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml max. sulfur content 1.0 % Adapt oil and oil change interval Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> Cetane number min. 45 or cetane index min. 42 	Not approved

Diesel fuel NATO Code F-76

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
NATO Code F-76 in accordance with STANAG 1385 Edition 6 <ul style="list-style-type: none"> • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Generally not approved, approval upon request	Generally not approved, approval upon request
NATO-Code F-76 in accordance with DEF-STAN 91-4 Issue 8 <ul style="list-style-type: none"> • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Generally not approved, approval upon request	Generally not approved, approval upon request
NATO-Code F-76 in accordance with MIL-DTL-16884N <ul style="list-style-type: none"> • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Generally not approved, approval upon request	Generally not approved, approval upon request
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
NATO Code F-76 in accordance with STANAG 1385 Edition 6 <ul style="list-style-type: none"> • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 	Not approved
NATO-Code F-76 in accordance with DEF-STAN 91-4 Issue 8 <ul style="list-style-type: none"> • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
NATO-Code F-76 in accordance with MIL-DTL-16884N <ul style="list-style-type: none"> • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 	Not approved

4.2.8 Paraffinic diesel fuel according to DIN EN 15940

Selected paraffinic diesel fuels according to DIN EN 15940 are currently in the qualification phase.

Important information

Project-specific approval from MTU-Friedrichshafen GmbH is possible upon request.

4.2.9 B20 diesel fuel

B20 diesel fuel is a diesel fuel with a biodiesel share of 20%.

Important information

Project-specific approval from MTU-Friedrichshafen GmbH is possible upon request.

The following section provides additional information on B20 diesel fuel.

Use of B20 diesel fuels

Biodiesel mixtures consist of fuels which are obtained from biological raw materials and mixed with conventional diesel fuel. For instance, B20 denotes a mixture comprising 20% biodiesel and 80% fuel based on crude oil/mineral oil. MTU engines were not specially designed to be operated with biodiesel mixtures. For this reason, the use of biodiesel mixtures may have negative effects in terms of engine power, service and maintenance requirements, emissions and service life.

Operators of MTU engines therefore need to be clear about the effects that biodiesel may have on their engines, and must take all of the necessary measures to ensure the reliability and safety of their engines. This letter provides MTU customers with important information on the use of biodiesel mixtures in MTU engines, and explains the potential impact these fuels may have on the MTU warranty. Please read this information carefully before using biodiesel mixtures in MTU engines.

1. Regarding the use of approved biodiesel mixtures

At present, only biodiesel mixtures with up to 7% biodiesel (in accordance with DIN EN 590) or 5% biodiesel (in accordance with ASTM D 975) are approved for use in the MTU Fluids and Lubricants Specifications.

Although biodiesel mixtures with up to 20% biodiesel (B20) are not yet approved in the MTU Fluids and Lubricants Specifications at present, they can be used in the engines listed below in section 6, AS LONG AS the following requirements are met:

- The biodiesel complies with DIN EN 14214 or ASTM D 6751.
- The B20 fuel grade corresponds with DIN EN 16709.
- The distilled diesel fuel added to the biodiesel is approved in the latest version of the MTU Fluids and Lubricants Specifications.
- The operator complies with the operating requirements given in section 2 and the additional maintenance recommendations from section 5.

Important information

The provisions with regard to requirements placed on fuel may differ depending on legislation and application of the engine. The operator is responsible for ensuring that only fuels which comply with the applicable provisions are used in the engines.

2. Operating requirements for the use of B20

The following operating requirements must be met when biodiesel mixtures are used in MTU engines:

- a For engines used in emergency generators, an additive must be used to improve the oxidation stability of the biodiesel.
- b All engines used in fire pumps, fire-extinguishing equipment or police equipment must be thoroughly rinsed with pure, high-quality distilled diesel fuel which complies with the MTU Fluids and Lubricants Specifications each time they are operated with a biodiesel mixture. Furthermore, an additive must be used in these engines to improve the oxidation stability of the biodiesel.
- c All engines which are only used seasonally or which are not operated for extended periods between uses must be thoroughly rinsed with pure, high-quality distilled diesel fuel which complies with the MTU Fluids and Lubricants Specifications before they are decommissioned.
- d Biodiesel mixtures cannot be used in engines equipped with an exhaust gas after-treatment system (e.g. catalytic converters, particle filters (DPF) and/or systems for reducing NOx emissions, e.g. SCR systems).

3. Impact on the MTU warranty

The manufacturer shall not be responsible for breakdowns which can be attributed to the use of fuels not approved in the MTU Fluids and Lubricants Specifications and such breakdowns shall therefore not be covered by the MTU warranty. MTU shall reject all warranty claims connected to the use of biodiesel mixtures with a biodiesel content of more than 7% (in accordance with DIN EN 590) or 5% (in accordance with ASTM D 975) if the operator is unable to prove that the operating requirements and recommendations contained in this letter were met and strictly followed. Regardless of this, MTU shall on no account be liable for providing compensation for costs arising from the effects described below in section 4.

Important information

All properties guaranteed by MTU in terms of engine power and/or availability in operation only apply to the cases in which fuels approved by MTU are used and the engine demonstrates no defects or damage arising from operation with fuels not approved in the MTU Fluids and Lubricants Specifications.

4. Effects of biodiesel on engines/exclusion of liability

The biodiesel contained in biodiesel mixtures is a natural product and therefore undergoes natural aging processes. These may have a negative effect on the engines in which the biodiesel mixtures are used. The effects that biodiesel may have on engines are explained below.

Important: THESE EFFECTS ARE NOT FAULTS CAUSED BY THE ENGINE MANUFACTURER. THEY ARE THEREFORE EXCLUDED FROM THE MTU WARRANTY. MTU SHALL NOT ASSUME ANY LIABILITY FOR COSTS ARISING FROM THE EFFECTS DESCRIBED BELOW.

- The formation of deposits may cause components to become "sticky", which potentially restricts their movement. On engines with long downtimes, this can result in a situation where the engine can no longer be started. This is why additives for improving the oxidation stability of the biodiesel must be employed when biodiesel mixtures are used in emergency generators. MTU SHALL ACCEPT NO LIABILITY IN THE EVENT THAT THE ENGINE IN AN EMERGENCY GENERATOR CAN NOT BE STARTED AS A RESULT OF THE FORMATION OF DEPOSITS.
- The formation of deposits may have an adverse effect on the interaction of components inside the unit. This results in an increased risk of components failing, and even the breakdown of entire cylinders. The high operating temperatures in the surroundings encourage the formation of mineral deposits, other deposits and encrustations which may render the valve unable to correctly regulate the fuel supply. This means that it is no longer possible for the quantity of fuel required at full load to be injected into the engine, thereby reducing the maximum engine power.
- The viscosity properties of biodiesel are less favorable at low temperatures. The use of biodiesel at low temperatures may therefore cause the fuel filter to become blocked.
- On all engines, lubricating the piston skirts with oil leads to a small amount of fuel entering the engine oil. This is generally of little importance with conventional diesel fuels in accordance with the MTU Fluids and Lubricants Specifications since the fuel evaporates quickly upon reaching the operating temperature. On the other hand, biodiesel evaporates much less effectively, with the result that more biodiesel accumulates in the oil. Aging of the biodiesel can therefore cause residues to form, filters to become clogged and ultimately cause the engine to come to a stop, resulting in significantly shorter oil change intervals.
- Compared to conventional diesel fuels according to the MTU Fluids and Lubricants Specifications, biodiesel has a lower energy density. Operating the engine with B20 results in a power reduction of approximately 2% and an increase in fuel consumption of around 3%.
- Biodiesel contains chemical components which can interact with the sensors in the exhaust gas recirculation system in such a way that incorrect data is reported to the engine control system. This can have consequences such as engine operation being adapted to the wrong values and emissions therefore no longer complying with the applicable provisions. This is why biodiesel must not be used in engines which feature exhaust gas recirculation (EGR) and/or exhaust gas after-treatment systems.
- Compared to conventional diesel fuels according to the MTU Fluids and Lubricants Specifications, biodiesel has a higher water solubility, meaning that a higher proportion of water should be expected depending on the fuel temperature. This can lead to increased corrosion and faster microbe growth in the fuel system. Due to the higher proportion of water in biodiesel, reduced water separator performance must be expected.
- Biodiesel is a solvent. After switching over to a biodiesel mixture, impurities and certain deposits may become loose in the tank and lines, causing the fuel filter to be subjected to an increased accumulation of these. Biodiesel mixtures may also strip paint when they come into contact with painted surfaces.
- On engines with exhaust gas aftertreatment systems, the functioning of the catalytic converter may be impaired as biodiesel mixtures can contain a higher proportion of trace elements (e.g. calcium, magnesium, sodium, potassium and phosphorus) than conventional diesel fuels according to the MTU Fluids and Lubricants Specifications. This means that the legally prescribed emission limits are not complied with and the operating license becomes invalid. Furthermore, legally prescribed technologies for checking emissions on these engines (e.g. NOx monitoring diagnostics) lead to a significant decrease in engine power. The aforementioned trace elements may also result in excess ash formation and accumulations in the soot filters and catalytic converters. Excess ash formation results in a constantly rising exhaust back pressure and can therefore cause a slow reduction in engine power.

The aforementioned points do not constitute a complete risk assessment. MTU is unable to assess all biodiesel variants and their long-term effects on MTU products.

5. Additional maintenance recommendations

The following requirements must be met to ensure the quality and availability of your engine:

- Select the highest possible content of distilled fuel. Only use fuels approved in the MTU Fluids and Lubricants Specifications.
- After switching over to a biodiesel mixture, replace the fuel filters after 50 operating hours at the latest (in order to remove the impurities which become loose from the tank and lines).
- The fuel filters and fuel prefilters must be renewed every 250.
- Install a fuel preheating system if the engine is operated at temperatures below 0 °C (32 °F). This can reduce the negative effect on the fuel supply.
- Follow the recommendations below with regard to engine oil and maintenance:
 - If biodiesel mixtures are used, the change intervals for engine oil and filters must be halved in comparison to the intervals stated in the MTU Fluids and Lubricants Specifications.
 - The TO for the LP fuel pump, the O-rings in the LP fuel system as well as the valves in the fuel filter head is shortened to TBO/3.
 - In addition to changing the oil and filters on time, the engine oil and filters must be analyzed regularly in order to ensure that the oil quality is correct. Interval: Every 100 operating hours or every three months, depending on which comes first. A decision must be made to either further reduce or extend the change intervals on the basis of the results.
 - The oil and oil filter must be replaced before biodiesel is used.
 - High-quality engine oil must be used. Operating the engine without high-quality category 2 oil leads to a deterioration in oil quality. The MTU Fluids and Lubricants Specifications contain a list of approved oil types.
- Use a suitable tank and line system:
 - Do not use any components which contain zinc, copper or NBR seals.
 - Ensure that the system can be filled up to the fill line.
 - Minimize the entry of atmospheric oxygen through the tank vent in the event of temperature fluctuations, etc. (e.g. by installing a pressure relief valve and filter; contact your tank supplier to do this).
 - It is recommended to use a tank vent with humidity separator.
- For systems without a water separator: Retrofit a water separator to reduce the risk of microbe growth and corrosion in the fuel system.
- Regular maintenance of the water separator is mandatory. Separated water must be drained off daily, depending on the water quantity.
- Avoid relatively long engine downtimes and temporary decommissioning (more than one week). If downtimes cannot be avoided, you must use a suitable additive to improve oxidation stability. In Q4/2013, MTU approved an additive specially certified for MTU diesel engines. When this additive is used, B20 can be stored for up to four months, depending on the storage conditions and quality of the biodiesel. Prior to this point, we provided an additive on request.
- For engines used seasonally, we strongly recommend rinsing the fuel system, including the fuel tank, with pure, high-quality distilled diesel fuel in accordance with the MTU Fluids and Lubricants Specifications before the engine is decommissioned for a relatively long period (more than one week).
- Prevent biodiesel from coming into contact with painted surfaces to avoid damaging and stripping the paint.
- You must also always comply with the latest version of the MTU Fluids and Lubricants Specifications.

More extensive preventative measures are additionally required for some applications. Our Customer Service department is available to answer any questions you may have on this topic.

6. Affected engines

This customer information applies to the following engine series:

Series	Remarks
S1600Gx0	All years of manufacture
S2000Gx2	All years of manufacture
S2000Gx3	With metal low-pressure fuel lines
S2000Gx4	All years of manufacture
S2000Gx5	All years of manufacture
S2000Gx6	All years of manufacture
S4000Cx0	All years of manufacture
S4000Cx1	All years of manufacture
S4000Gx1	With metal low-pressure fuel lines
S4000Gx2	All years of manufacture
S4000Gx3	All years of manufacture

Table 13:

Should you have any questions about this customer information, please contact your on-site MTU representative.

4.3 Biodiesel – Biodiesel admixture

The standardized general term "FAME", (Fatty Acid Methyl Esters) is used here to designate biodiesel fuels.

General information

- We can make no comment with regard to the level of FAME resistance of the fuel system, which is not part of our scope of supply.
- FAME is an extremely effective solvent. Any contact with paint, for example, must therefore be avoided.
- The characteristic smell of FAME exhaust, especially during long periods of idling, may be perceived as unpleasant. The nuisance caused by smell can be reduced by an oxidation catalyst which may be installed by the vehicle / equipment manufacturers at their own risk.

Important information

Our company accepts no responsibility for and provides no warranty in respect of any fault or damage connected in any way with the use of FAME of a lower quality or resulting from noncompliance with our specifications on operation using FAME. All resultant irregularities and consequential damage lie outside our responsibility.

Use of B20 fuels

Important information

Information on the use of B20 fuels can be obtained from the chapter (→ Page 53).

The following engines are approved/not approved for operation with 100% FAME in compliance with DIN EN 14214:2014-06.

Approved/non-approved engines for operation with 100% FAME

Series	Approved / Not approved	Conversion necessary
SUN	No approval	
700	No approval	
750	No approval	
OM 457 LA	From series introduction	no
460	From series introduction	no
900	From series introduction	no
500	From series introduction	no
S40	No approval	
S50	No approval	
S60	No approval	
183	No approval	
2000	No approval	
396	No approval	
4000	No approval	
538	No approval	
595	No approval	
956	No approval	

Series	Approved / Not approved	Conversion necessary
1163		No approval
8000		No approval

Table 14:

Important information
Diesel fuel with a FAME content of max. 7% in compliance with DIN EN 590:2014-04 may be used. Such fuel may also be used in engines which have not been approved for operation with FAME, without affecting oil drain intervals.

Fuel

- The fuel must comply with DIN EN 14214:2014-06. Operation with fuels of lower quality can lead to damage and malfunctions.
- Either FAME or diesel fuel may be used. The various mixtures of FAME and normal diesel fuel, which may occur in the fuel tank as a result, present no problems.

Engine oil and servicing

- For operation using 100% FAME, engine oils are to be preferred which comply with MB Fluids and Lubricants Specifications, Sheet 228.5 or Oil Category 3 in accordance with MTU Fluids and Lubricants Specifications. Engine oils in accordance with Sheet 228.3 or Oil Category 2 as per MTU Fluids and Lubricants Specifications may also be used provided that oil drain intervals are reduced.
- A certain amount of fuel always finds its way into the engine oil via the pistons and cylinders. Its high boiling point means that FAME does not evaporate but remains in the engine oil in its entirety. Under certain conditions chemical reactions may take place between FAME and the engine oil. This can lead to engine damage.
- For this reason, engine oil and filter change intervals must be shortened for operation both with pure FAME and with FAME-diesel mixtures.
- For Series 457, 460, 900 and 500 engines, special equipment is available which facilitates an increase in the engine oil change intervals for operation with 100% FAME (→ Table 15). This involves fitting the engines with special equipment Code MK21 (special unit pump) and Code MK04 (fuel prefilter with heated water separator).

Effects on the engine oil change interval with operation with 100% FAME

Engine version	Engine oil change interval
Engines not fitted with special equipment for operation with FAME	Reduction of engine oil change interval to 30% of the standard interval required for operation with fossil diesel fuels
Engines fitted with special equipment Code MK21 and Code MK04	Reduction of engine oil change interval to 50% of the standard interval required for operation with fossil diesel fuels

Table 15:

Important information
The relevant engine oil change intervals must be complied with without fail! Exceeding the engine oil change intervals can cause engine damage!

- Operation with 100% FAME requires shortened fuel filter change intervals. A new fuel filter must be fitted each time the engine oil is changed.
- FAME has a high cleaning effect, which results in a risk of clogging by loosened deposits. If a switch has been made to FAME, a fuel filter and engine oil change should therefore be carried out after approx. 25 operating hours.
- Over longer periods, fuel filter service life may be reduced as a result of old residues being carried into the filter from the fuel system. A special, approved fuel prefilter can be installed as an improvement. This fuel prefilter with heated water separator is already installed on engines fitted with special equipment Code MK04.

Engine power and engine standstill

- Due to its calorific value, operation with 100% FAME involves a reduction of approx.8% to 10% in engine power. This leads to a corresponding increase in fuel consumption as compared to operation with diesel fuel. Engine power corrections are not permissible.
- Prior to any extended period out of operation, the fuel system must be flushed out in order to prevent congestion. For flushing, the engine must be operated for at least 30 minutes on FAME-free diesel fuel.

Vegetable oils as an alternative to diesel fuel

Important information

The use of pure vegetable oils as an alternative to diesel fuel or FAME is strictly prohibited due to the absence of standardization and to negative experience (engine damage caused by coking, deposits in the combustion chambers and oil sludge)!

Diesel fuels in winter operation

At low outdoor temperatures, the diesel fuel's fluidity can be inadequate on account of paraffin precipitation.

In order to prevent operational problems (e.g. clogged filters) during the winter months, diesel fuel with suitable cold-flow characteristics is available on the market. Deviations are possible during transitional periods and in individual countries.

4.4 Heating oil EL

Heating oil differs from diesel fuel mainly because of the following non-specified characteristics:

- Cetane number
- Sulfur content
- Oxidation stability
- Corrosion effect on copper
- Lubricity
- Low temperature behavior

If the heating requirements comply with the specifications of the diesel fuel DIN EN 590:2014-04 (summer and winter quality), there are no technical reasons why it can not be used in the diesel engine

4.5 Supplementary fuel additives

Supplementary fuel additives

The engines are designed such that satisfactory operation with normal, commercially available fuels is ensured. Many of these fuels already contain performance-enhancing additives.

The additives are added by the supplier as the agent responsible for product quality.

The anti-wear additives and biocides represent an exception(→ Page 62).

Important information

Attention is drawn to the fact that the use of diesel fuels or additives other than those stipulated in the MTU Fluids and Lubricants Specifications is always the responsibility of the operator.

Diesel fuels with sulfur content < 500 mg/kg

On Series 362, 396, 538, 652, 595, 956, 1163-02 and -03 engines with cylinder heads not fitted with valve seat inserts, the use of low-sulfur fuel (< 500 mg/kg) can lead to increased valve seat wear. If anti-wear additives are mixed in, this wear can be reduced. The approved supplementary additives must be mixed with the fuel in the predefined concentration. The additive must be filled before every refueling.

Microorganisms in fuel

Bacterial attack and sludge formation may occur in the fuel under unfavorable conditions. In such cases, the fuel must be treated with biocides in accordance with the manufacturer's specifications. Overconcentration must always be avoided.

The biocides approved at MTU are listed in table (→ Table 17).

Approved anti-wear additives

Manufacturer	Brand name	Concentration for use
The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092 USA Tel. 01 440-943-4200	ADX 766 M	250 to 350 mg/kg
Tunap Industrie GmbH Bürgermeister-Seidl-Str. 2 82515 Wolfratshausen Tel. +49 (0) 8171 1600-0 Fax. +49 (0) 8171 1600-91	Tunadd PS	250 to 350 mg/kg

Table 16:

Important information

The use of anti-wear additives is not permitted on engines/plants with exhaust aftertreatment!

Approved biocides

Biocides should have a pure hydrocarbon structure, i.e. should only consist of the following components:

- Carbon
- Hydrogen
- Oxygen
- Nitrogen

They must not contain inorganic substances because they can cause damage to the engine. The use of halogenated biocides is prohibited due to their effects on the engine system and the environment.

A release for biocides that meet the above requirements is possible upon request.

Manufacturer	Brand name	Concentration for use
ISP Biochema Schwaben GmbH Ashland Specialty Ingredients Luitpoldstrasse 32 87700 Memmingen Tel. +49 (0)8331 9580 0 Fax. +49 (0)8331 9580 51	Bakzid	100 ml / 100 l
Maintenance Technologies Paddy's Pad 1056 CC t/a Maintenance Technologies Tel. +27 21 786 4980 Cell +27 82 598 6830	Diesecure Fuel Decontainment	1 : 1200 (833 mg/kg)
Adolf Würth GmbH & Co. KG Reinhold Würth-Straße 12-17 74653 Künzelsau Tel. +49 (0) 7940 15-2248	Diesecure Fuel Decontainment	1 : 1200 (833 mg/kg)
Schülke und Mayr 22840 Norderstedt Tel. +49 (0) 40 52100-00 Fax. +49 (0) 40 52100-244	grotamar 71 grotamar 82 StabiCor 71	0.5 l / ton 1.0 l / 1000 l 0.5 l / ton
Supafuel Marketing CC PO Box 1167 Allens Nek 1737 Johannesburg South Africa Tel. +27 83 6010 846 Fax. +27 86 6357 577	Dieselfix / Supafuel	1:1200 (833 mg/kg)
Wilhelmsen Ships Service AS Willem Barentszstraat 50 3165 AB Rotterdam-Albrtand-swaard Tel. +31 10 487 7777 Fax. +31 10 487 7888 Netherlands	DieselPower MAR 71 (Biocontrol MAR 71)	333 ml / ton

Table 17:

Flow improvers

Flow improvers can not prevent paraffin precipitation but they do influence the size of the crystals and thus allow the diesel fuel to pass through the filter.

The effectiveness of the flow improvers is not guaranteed for every fuel.

Certainty is only assured after laboratory testing of the filtering capability.

Required quantities and mixing procedures must be carried out according to the manufacturer's instructions.

4.6 Unsuitable materials in the diesel fuel circuit

Components made of copper and zinc materials

The use of components made of copper and zinc materials in the fuel circuit is prohibited. They can cause chemical reactions in the fuel and thus lead to formation of a coating in the fuel system.

Requirements

Based on current knowledge, the following materials and coatings must not be used in a diesel fuel circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- Zinc, also as surface protection
- Zinc-based alloys
- Copper
- Copper-based alloys with the exception of CuNi10 and CuNi30 (e.g. seawater cooler)
- Tin, also as surface protection
- Magnesium-based alloys

Non-metallic materials

- Elastomers: Nitrile rubber, natural rubber, chloroprene rubber, butyl rubber, EPDM
- Silicone elastomer
- Fluorosilicone elastomer
- Polyurethane
- Polyvinyl

Information:

In case of doubt about the use of materials on the engine and add-on components / components in coolant circuit, consultation with the respective MTU specialist department must be held.

4.7 MTU Advanced Fluid Management System for fuels – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following:

For full information on the MTU Advanced Fluid Management System available in North America, please contact an authorized MTU Onsite Energy service partner.

The following test packages from MTU Advanced Fluid Management System can be ordered from authorized MTU Onsite Energy service partners in North America:

- F-PDFM1
Basic test – For checking the degree of contamination of the diesel fuel.
The test determines existing metallic elements and examines the proportion of water and contamination with bacteria and particles.
- F-PDFM2
Extended test – Includes the basic test plus an examination for determination of the degree of contamination, any possible filter contamination and ignition behavior of the engine.
- F-PDFM3
Extended Test Plus – Includes the extended text plus a lubricity analysis.
Maintenance of the correct lubricity has a positive effect on the service life of the components of the engine fuel system.

The following fuel parameters can be determined:

Fuel parameter	F-PDFM1	F-PDFM2	F-PDFM3
24 elementary metals	✓	✓	✓
Viscosity at 40 °C	-	✓	✓
Percent sulfur	-	✓	✓
Water and sediment	✓	✓	✓
Pour point	✓	✓	✓
Thermal stability	✓	✓	✓
Bacteria, fungi and mildew	✓	✓	✓
Flashpoint according to Pensky-Marten	-	✓	✓
Calculated centane index	-	✓	✓
Distillation	-	✓	✓
Cloud point	-	✓	✓
Percentage of water according to Karl Fischer	✓	✓	✓
Particle content	✓	✓	✓
Density according to API	-	✓	✓
Lubricity	-	-	✓

The MTU Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Samples must be taken:

- While the engine is operating under normal conditions or immediately after stopping the engine while the engine is still at operating temperature
- Every 250 hours at the same point

Note: The software offered by MTU for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The MTU Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

5 Approved Engine Oils and Lubricating Greases

5.1 Single-grade oils – Category 1, SAE grades 30 and 40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Single-grade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Marine MS4011	40	X			
	Addinol Turbo Diesel MD305	30		X		
	Addinol Turbo Diesel MD405	40		X		
Aegean Oil SA	Vigor Super D	40	X			
Avia	Avia Special HDC	30, 40	X			
Castrol Ltd.	Castrol MLC	30, 40		X		
Cepsa Lubricantes	Cepsa Rodaje Y Proteccion	30	X			Increased corrosion protection
Cyclon Hellas	Cyclon D Prime	30, 40	X			
Gulf Oil International	Gulf Superfleet	40	X			
Motor Oil (Hellas)	EMO Turbo Champion Plus	30, 40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310	30		X		
	Marbrax CCD-410	40		X		
PT. Pertamina Lubricants	Meditiran SMX	40	X			
PTT Public Comp.	PTT Navita MTU Type 1	40	X			
Repsol Lubricantes y Especialidades, S.A.	Repsol Serie 3	30, 40		X		
	Repsol Marino 3	30		X		
	Repsol Marino 3 SAE 40	40			X	
SRS Schmierstoff Vertrieb GmbH	SRS Rekord	30, 40		X		
Shell International Petroleum Company	Shell Gadinia S	30, 40		X		
	Shell Rimula R3	30, 40	X			
	Shell Rimula R3+	30	X			
	Sirius	30	X			
	Shell Sirius Monograde	30, 40	X			
SK Lubricants	SD 5000	40	X			
Total	Total Caprano TD 30	30		X		
	Total Caprano TD 40	40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
United Oil	XD 7000 Extra Duty-3U		X			
	XD 7000 Extra Duty-4U		X			

Table 18:

5.2 Multigrade oils - Category 1, SAE grades 15W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Important information

¹⁾ = These multigrade oils can only be used if crankcase ventilation is routed to atmosphere.

²⁾ = Engine oils marked ²⁾ are also permitted for the "Series 60"

Multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Super Star MX 1547	15W-40		X		
Advanced Lubrication Specialties	Translub 15W40 CI-4	15W-40		X		
BP p.l.c.	BP Vanellus Multi	15W-40	X			
ENI S.p.A	eni i-Sigma universal DL	15W-40	X			
Exxon Mobil Corporation	Mobil Delvac Super 1400E	15W-40	X			
Exxon Mobil Corporation	Mobil Delvac XHP	15W-40	X			
Gulf Oil International	Gulf Superfleet	15W-40	X			
Manufacture Zavod imeni Shau-myana	M5z/14D ₂ CE	15W-40			X	
Petróleos de Portugal, Petrogal S.A.	Galp Galaxia Super 15W-40	15W-40	X			
Singapore Petroleum Company Limited	SPC SDM 801	15W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Primalub	15W-40	X			
Total	Total Caprano TD	15W-40	X			
Unil Opal	Intercooler 400	15W-40	X			
United Oil	XD 9000 Ultra Diesel-U	15W-40	X			

Table 19:

5.3 Single-grade oils – Category 2, SAE-grades 30 and 40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

MTU single-grade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MTU Friedrichshafen GmbH	Power Guard® DEO SAE 40	40	X			20 l container: X00062816 210 l container X00062817 IBC: X00064829
MTU America	Power Guard® SAE 40 Off-Highway Heavy Duty	40		X		5 gallons: 23532941 55 gallons: 23532942 Approved for Series 8000 [(→ Table 20), note] available through MTU America Not approved for Series 2000 M72
MTU India Pvt Ltd.	Diesel Engine Oil DEO SAE 40	40		X		20 l container: 73333/P 205 l container: 75151/D Sale of Indian oil only intended in Indian market

Table 20:

Important information
For Series 8000 engines, the approved SAE class 40 engine oils may only be used in combination with pre-heating and oil priming ($T_{oil} > 30 \text{ °C}$).

Further single-grade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil GmbH	Addinol Turbo Diesel MD 407	40	X			
Adnoc Distribution	ADNOC Voyager Plus 40 CF/SL	40	X			
Atak Madeni Yag Lubricants	Protector MX 30	30			X	
	Protector MX 40	40			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
BayWa AG	Tectrol HD 30	30		X		
	Tectrol HD 40	40		X		
Belgin Madeni Yaglar	Lubex Marine M	30		X		
	Lubex Marine M	40		X		
	Lubex Marine LTM-30	30		X		
	Lubex Marine LTM-40	40		X		
Bucher AG Langenthal	Motorex Monolube	30		X		
Castrol Ltd.	Castrol HLX	30, 40		X		Approved for fast commercial vessels up to 1500 h, Series 595, 1163
Cepsa Lubricants	Cepsa Petrel HDL 40	40			X	
Chevron Lubricants (Texaco)	Ursa Premium TDX	40		X		
	Delo 400	30, 40		X		
	Delo Gold	40		X		
Chevron – Lyteca – (Texaco)	Ursa Premium TDX	40		X		
Cyclon Hellas	Cyclon D Super	40		X		
Delek	Delkol Super Diesel	40		X		
	Delkol Super Diesel MT Mono	40	X			
ENI S.p.A.	Agip Sigma GDF	40		X		
ENOC Marketing L.L.C.	ENOC Strata Super Duty	40		X		
Exxon Mobil Corporation	Mobil Delvac 1630	30		X		Not approved for Series 2000 M72
	Mobil Delvac 1640	40		X		Not approved for Series 2000 M72
Fuchs Europe Schmierstoffe GmbH	Titan Universal HD	30, 40	X			
	Titan Universal HD 30 MTU	30	X			Increased corrosion protection
Gulf Oil International	Gulf Superfleet Plus	40	X			
Gulf Western Oil, Australia	Turboil	40			X	
GS Caltex Corporation	Kixx D1 40	40	X			
Hyrax Oil Sdn Bhd	Hyrax Top Deo	40	X			
Koçak Petrol Ürünleri San. ve TIC. Ltd.	Speedol Ultra HDX 30 TBN 12	30		X		
	Speedol Ultra HDX 40 TBN 12	40		X		
	Speedol Deniz Dizel Motor Yağı	30, 40		X		
	Speedol Ultra HDX	30, 40	X			
Kuwait Petroleum	Q8 T 750	30, 40	X			

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Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Manufacture Zavod imeni Shau-myana Ltd.	M-14D2CE	40			X	
Motor Oil, Hellas	EMO SHPD Plus	30, 40		X		
OOO Lukoil International	Lukoil Avantgarde M 40	40	X			
Oryx Energies	Supreme RR	40			X	
Panolin AG	Panolin Extra Diesel	40	X			
Paz Lubricants & Chemicals	Pazl Marine S 40	40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310-AP	30		X		
	Marbrax CCD-410-AP	40		X		
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia 40	40		X		
Prista Oil Holding EAD	Prista SHPD 40	40			X	
PTT Public Comp.	PTT Navita MTU Type 2	40		X		
	Navita Plus, SAE 40	40		X		
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Serie 3 MT	40			X	
Shell International Petroleum Company	Shell Sirius X	30			X	
	Shell Sirius X	40			X	
Singapore Petroleum Company Limited	SPC SDM 900, SAE30	30		X		
	SPC SDM 900, SAE40	40		X		
Sonol	Seamaster 40	40	X			
SRS Schmierstoff Vertriebs GmbH	SRS Rekord plus 30	30		X		
	SRS Rekord plus 40	40		X		
	SRS Antikorrol M plus	30		X		Increased corrosion protection Only permitted for run-in and series acceptance
	SRS Motorenöl O-278	40		X		
Total	Total Caprano MT 30	30			X	
	Total Caprano MT 40	40			X	
	Total Disola MT 30	30	X			
	Total Disola MT 40	40	X			
	Total Rubia MT 30	30			X	
	Total Rubia MT 40	40			X	
Viva Energy Australia	Penske Power Systems Premium	40			X	

Table 21:

5.4 Multigrade oils – Category 2 of SAE grades 10W-40, 15W-40 and 20W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Important information

²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

MTU multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MTU Friedrichshafen GmbH	Diesel Engine Oil DEO SAE 15W-40	15W-40		X		20 l container: X00070830 210 l container: X00070832 IBC: X00070833 Loose items: X00070835 (only on request)
MTU Asia	Diesel Engine Oil - DEO 15W-40	15W-40		X		20 l container: 64247/P 200 l container: 65151/D
MTU Asia China	Diesel Engine Oil - DEO SAE 15W-40	15W-40		X		20 l canister: X00064242/P 205 l barrel: 65151/D
	Diesel Engine Oil - DEO SAE 10W-40	10W-40		X		20 l canister: 60606/P
MTU India Pvt. Ltd.	Diesel Engine Oil - DEO 15W-40	15W-40		X		20 l canister: 63333/P ²⁾ 205 l barrel: 65151/D Sale only intended in Indian market

Table 22:

Further multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 mgKOH/g	
Adnoc Distribution	Adnoc Voyager Plus	15W-40		X		²⁾
Aegean Oil S.A.	Vigor Turbo SD 15W-40	15W-40	X			²⁾
Addinol Lube Oil	Addinol Super Longlife MD1047	10W-40		X		²⁾
	Addinol Diesel Longlife MD1548	15W-40		X		²⁾

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Anomina Petroli Italiana	IP Tarus	15W-40	X			
	IP Tarus Turbo	15W-40	X			
	IP Tarus Turbo Plus	15W-40	X			2)
Arabi Eneritech KSC	Burgan Ultra Diesel CH-4	15W-40		X		2)
Aral AG	Aral Turboral 10W-40	10W-40		X		
	Aral Turboral 15W-40	15W-40		X		2)
Atak Madeni Yag Lubricants	Alpet Turbot Fleetmax 1540	15W-40		X		2)
Auto-Teile-Ring GmbH	Cartechnic Motorenöl SAE 15W-40	15W-40	X			
Avista Oil Refining & Trading Deutschland GmbH	Avista Advantage SHPD	15W-40	X			
	Avista Advantage UHPD	15W-40	X			
	Pennasol Turbo Super	15W-40		X		2)
	MOTOR GOLD Turbotec	15W-40		X		2)
Bahrain Petroleum Company B.S.C.	Frontier Megatek	10W-40	X			
	Frontier Super Plus	15W-40		X		2)
	Frontier Turbo	15W-40		X		
	Frontier Turbo LD	10W-40		X		
BayWa AG	Tectrol Turbo 4000	10W-40		X		
Belgin Madeni Yaglar	Lubex Marine M	15W-40		X		
BP p.l.c.	BP Vanellus C6 Global Plus	10W-40		X		
	BP Vanellus Multi-Fleet	15W-40			X	2)
	BP Multi Mine	15W-40	X			2)
	BP Mine Multi 15W-40	15W-40		X		2)
	BP Vanellus Longdrain	15W-40		X		2)
	BP Vanellus Multi A	10W-40		X		2)
	BP Vanellus Agri	10W-40		X		2)
	BP Vanellus Multi A	15W-40	X			2)
	BP Vanellus Agri	15W-40	X			2)
	BP Vanellus Max Extra	15W-40			X	2)
Bucher AG Langenthal	Motorex Universal	10W-40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Castrol Ltd.	Castrol CRB Multi 10W-40 CI-4/E7	10W-40		X		
	Castrol CRB Multi 15W-40 CI-4/E7	15W-40		X		2)
	Castrol CRB Turbo 15W-40 CH-4/E7	15W-40	X			2)
	Castrol Rivermax CRB 15W-40 CI-4/E7	15W-40		X		2)
	Castrol Rivermax RX+ 15W-40	15W-40	X			2)
	Castrol Vecton 15W-40 DH-1	15W-40			X	2)
	Castrol RX Diesel	15W-40	X			
	Castrol RX Diesel 15W-40 CI-4/E7	15W-40		X		2)
	Castrol Vecton	10W-40		X		
	Castrol Vecton 15W-40 CI-4/E7	15W-40		X		2)
	Castrol Vecton 15W-40 CI-4/E7	15W-40			X	2)
Cepsa	Cepsa Euromax SHPD	15W-40		X		2)
Champion Chemicals N.V.	Champion New Energy	15W-40		X		2)
Chevron Lubricants (Caltex)	Delo SHP Multigrade	15W-40		X		
	Delo Gold Multigrade	15W-40	X			
	Delo Gold Ultra	15W-40		X		
	Delo Gold Ultra E	10W-40		X		
	Delo Gold Ultra E	15W-40	X			2)
	Delo 400 Multigrade	15W-40			X	2)
	OEC SAE 15W-40	15W-40		X		
Chevron Lubricants (Texaco)	Ursa Super TD	15W-40		X		2)
	Ursa Premium TDX	15W-40		X		2)
	Ursa Premium TDX Plus	15W-40		X		2)
	Ursa Heavy Duty	15W-40	X			
CPC Corporation, Taiwan	CPC Superfleet CG4 Motor Oil	15W-40	X			
Cubalub	Cubalub Extra Diesel MX	15W-40			X	2)
	Cubalub Extra Diesel	15W-40	X			
Cyclon Hellas	Cyclon D Super	15W-40	X			2)
Delek	Delkol Super Diesel	15W-40	X			
Delek Industries Ltd.	Super Diesel	15W-40		X		
Dunwell Petro-Chemical Co., Ltd.	Apex Super Motor Oil SL/CI-4, 15W-40	15W-40		X		2)
EKO A.B.E.E.	Eko Forza plus	15W-40	X			
Engen Petroleum Ltd.	Engen Dieselube 600 Super	15W-40	X			2)
	Engen Dieselube 700 Super	15W-40		X		2)

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Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
eni S.p.A.	Agip Blitum T	15W-40	X			
	eni i-Sigma super fleet	15W-40		X		
	eni i-Sigma performance E3	15W-40	X			
	eni i-Sigma performance E7	15W-40		X		2)
	eni i-Sigma performance E7	15W-40	X			2)
Exol Lubricants Ltd.	Taurus Extreme M	15W-40	X			2)
	Taurus Extreme HST	15W-40		X		2)
Exxon Mobil Corporation	Mobilgard 1 SHC	20W-40			X	Approved for fast commercial vessels up to 1500 h, 396, 1163
	Mobil Delvac Super 1400	15W-40	X			
	Mobil Delvac MX	15W-40		X		
	Mobil Delvac MX Extra	15W-40		X		
	Mobil Delvac Advanced City Logistics	15W-40	X			
Finke Mineralölwerk GmbH	AVIATICON Turbo Super Plus	15W-40	X			2)
Fuchs Europe Schmierstoffe GmbH	Fuchs Titan Truck Plus	15W-40		X		2)
	Titan Unimax Ultra MC	10W-40		X		
	Titan Formel Plus	15W-40		X		
	Fuchs Titan Truck	15W-40	X			2)
	Titan Unimax Plus MC	10W-40		X		
	Fuchs Titan Universal HD	15W-40	X			
Fuchs Lubrifiants France	Cofran Plura Super	15W-40		X		2)
Fuchs Petrolub SE	Fuchs Max Way	15W-40		X		2)
	Fuchs Titan Truck Plus	10W-30		X		
	Fuchs Titan Truck Plus	15W-40		X		
Gazpromneft Lubricants Ltd.	Belaz G-Profi Mining	15W-40		X		2)
	Belaz G-Profi Mining FF	15W-40		X		2)
	G-Profi MSI 10W-40	10W-40		X		
	G-Profi MSI 15W-40	15W-40		X		
	G-Profi MSH 15W-40	15W-40		X		
	G-Profi MSI Plus	15W-40		X		2)
	Gazpromneft Diesel Premium	15W-40	X			2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
German Mirror Lubricants and Greases Co. FZE	Mirr Turbo Plus Diesel Engine Oil API CI-4 SAE 10W-40	10W-40		X		
	Mirr Turbo Plus Diesel Engine Oil API CI-4 SAE 15W-40	15W-40	X			2)
	Mirr Turbo Diesel Engine Oil API CH-4 SAE 15W-40	15W-40	X			2)
Ginouves Georges SAS	York 849	15W-40		X		2)
GS Caltex India Private Limited	Kixx Dynamic Gold	15W-40		X		2)
GS Caltex Corporation	Kixx HD 1	10W-40		X		
	Kixx HD 1	15W-40		X		2)
Gulf Oil International	Gulf Super Duty VLE	15W-40	X			
	Gulf Superfleet LE	10W-40		X		
	Gulf Superfleet LE	15W-40	X			2)
	Gulf Superfleet Supreme	10W-40		X		
	Gulf Superfleet Supreme	15W-40		X		2)
	Gulf Superfleet Plus	15W-40	X			
Gulf Western Oil, Australia	TOP DOG XDO	15W-40	X			2)
Hafa France	Stradex 1800	10W-40		X		
Hessol Lubrication GmbH	Hessol Turbo Diesel	15W-40		X		2)
	Hessol Super Longlife	10W-40		X		
High Industrial Lubricants & Liquids Corporation (HILL)	Fastroil Force F300 Diesel	15W-40		X		2)
	Fastroil Force F500 Diesel	15W-40		X		2)
	Fastroil Force F700 Diesel Pro	10W-40		X		
Hitachi Construction Machinery CO., Ltd.	Hitachi Premium Orange	15-W40	X			
Huiles Berliet S.A.	RTO Maxima RD	15W-40	X			2)
	RTO Maxima RLD	15W-40		X		2)
Hyrax Oil Sdn Bhd	Hyrax Admiral 15W-40	15W-40	X			2)
INA Maziva Ltd.	INA Super Max	15W-40		X		2)
Indian Oil Corporation	Servo Premium (N)	15W-40		X		
Ipiranga Produtos des Petróleo S.A.	Ipiranga Brutus Alta Performance	15W-40		X		2)
Kuwait National Lube Oil MfgCo (KNLOC)	Burgan Ultra Diesel CH-4	15W-40		X		2)
Kuwait Petroleum	Q8 T 750	15W-40	X			2)
	Q8 T 800	10W-40	X			2)
Kocak Petrol Ürünleri San	Speedol SHPD Tirot 15W-40	15W-40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Liqui Moly	Liqui Moly Marine 4T Motor Oil	15W-40		X		2)
	Liqui Moly Touring High Tech SHPD	15W-40	X			
Lotos Oil	Turdus Powertec CI-4 15W-40	15W-40		X		2)
	Turdus Powertec 1000	15W-40		X		2)
LPC S.A.	Cyclon Granit Maximum	15W-40		X		2)
Lubricantes de América	Generac Aceite	15W-40		X		
	Lubral Nano Diesel	15W-40		X		
Lubricating Specialties Company (LSC)	Top 1 Transport	15W-40		X		2)
Lubrisa	Gulf Superfleet Supreme	15W-40		X		2)
Lukoil Lubricants Europe Oy	Teboil Power Plus	15W-40	X			
	Tepoil Super HPD	15W-40		X		
	Tepoil Super HPD C	10W-40		X		
Mega Lube Marketers cc.	Megalube Diesel Engine Oil	15W-40		X		
Meguín GmbH	megol Motorenoel SHPD	15W-40	X			
Modriča Oil Refinery	Maxima Turbo	15W-40		X		
MOL-LUB Kft..	MOL Dynamic MK9	15W-40		X		
	MOL Mk-9	15W-40		X		
	Mol Dynamic Super Diesel	15W-40	X			
	Mol Dynamic Transit	10W-40		X		2)
	Mol Dynamic Transit	15W-40		X		2)
	MOL Super Diesel	15W-40	X			
Motor Oil, Hellas	EMO SHPD Plus	15W-40		X		
MPM International Oil Company B.V.	Motor Oil 15W-40 Super High Performance	15W-40		X		2)
NetLube Iran	Max Turbo	15W-40		X		2)
NSL OilChem Trading Pte Ltd	Liquid Gold D-Flo X4	15W-40		X		2)
Oman Oil Marketing Company SAOG	Omanoil Maximo Super 15W40 CH-4	15W-40	X			2)
Orlen Oil	Mogul Diesel DTT Extra	15W-40			X	2)
	Platinum Ultor	15W-40	X			2)
	Platinum Ultor Plus	15W-40			X	2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
OOO "LLK-International"	BELAZ CI-4	15W-40	X			2)
	Lukoil Avantgarde Extra	15W-40	X			
	Lukoil Avantgarde Ultra	15W-40		X		
	Lukoil Avantgarde NP	15W-40		X		
	Lukoil Avantgarde Ultra Plus	10W-40		X		
Oryx Energies	Enduro 600	15W-40		X		
Panolin AG	Panolin Universal SFE	10W-40		X		
	Panolin Diesel Synth	10W-40		X		
PDVSA CA	PDV Ultradiesel	15W-40		X		2)
Pertamina	Meditran SX Plus	15W-40		X		2)
Petrobras Colombia Combustibles	Petrobras Top Turbo T2	15W-40	X			
Petrobras Distribuidora S.A.	Lubrax Nautica Diesel	15W-40		X		2)
Petro-Canada Lubricants	Duron	15W-40		X		2)
	Duron XL	15W-40		X		2)
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia LD star	15W-40		X		
Petron Corporation	Petron Rev-x Premium Multi Grade	15W-40		X		2)
Petronas Lubricants International	Petronas Urania 3000	15W-40		X		2)
	Petronas Urania LD7	15W-40		X		
	Petronas Urania LD 7	10W-40	X			
	Petronas Urania Supremo CI-4	10W-40	X			2)
	Petronas Urania Supremo CI-4	15W-40	X			2)
Petromin Corporation	Petromin Turbomaster XD	15W-40		X		2)
Phillips 66 Lubricants	Conoco Hydroclear Power D	15W-40			X	
Prista Oil AD	Prista Turbo Diesel	15W-40	X			
PTT Public Limited	Navita Plus SAE 15W-40	15W-40	X			
Qatar Lubricants Company Ltd.	QALCO Topaz HMF	15W-40	X			
Qingdao Copton Technology Co., LTD.	Copton CH-4 Diesel Engine Oil	15W-40	X			
Raloy Lubricantes, S.S. de C.V.	Raloy Diesel Power	15W-40		X		2)
Raj Petro Specialities P Ltd.	Zoomol Rforce 3100 RF1	15W-40	X			2)
	Zoomol Rforce 3100 RF4	15W-40		X		2)
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Expert SHPD	10W-40		X		
	RAVENOL Mineralöl Turbo Plus SHPD	15W-40	X			2)

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Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Super Turbo SHPD	15W-40	X			2)
	Repsol Neptuno S-Turbomar	15W-40	X			2)
RN-Lubricants, LLC	Rosneft Revolut D2	15W-40	X			
	Rosneft Revolut D3	15W-40		X		2)
	Rosneft Revolut D5	15W-40		X		
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40		X		2)
S.A.E.L.	Gulf Gulfleet Long Road	15W-40	X			
Shell International Petroleum Company	Shell Rimula MV	15W-40	X			
	Shell Rimula R3 MV	15W-40	X			2)
	Shell Rimula R3 X	15W-40		X		2)
	Shell Rimula R4	15W-40		X		2)
	Shell Rimula R4 X	15W-40		X		2)
	Shell Rimula RT4	15W-40		X		2)
	Shell Rimula RT4 X	15W-40		X		2)
	Shell Rimula T3	15W-40		X		2)
	Shell Rimula T4	15W-40		X		2)
	Shell Rimula X	15W-40		X		
	Shell Rotella T2	15W-40		X		
	Shell Rotella T Multigrade	15W-40		X		2)
	Shell Sirius	15W-40		X		2)
	Eicher Premium Plus Diesel Engine Oil	15W-40		X		2)
Shanghai HIRI Lubricants R & D Centre	HIRI	15W-40	X			
Singapore Petroleum Company Limited	SDM 900 SAE 15W40	15W-40		X		
Sinopec Lubricant Co., Ltd.	Sinopec Tulux T500	15W-40		X		2)
SK Lubricants Co. Ltd.	ZIC X5000 10W-40	10W-40		X		
	ZIC X5000	15W-40	X			2)
	ZIC X7000 CI-4 10W-40	10W-40		X		
	ZIC X7000 CI-4	15W-40	X			2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
SRS Schmierstoff Vertrieb GmbH	SRS Motorenöl O-236	15W-40	X			2) enhanced corrosion protection
	SRS Multi-Rekord top	15W-40		X		2)
	SRS Multi Rekord plus	15W-40	X			
	SRS Turbo Rekord	15W-40	X			2)
	SRS Cargolub TFX	10W-40		X		
Tesla Technoproducts FZE	Denebola Saheli Ultra XS 1120	15W-40		X		2)
Total Lubrificants	Antar Milantar PH	15W-40	X			2)
	Antar Milantar PX	15W-40	X			2)
	Fina Kappa Optima	15W-40		X		2)
	Fina Kappa Extra Plus	15W-40	X			2)
	Total Caprano Energy FE	15W-30		X		
	Total Caprano TDH	15W-40		X		2)
	Total Caprano TDI	15W-40		X		2)
	Total Disola W	15W-40		X		
	Total Genlub TDX	15W-40	X			
	Total Rubia TIR 6400	15W-40	X			
	Total Rubia Works 1000	15W-40		X		2)
	Hitachi Genuine Engine Oil 15W40 DH-1	15W-40		X		2)
Unil Opal	Medos 700	15W-40	X			2)
Valvoline EMEA	All-Fleet Extra SAE 15W-40	15W-40	X			2)
	All-Fleet Plus	15W-40	X			2)
	NextGen All-Fleet extra	15W-40		X		2)
	Premium Blue Classic	15W-40		X		2)
	Valvoline Premium Blue 7800	15W-40		X		
Viscolube	Revivoil - Re Refined High-Tech HD Motoroil	15W-40	X			2)
Viva Energy Australia	Penske Power Systems Premium	15W-40	X			2)
Wolf Oil Corporation NV.	Wolf Vitaltech 15W40	15W-40		X		2)
Wunsch Öle GmbH	Wunsch Rekord TLM-TU 10W-40	10W-40		X		

Table 23:

5.5 Multigrade oils – Category 2.1 (Low SAPS oils) of SAE grades 0W-30, 10W-30, 5W-40, 10W-40 and 15W-40

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Important information
²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

MTU multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MTU America	Power Guard® SAE 15W-40 Off-Highway Heavy Duty	15W-40	X			5 gallons: 800133 55 gallons: 800134 IBC: 800135 available through MTU America ²⁾

Table 24:

Further multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Bucher AG Langenthal	Motorex Focus CF	15W-40	X			²⁾
BP p.l.c.	BP Vanellus Eco	15W-40	X			²⁾
Castrol Ltd.	Castrol CRB Mining 15W-40	15W-40	X			²⁾
	Castrol CRB Mining 15W-40 CK-4		X			²⁾
	Castrol CRB Turbo G4 15W-40	15W-40	X			²⁾
	Castrol Hypuron	10W-30		X		
Champion Chemicals N.V.	Champion OEM Specific 15W40 MS	15W-40	X			
Chevron Lubricants (Caltex)	Delo 400 LE	15W-40	X			²⁾

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Chevron Lubricants (Chevron)	Delo 400 LE	15W-40	X			2) also approved for Series 4000-04 T
	Delo 400 MGX	15W-40	X			2)
	Delo 400 SDE	15W-40	X			2)
	Delo 400 XLE	10W-30		X		
	Delo 400 XLE	15W-40		X		2)
Chevron Lubricants (Texaco)	Ursa Ultra LE	15W-40	X			2)
ExxonMobil Corporation	Mobil Delvac 1 ESP	0W-30	X			
	Mobil Delvac 1 ESP	5W-40		X		
	Mobil Delvac 1300 Super F2	15W-40	X			
	Mobil Fleet	15W-40	X			2)
eni S.P.A.	eni i-Sigma top MS	15W-40	X			2)
Fuchs Europe	Fuchs Titan Cargo	15W-40	X			2)
Fuchs Petrolub SE	Fuchs Titan Cargo	10W-30	X			
	Fuchs Titan Cargo	15W-40	X			2)
Gulf Oil International	Gulf Supreme Duty XLE	15W-40	X			2)
	Gulf Supreme Duty XLE	10W-30	X			
Hitachi	Hitachi Genuine Engine Oil 10W-40 DH-2	10W-40	X			
Kuwait Petroleum	Q8 T 760	10W-30	X			
Lotos Oil	Turdus Powertec 1100	15W-40	X			2)
Morris Lubricants	Versimax HD6	15W-40	X			2)
MPM International Oil Company B.V.	Motor Oil 15W-40 Extra High Performance	15W-40	X			2)
OOO "LLK-International"	Lukoil Avantgarde Professional LA	10W-30	X			
	Lukoil Avantgarde Professional LA	10W-40	X			
	Lukoil Avantgarde Professional LA	15W-40	X			2)
Panolin AG	Panolin Universal LA-X	15W-40	X			2)
Pennzoil Products	Pennzoil Long-Life Gold	15W-40		X		2)
Petro-Canada	Duron -E	15W-40	X			2)
Phillips 66 Lubricants	Fleet Supreme EC	15W-40	X			2) also approved for Series 4000-04 C
	Guardol ECT	15W-40	X			2)
	Kenndall Super-D XA	15W-40	X			2)

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Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Prolube Lubricants	Prolube Ultraplus	15W-40	X			2)
Repsol Lubricantes Y Especialidades, S.A.	Repsol Diesel Turbo THPD Mid Saps	15W-40	X			2)
Shell International Petroleum Company	Shell Rimula Super	15W-40		X		2)
	Shell Rimula RT4L	15W-40		X		2)
	Shell Rotella T	15W-40		X		2)
	Shell Rotella T3	15W-40		X		2)
	Shell Rotella T5	10W-30	X			
	Shell Rotella T5	10W-40	X			
	Shell Rotella T6	5W-40		X		
	Shell Rimula R5 LE	10W-30	X			
	Shell Rimula R5 LE	10W-40	X			
	Shell Rotella T Triple Protection	15W-40		X		
	Shell Rimula R4 MV	15W-40	X			2)
	Shell Rimula R4 L	15W-40	X			2)
	SK energy	ZIC XQ 5000	15W-40	X		
SRS Schmierstoff Vertrieb GmbH	SRS Turbo Rekord plus	15W-40	X			2)
	SRS Turbo Rekord plus FE	10W-40	X			
Total Lubrifiants	Total Rubia TIR 7900	15W-40	X			
	Total Rubia Works 2000	10W-40	X			
	Total Max Star FE	10W-30	X			
	Total Rubia Works 2000 FE 10W-30	10W-30	X			
Trinidad & Tobago National Petroleum Marketing Company Ltd. (NPMC)	Ultra Duty 15W-40 Engine Oil	15W-40	X			2)
Valvoline EMEA	Valvoline All Fleet Extra LE SAE 15W-40	15W-40	X			2)
	All-Fleet Extra LE NTI	15W-40	X			2)
	Premium Blue 8100 15W-40	15W-40	X			2)
Valvoline USA	All Fleet Plus	15W-40	X			2)
Verco International	April Superpro RXL 1 Gold Plus	15W-40	X			2)

Table 25:

5.6 Multigrade oils – Category 3 of SAE grades 5W-30, 5W-40 and 10W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

MTU multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 mgKOH/g	
MTU Asia China	Diesel Engine Oil - DEO 5W-30	5W-30			X	20 l canister: 60808/P available through MTU Suzhou

Table 26:

Further multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 mgKOH/g	
Addinol Lube Oil GmbH	Addinol Commercial 1040 E4	10W-40		X		
	Addinol Ultra Truck MD 0538	5W-30			X	
	Addinol Super Truck MD 1049	10W-40			X	
Aral AG	Aral Mega Turboral	10W-40			X	
	Aral Mega Turboral 10W-40	10W-40			X	
	Aral Super Turboral	5W-30			X	
Avia Mineralöl AG	Avia Turbosynth HT-E	10W-40			X	
	Avia Turbosynth HT-U	5W-30			X	
BayWa AG	Tectrol Super Truck 530	5W-30			X	
	Tectrol Super Truck 1040	10W-40		X		
Bucher AG Langenthal - Motorex Schmiertechnik	MC Power Plus SAE 10W/40	10W-40			X	
BP p.l.c.	BP Energol IC-MT 10W-40	10W-40			X	
	BP Vanellus Max	5W-30			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Castrol Ltd.	Castrol CRB Turbomax 10W-40 E4/E7	10W-40			X	
	Castrol Enduron MT	10W-40			X	
	Castrol Enduron Plus	5W-30			X	
	Castrol Elixion HD	5W-30			X	
	Castrol Vectron 10W-40 E4/E7	10W-40			X	
	Castrol Vectron Long Drain	10W-40			X	
	Castrol Vectron Long Drain 10W-40 E4/E7	10W-40			X	
	Castrol Vectron 5W-30 Arctic	5W-30			X	
	Castrol Vectron Fuel Saver 5W-30	5W-30			X	
	Castrol Vectron Fuel Saver E7	5W-30			X	
Cepsa	Cepsa Eurotrans SHPD	5W-30			X	
	Cepsa Eurotrans SHPD	10W-40		X		
Champion Chemicals N.V.	Champion New Energy 10W40 Ultra	10W-40			X	
Chemicis Khavremianeh Kohan	Chemicis Excel Plus	10W-40			X	
Chevron Lubricants (Caltex)	Delo Gold Ultra T	10W-40			X	
	Delo XLD Multigrade	10W-40			X	
Chevron Lubricants (Texaco)	Ursa HD	10W-40			X	
	Ursa Premium FE	5W-30			X	
	Ursa Super	10W-40		X		
	Ursa Super TDX	10W-40			X	
	Ursa TDX	10W-40			X	
Deutsche Ölwerke Lubmin GmbH	AVENO HC PT Diesel	10W-40			X	
eni S.P.A.	Agip Sigma Trucksint TFE	5W-40			X	
	Agip Sigma Super TFE	10W-40			X	
	eni i-Sigma top	10W-40			X	
Enoc Marketing LLC	Enoc Vulcan 770 SLD	10W-40		X		
	Enoc Vulcan SLD	10W-40			X	
Exxon Mobil Corporation	Mobil Delvac XHP Extra	10W-40			X	
	Mobil Delvac XHP Ultra 5W-30	5W-30			X	
	Mobil Delvac 1 SHC 5W-40	5W-40			X	
Exol Lubricants Ltd.	Taurus Extreme M3	10W-40			X	
Fabrika Maziva, FAM AD	Fenix Ultra Sint	10W-40			X	
Finke Mineralölwerk GmbH	AVIATICON Finko Truck LD	10W-40			X	
Fuchs Europe Schmierstoffe GmbH	Titan Cargo SL	5W-30			X	
	Titan Cargo MC	10W-40			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Fuchs Lubricants France	Cofran Marathon	10W-40			X	
	Fuchs Max Way E4	10W-40				
	Fuchs Max Way Ultra	5W-30				
Gulf Oil International	Gulf Fleet Force synth.	5W-30			X	
	Gulf Superfleet ELD	10W-40			X	
	Gulf Superfleet XLD	10W-40			X	
	Gulf Superfleet Synth ELD	10W-40			X	
High Industrial Lubricants & Liquids Corporation	Fastroil Force Ultra High Performance Diesel (UHPD)	10W-40			X	
Huiles Berliet S.A.	RTO Extensia RXD ECO	5W-30			X	
Iranol Oil Co.	Iranol D40000-EIII	10W-40			X	
Kuwait Petroleum	Q8 T 860	10W-40		X		
	Q8 T 860 D	10W-40			X	
	Q8 T 860 S	10W-40			X	
	Q8 T 905	10W-40	X			
Lotos Oil	Turdus Powertec 3000	10W-40			X	
	Turdus Powertec Synthetic	5W-30			X	
Lukoil Lubricants Europe Oy	Teboil Super XLD-2	5W-30			X	
Meguin	Megol Motorenöl Super LL Dimo Premium	10W-40			X	
MOL-LUB Kft	MOL Synt Diesel	10W-40		X		
	MOL Dynamic Synt Diesel E4	10W-40			X	
Orlen Oil Sp.o.o.	Platinum Ultor Max	5W-30			X	
OOO LLK International	Lukoil Avantgarde Professional	5W-30			X	
	Lukoil Avantgarde Professional	10W-40			X	
	Lukoil Avantgarde Professional M5	10W-40			X	
	Lukoil Avantgarde Professional M6	10W-40			X	
	Lukoil Avantgarde Ultra M3	15W-40			X	
Panolin	Panolin Diesel HTE	10W-40			X	
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia Extreme	5W-30		X		
	Galp Galaxia Ultra XHP	10W-40			X	
Petromin Corporation	Petromin Turbo Master LD	10W-40			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Petronas Lubricants International	Petronas Akros Synt Gold	10W-40			X	
	Arexons HD-Truck E7	10W-40			X	
	Urania Maximo	10W-40			X	
	Petronas Urania Optimo	10W-40			X	
	Urania 100 K	10W-40			X	
	Urania 5000 F	5W-30			X	
	Urania 5000 LD	10W-40			X	
	Urania FE	5W-30			X	
	Petronas Urania Maximo	5W-30			X	
PHI OIL GmbH	Motordor Silver 10W40	10W-40			X	
Raj Petro Specialities P Ltd.	Zoomol Rforce 8200 RF1	10W-40			X	
Ramoil S.p.A.	Duglas Oil Ultra HC 10W-40 UHPDO	10W-40			X	
Ravensberger Schmierstoff Vertrieb GmbH	RAVENOL Super Performance Truck	5W-30			X	
	RAVENOL Performance Truck	10W-40			X	
Repsol Lubricantes y Especialidades S.A.	Repsol Turbo UHPD	10W-40			X	
	Repsol Diesel Turbo VHPD	5W-30			X	
	Repsol Diesel Turbo UHPD Urban	10W-40			X	
RN-Lubricants, LLC	Rosneft Revolux D4	10W-40			X	
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40			X	
SCT Vertriebs GmbH	Fanfaro TRD E4 UHPD	10W-40		X		
	Mannol TS-6 UHPD Eco	10W-40		X		
	Pemco Diesel G-6 Eco UHPD	10W-40		X		
Shell International Petroleum Company	Shell Rimula R5 M	10W-40			X	
	Shell Rimula R6 M	10W-40			X	
	Shell Rimula R6 ME	5W-30			X	
	Shell Rimula R6 MS	10W-40			X	
SK Lubricants Co.	ZIC X7000	5W-30			X	
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TFF	10W-40			X	
	SRS Cargolub TFL	5W-30			X	
	SRS Cargolub TFG	10W-40			X	
	SRS Cargolub TFG plus	10W-40			X	
Tedex SA	Tedex Diesel Truck UHPD (S) Motor Oil	10W-40			X	
Total Lubrifiants	Gulf Gulfleet Highway 10W-40	10W-40			X	
	RTO Extensia ECO	5W-30			X	
	Total Rubia TIR 9200 FE	5W-30			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Transnational Blenders B. V.	Engine Oil Super EHPD	10W-40			X	
Unil Opal	Unil Opal LCM 800	10W-40			X	
Valvoline EMEA	All Fleet Superior	10W-40			X	
	Profleet	10W-40			X	
	Valvoline All-Fleet Extreme NTI	10W-40		X		
Wolf Oil Corporation N.V.	Wolf Vitaltech 10W40 Ultra	10W-40			X	
	Champion New Energy 10W40 Ultra	10W-40			X	

Table 27:

5.7 Multigrade oils – Category 3.1 (Low SAPS oils) of SAE grades 5W-30, 10W-30 and 10W-40

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Important information

²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

Multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Extra Truck MD 1049 LE	10W-40	X			
Aral AG	Aral Mega Turboral LA	10W-40	X			
	Aral Super Turboral LA	5W-30	X			
BayWa AG	Tectrol Super Truck Plus XL 1040	10W-40	X			
Bucher AG Langenthal	Motorex Focus QTM	10W-40	X			
	Motorex Nexus FE SAE 5W-30	5W-30	X			
BP p.l.c.	BP Vanellus Max Drain Eco	10W-40		X		
	BP Vanellus Max Eco 10W-40	10W-40		X		
BVG Vertriebsgesellschaft AG	Alpha Advanced Eco-Efficiency low SAPS	10W-40	X			
Castrol Ltd.	Castrol Vecton Long Drain 10W-30 E6/E9	10W-30	X			
	Castrol Vecton Long Drain 10W-40 E6/E9	10W-40	X			
	Castrol Vecton Fuel Saver 5W-30 E6/E9	5W-30	X			
Cepsa Comercial Petroleo, SA	Cepsa Eurotech LS 10W40 Plus	10W-40		X		
Champion Chemicals N.V.	Champion OEM Specific 10W40 Ultra MS	10W-40		X		
Chevron Lubricants (Caltex)	Delo XLE Multigrade	10W-40	X			
Chevron Lubricants (Chevron)	Delo 400 RDE	10W-30		X		
	Delo 400 RDS	10W-40		X		
	Delo 400 XLE	15W-40	X			
	Delo 400 XLE HD	5W-30		X		
	Delo 400 XLE HD	10W-40		X		
	Delo 400 XLE SYN-HD	10W-40		X		
	Delo 400 XLE Synthetic	5W-30	X			
	Delo 400 LE Synthetic	5W-30	X			
Chevron Lubricants (Texaco)	Ursa Ultra X	10W-30		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
CONDAT Lubrifiants	Vicam Planet 10W40	10W-40			X	
Deutsche Ölwerke Lubmin GmbH	AVENO Universal UHPD	10W-40				
De Oliebron B.V.	Tor Turbosynth LSP Plus	10W-40			X	
eni S.p.a.	eni i-Sigma top MS	10W-40	X			
Enoc Marketing L.L.C.	Enoc Vulkan Green	10W-40			X	
Exxon Mobil Corporation	Mobil Delvac 1 ESP	5W-30		X		
	Mobil Delvac 1 LE	5W-30	X			
	Mobil Delvac HD	10W-40		X		
	Mobil Delvac XHP ESP M	10W-40			X	
	Mobil Delvac XHP LE	10W-40			X	55 gallons: 800141
	Mobil Delvac XHP Ultra LE	5W-30		X		
Finke Mineralölwerk GmbH	AVIATICON Finko Super Truck LA Plus	10W-40		X		
Fuchs Petrolub SE	Titan Cargo Maxx	5W-30			X	
	Titan Cargo Maxx	10W-40			X	
	Fuchs Titan Cargo EU6	5W-30	X			
Fuchs Schmierstoffe GmbH	Fuchs Titan Cargo LA	5W-30	X			
Gulf Oil International	Gulf Superfleet Synth ULE	5W-30	X			
	Gulf Superfleet XLE	10W-40	X			
	Gulf Superfleet Synth XLE	10W-30		X		
	Gulf Superfleet Synth XLE	10W-40	X			
	Gulf Superfleet Universal	10W-40			X	
Helios Lubeoil	Helios Premium KMXX 10W-40	10W-40	X			
Huiles Berliet S.A.	RTO Extensia FP	10W-40	X			
Igol	PRO 200 X	10W-40	X			
INA Maziva d.o.o.	INA Super 2009 5W-30	5W-30	X			
	INA Super 2009	10W-40			X	
Kuwait Petroleum R&T	Q8 905	10W-40	X			
	Q8 T 904	10W-40		X		
	Q8 T 904 FE	10W-30	X			
	Q8 T 905	10W-40	X			
	Q8 T 910	5W-30	X			
	Q8 Formula Truck 8500 FE	10W-30	X			
	Q8 Formula Truck 8700 FE	5W-30	X			
LLK finland Oy	Teboil Super XLD-2	5W-30			X	
Meguin GmbH & Co. KG	megal Motorenoel Low Saps	10W-40		X		

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Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Morris Lubricants	Ring Free Ultra	10W-40		X		
	Fendt Power Grade 10W-40	10W-40		X		
MPM International Oil Company B.V.	Motor Oil 10w-40 Premium Synthetic Ultra High Performance Diesel	10W-40		X		
Oel-Brack AG	Midland maxtra	10W-40		X		
OMV Petrol Ofisi A.Ş	Maximus HD-E	5W-30	X			
OOO LLK International	Lukoil Avantgarde CNG	10W-40	X			
	Lukoil Avantgarde Professional LE	5W-30			X	
	Lukoil Avantgarde Professional LS	5W-30	X			
	Lukoil Avantgarde Professional LS	10W-40			X	
	Lukoil Avantgarde Professional LS5	5W-30	X			
	Lukoil Avantgarde Professional LS5	10W-40	X			
Orlen Oil	Platinum Ultor Complete	10W-40	X			
	Platinum Ultor Optimo	10W-30	X			
	Platinum Ultor Progress	10W-40		X		
	Mogul Diesel L-SAPS	10W-40		X		
Panolin	Panolin Diesel Synth EU-4	10W-40	X			
	Panolin Ecomot	5W-30		X		
	Panolin Ecomot	10W-30	X			
	Panolin Ecomot	10W-40	X			
Petro-Canada Lubricants Inc.	Duron UHP 5W30	5W-30	X			
	Duron UHP E6 10W40	10W-40	X			
Petróleos de Portugal	Galp Galaxia Ultra LS	10W-40	X			
Petronas Lubricants International	Petronas Urania 5000 E	5W-30			X	
	Petronas Urania 5000 E	10W-40			X	
	Petronas Urania FE LS	5W-30			X	
	Petronas Urania Ecotech	10W-40			X	
PHI OIL GmbH	Motodor LSP Gold 5W30	5W-30			X	
	Motodor LSP Silver	10W-40		X		
Prista Oil Ad	Prista UHPD	10W-40	X			
Ravensberger Schmierölvertrieb GmbH	Ravenol Euro VI Truck	10W-40	X			
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Turbo UHPD MID SAPS	10W-40	X			
	Repsol DieselTurbo VHPD Mid Saps	5W-30		X		
Rowe Mineralölwerk GmbH	Rowe Hightec Truckstar SAE 10W-40 HC-LA	10W-40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Shell International Petroleum Company	Shell Rimula R6 LM	10W-40	X			Increased corrosion protection
	Shell Rimula R6 LME	5W-30		X		
	Shell Rimula Ultra	5W-30			X	
SK energy	ZIC XQ 5000	10W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Antikorrol MLA	10W-40		X		Increased corrosion protection
	SRS Cargolub TLA	10W-40	X			
	SRS Cargolub TLS	5W-30			X	
	SRS Cargolub TLS plus	5W-30		X		
	SRS Turbo Diesel LA	10W-40	X			
	SRS Cargolub low-friction engine oil LA	10W-40		X		
	SRS Turbo-Rekord top FE	10W-40		X		
	SRS Turbo-Rekord ultra FE	10W-40	X			
Statoil Lubricants	MaxWay Ultra E6 10W-40	10W-40			X	
Total Lubrificants	Total Rubia TIR 8900	10W-40	X			
	Total Rubia Works 2500	10W-40	X			
Transnational Blenders B. V.	Engine Oil Synthetic UHPD E6	10W-30		X		
	Engine Oil Synthetic UHPD E6	10W-40		X		
	Motor oil SCR	10W-40	X			
Valvoline EMEA	Valvoline ProFleet LS	5W-30			X	
	Valvoline ProFleet LS	10W-40	X			
	ProFleet LS NTI	10W-40	X			
Wibo Schmierstoffe GmbH	Wibokraft Ultra AF 10W40	10W-40		X		
Wolf Oil Corporation N.V.	Wolf Officialtech 10W40 Ultra MS	10W-40		X		
	Champion OEM Specific 10W40 Ultra MS	10W-40		X		
Yacco SAS	Yacco Transpo 65	10W-40			X	

Table 28:

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5.8 Lubricating Greases

5.8.1 Lubricating greases for general applications

For details and special features, see chapter "Lubricating greases" (→ Page 15)

Manufacturer	Brand name	Notes
Aral AG	Mehrzweckfett Arallub HL2	
BP p.l.c.	Energrease LS2	
Castrol Ltd.	Spheerol AP2	
Chevron	Multifak EP2	
SRS Schmierstoff Vertrieb GmbH	SRS Wiolub LFK2	
Shell Deutschland GmbH	Shell Gadus S2 V220 2	
Total	Total Multis EP2	
Veedol International	Multipurpose	

Table 29:

5.8.2 Lubricating greases for diesel engine-generator set components

Important		
Mixtures of different greases are not permitted!		
Manufacturer	Brand name	Notes
Exxon Mobil Corporation	Mobil Polyrex EM	High-temperature grease: Lubricity in the range from -30 to 250 °C (-22 to 482 °F) For: <ul style="list-style-type: none"> • Generator bearings of Marathon generators • Generator bearings of Leroy-Somer generators^{*)} • Fan wheel and belt pulley bearing on electrically driven coolant cooler, Series 4000
Shell	GADUS S3 V220C	For generator bearings of Leroy-Somer generators ^{*)}
SKF	Mehrzweckfett LGMT2	For generator bearings of HM generators
ROCOL Limited	Rocol RTD-Compound	For belt tensioner on electrically driven coolant cooler, Series 4000
ASCO Power Technologies	Lubrication Kit 75-100	For automatic transfer switch (ATS) ASCO

^{*)} NOTE: For information about the applicable lubricating greases for Leroy-Somer generators, refer to the nameplate on the generator.

For information about lubricating greases for generators made by other manufacturers, please contact MTU Onsite Energy service partners.

6 Approved Coolants

6.1 Coolants without antifreeze for cooling systems containing light metal

6.1.1 Coolant without antifreeze – Concentrates for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Important information

For the marine engine Series 1163-03 and 1163-04, only coolants marked with an asterisk * in the brand name can be used!

Coolants without antifreeze – concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate*		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool® Plus 6000 Concentrate*		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
Arteco NV	Freecor NBI		X				6000 / 2	
BASF SE	Glyscorr G93 green*		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	6000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 6000	X				X	6000 / 2	colored red
Drew Marine	Drewgard XTA*		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Valvoline	ZEREX G-93*		X				6000 / 2	
YORK SAS	York 719*		X				6000 / 2	

Table 30:

6.1.2 Coolant without antifreeze – Ready mixtures for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Important information

For the marine engine Series 1163-03 and 1163-04, only coolants marked with an asterisk * in the brand name can be used

Coolant without antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS10/90 Corrosion Inhibitor Premix*		X				6000 / 2	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)

Table 31:

6.2 Coolants without antifreeze for cooling systems free of light metal

6.2.1 Coolants without antifreeze – Concentrates for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Coolants without antifreeze – concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool®Plus 6000 Concentrate		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
Arteco NV	Freecor NBI		X				6000 / 2	
	Havoline Extended Life Corrosion Inhibitor [EU Code 32765] (XLI)	X					6000 / 2	
BASF SE	Glysacorr G93 green		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	6000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 2000		X	X			6000 / 2	
	Power Cool Plus 6000	X				X	6000 / 2	colored red
Drew Marine	Drewgard XTA		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Fleetguard	DCA-4L		X	X	X		2000 / 1	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Nalco	Alfloc (Maxitreat) 3477	X					6000 / 2	
	Alfloc 2000		X	X			6000 / 2	
	Nalco 2000		X	X			6000 / 2	
	Nalcool 2000		X	X			6000 / 2	
	Trac 102		X	X			6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	
Penray	Pencool 2000		X	X			6000 / 2	
PrixMax Australia Pty. Ltd.	PrixMax RCP	X					6000 / 2	
Total	Total WT Supra	X					6000 / 2	
Valvoline	Zerex G-93		X				6000 / 2	
YORK SAS	York 719		X				6000 / 2	

Table 32:

6.2.2 Coolant without antifreeze – Ready mixtures for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Coolant without antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X				6000 / 2	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)
Nalco	Alfloc (Maxitreat) 3443 (7 %)	X					6000 / 2	

Table 33:

6.3 Antifreezes for cooling systems containing light metal

6.3.1 Antifreeze – Concentrates for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100 Antifreeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l) also available through MTU Asia
Avia Mineralöl AG	Antifreeze APN	X	X				9000 / 5	
	Antifreeze APN - S	X					9000 / 3	
BASF SE	Glystantin G05		X	X			9000 / 5	
	Glystantin G48 blue green	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glystantin G30 pink	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48	X	X				9000 / 5	
Castrol	Castrol Radicool NF	X	X				9000 / 5	
CCI Corporation	L 415	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521	X				X	9000 / 3	
Clariant	Genantin Super		X	X			9000 / 5	
Classic Schmierstoff GmbH + Co KG	Classic Kolda UE G48	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream® G30® Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48® Antifreeze Coolant Concentrate	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant	X				X	9000 / 3	
	Power Cool Diesel Engine Coolant		X	X			9000 / 3	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Mobil Heavy Duty Coolant		X	X			9000 / 3	
	Mobil Mining Coolant		X	X			9000 / 3	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F30	X					9000 / 3	
	AVIATICON Finkofreeze F48	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
Gazpromneft Lubricants Ltd.	Belaz G-Profi Antifreeze Red	X					9000 / 3	
Krafft S.L.U.	Refrigerante ACU 2300		X	X			9000 / 3	X00058075 (barrel)
Kuttenkeuler GmbH	Kuttenkeuler Antifreeze ANF KK48	X	X				9000 / 5	
	Glycostar®ST48	X	X				9000 / 5	
INA Maziva Ltd.	INA Antifriz AI Super	X	X				9000 / 5	
Mitan Mineralöl GmbH	Alpine C48	X	X				9000 / 5	
Nalco	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48 C	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X	9000 / 3	
	Fleet Charge SCA Pre-charged Coolant / Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze	X				X	9000 / 3	
OMV	OMV Coolant Plus	X	X				9000 / 5	
	OMV Coolant SF	X					9000 / 3	
Panolin AG	Panolin Anti-Frost MT-325	X	X				9000 / 5	
Penske Power Systems	Power Cool - HB500 Coolant Concentrate	X	X				9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Concentrate	X	X				9000 / 5	
Recochem Inc.	R542	X	X				9000 / 3	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
SMB - Sotagal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total	Glacelf MDX	X	X				9000 / 5	
Valvoline	Zerex G-05		X	X			9000 / 5	
	Zerex G-48	X	X				9000 / 5	
	Zerex G-30	X					9000 / 3	
YORK SAS	York 716	X	X				9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 K	X					9000 / 3	

Table 34:

6.3.2 Antifreeze – Concentrates for special applications

For details and special features, see chapter on “Coolants” (→ Page 17)

Concentrates for special applications

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
BASF SE	G206	X	X				9000 / 3	For use in arctic regions (< -40 °C)

Table 35:

6.3.3 Antifreeze – Ready mixtures for cooling systems containing light metals

For details and special features, see chapter on “Coolants” (→ Page 17)

Ready mixtures for cooling systems containing light metals

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Antifreeze Premix	X	X				9000 / 5	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant AH 40/60 Antifreeze Premix	X	X				9000 / 5	X00070533 (20 l) X00070531 (210 l) X00070532 (1000 l) (sales region: England, Spain)
	Coolant AH 50/50 Antifreeze Premix	X	X				9000 / 5	X00070528 (20 l) X00070530 (210 l) X00070527 (1000 l) (sales region: England)
	Coolant RM30 (40 %)	X					9000 / 3	X00073922 (20 l) X00073916 (205 l) X00073923 (1000 l)
MTU America Inc.	Power Cool® Universal 35/65 mix	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix	X	X				9000 / 5	800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			9000 / 5	23533531 (5 gallons) 23533532 (55 gallons)
Bantleon	Avilub Antifreeze Mix (50 %)	X	X				9000 / 5	X00049213 (210 l)
BayWa AG	Tectrol Coolprotect Mix 3000	X					9000 / 3	Antifreeze protection up to -24 °C
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
Castrol	Castrol Radicool NF Pre-mix (45%)	X	X				9000 / 5	
CCI Corporation	L 415 (50%)	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	X				X	9000 / 3	
Cepsa Comercial Petróleo S.A.U.	XTAR Super Coolant Hybrid NF 50%	X	X				9000 / 5	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X	9000 / 3	
	Power Cool Prediluted 50/50 Diesel Engine Coolant		X	X			9000 / 3	
Exxon Mobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F48 RM 50/50	X	X				9000 / 5	
	AVIATICON Finkofreeze F30 RM 40:60 +	X					9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/ Antifreeze (50/50)	X				X	9000 / 3	
	Fleet Charge SCA Pre-charged 50/50 Prediluted Coolant		X	X			9000 / 3	
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
Raloy Lubricantes	Antifreez Long Life NF-300 Ready-to-Use (50:50)	X	X				9000 / 5	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	X					9000 / 3	
	Glysantin Alu Protect Plus G48 Ready Mix	X	X				9000 / 5	
Total	Coolelf MDX (-26 °C)	X	X				9000 / 5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready	X					9000 / 3	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 (50%)	X					9000 / 3	

Table 36:

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6.4 Antifreezes for cooling systems free of light metal

6.4.1 Antifreeze – Concentrates for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Important information

For the Series 4000-04 and 4000-05, only coolants marked with an asterisk * in the brand name can be used!

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100* Antifreeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l) also available through MTU Asia
Artego NV	Havoline Extended Life Coolant XLC [EU Code 30379]	X					9000 / 3	
Avia Mineralöl AG	Antifreeze APN*	X	X				9000 / 5	
	Antifreeze APN - S*	X					9000 / 3	
BASF SE	Glysantin G05		X	X			9000 / 5	
	Glysantin G48 blue green*	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30 pink*	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
BayWa AG	Tectrol Coolprotect*	X	X				9000 / 5	
BP Lubricants	ARAL Antifreeze Extra*	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant*	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48*	X	X				9000 / 5	
Caltex	Caltex Extended Life Coolant [AP Code 510614] (XLC)	X					9000 / 3	
Castrol	Castrol Radicool NF*	X	X				9000 / 5	
CCI Corporation	L415*	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C521*	X				X	9000 / 3	
Chevron Corp.	Havoline Dexcool Extended Life Antifreeze [US Code 227994]	X					9000 / 3	
Clariant	Genantin Super		X	X			9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Classic Schmierstoff GmbH + Co. KG	Classic Kolda UE G48*	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream® G30®* Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48®* Antifreeze Coolant Concentrate	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant*	X				X	9000 / 3	
	Power Cool Diesel Engine Coolant		X	X			9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant*	X				X	9000 / 3	
	Mobil Antifreeze Advanced*	X					9000 / 3	
	Mobil Antifreeze Extra*	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Mobil Heavy Duty Coolant		X	X			9000 / 3	
	Mobil Mining Coolant		X	X			9000 / 3	
	Esso Antifreeze Advanced*	X					9000 / 3	
	Esso Antifreeze Extra*	X	X				9000 / 5	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F30*	X					9000 / 3	
	AVIATICON Finkofreeze F48*	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin*	X	X				9000 / 5	
	Maintain Fricofin G12 Plus*	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
	Maintain Fricofin HDD [Oil-code T-AF3-1]		X	X		X	9000 / 3	
Gazpromneft Lubricants Ltd.	Belaz G-Profi Antifreeze Red*	X					9000 / 3	
	G - Energy Antifreeze SNF	X					9000 / 3	
Krafft S.L.U	Refrigerante ACU 2300		X	X			9000 / 3	X00058075 (barrel)
Kuttenkeuler GmbH	Kuttenkeuler Antifreeze ANF KK48*	X	X				9000 / 5	
	Glycostar® ST48*	X	X				9000 / 5	
INA Maziva Ltd.	INA Antifriz AI Super*	X	X				9000 / 5	
Mitan Mineralöl GmbH	Alpine C48*	X	X				9000 / 5	
MOL-Lub Kft.	EVOX Premium concentrate	X					9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Nalco	Nalcool 4070	X	X	X			9000 / 3	
	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48 C*	X	X				9000 / 5	
OAo Technoform	Cool Stream Premium C	X					9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant*	X				X	9000 / 3	
	Fleetcharge SCA Pre-charged Coolant / Anti-freeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze*	X				X	9000 / 3	
OMV	OMV Coolant Plus*	X	X				9000 / 5	
	OMV Coolant SF*	X					9000 / 3	
Panolin AG	Panolin Anti-Frost MT-325*	X	X				9000 / 5	
Penske Power Systems	Power Cool - HB500	X	X				9000 / 3	
	Power Cool - HB800	X	X	X			9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Concentrate*	X	X				9000 / 5	
Recochem Inc.	R542	X	X				9000 / 3	
	R824M	X	X	X			9000 / 3	
Shell	Shell HD Premium N		X	X			9000 / 3	
SMB - Sotragal / Mont Blanc	Antigel Power Cooling Concentrate*	X	X				9000 / 5	
Total	Glacelf Auto Supra	X					9000 / 3	
	Glacelf MDX*	X	X				9000 / 5	
	Glacelf Supra	X					9000 / 3	
Valvoline	Zerex G-05		X	X			9000 / 5	
	Zerex G-48*	X	X				9000 / 3	
	Zerex G-30*	X					9000 / 5	
YORK SAS	York 716*	X	X				9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 K*	X					9000 / 3	

Table 37:

6.4.2 Antifreeze – Concentrates for special applications

For details and special features, see chapter on “Coolants” (→ Page 17)

Concentrates for special applications

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
BASF SE	G206	X	X				9000 / 3	For use in arctic regions (< -40 °C) No approval for Ser- ies 4000-04

Table 38:

6.4.3 Antifreeze – Ready mixtures for cooling systems free of light metals

For details and special features, see chapter on “Coolants” (→ Page 17)

Important information

For the Series 4000-04 and 4000-05, only coolants marked with an asterisk * in the brand name can be used!

Antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Antifreeze Premix*	X	X				9000 / 5	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant AH 40/60 Antifreeze Premix*	X	X				9000 / 5	X00070533 (20 l) X00070531 (210 l) X00070532 (1000 l) (sales region: England, Spain)
	Coolant AH 50/50 Antifreeze Premix*	X	X				9000 / 5	X00070528 (20 l) X00070530 (210 l) X00070527 (1000 l) (sales region: England)
	Coolant RM 30 (40%)*	X					9000 / 3	X00073922 (20 l) X00073916 (205 l) X00073923 (1000 l)
MTU America Inc.	Power Cool® Universal 35/65 mix*	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix*	X	X				9000 / 5	800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			9000 / 5	23533531 (5 gallons) 23533532 (55 gallons)
Arteco NV	Havoline Extended Life Coolant + B2 50/50 OF01 [EU Code 33073] (50%)	X					9000 / 3	
	Havoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40%)	X					9000 / 3	
	Havoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35%)	X					9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)*	X	X				9000 / 5	X00049213 (210 l)
BayWa AG	Tectrol Coolprotect Mix 3000*	X					9000 / 3	Antifreeze protection up to -24 °C

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)*	X	X				9000 / 5	
Caltex	Caltex Extended Life Coolant Pre-Mixed 50/50 [AP Code 510609] (50 %)	X					9000 / 3	
Castrol	Castrol Radicool NF Premix (45 %)*	X	X				9000 / 5	
CCI Corporation	L 415 (50 %)*	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50 %)*	X				X	9000 / 3	
Cepsa Comercial Petróleo S.A.U.	Xtar Super Coolant Hybrid NF 50%*	X	X				9000 / 5	
Chevron Corp.	Havoline Dexcool Extended Life Prediluted 50/50 Antifreeze Coolant [US Code 227995]	X					9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)*	X				X	9000 / 3	
	Power Cool Prediluted 50/50 Diesel Engine Coolant		X	X			9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F48 RM 50/50*	X	X				9000 / 5	
	AVIATICON Finkofreeze F30 RM 40:60 +	X					9000 / 3	
Fuchs Petrolub SE	Maintain Fricofin HDD Premix 50/50 [Oilcode T-AF3-2]		X	X		X	9000 / 3	
Nalco	Nalcool 4100 (50 %)	X	X	X			9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant / Antifreeze (50/50)*	X				X	9000 / 3	
	Fleet Charge SCA Pre-charged 50/50 Prediluted Coolant		X	X			9000 / 3	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
	Power Cool - HB800 Premix 50/50	X	X	X			9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Ready-to-Use (50:50)*	X	X				9000 / 5	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44 %)*	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)*	X	X				9000 / 5	
Total	Coolelf MDX (-26 °C)*	X	X				9000 / 5	
	Coolelf Supra (40%)	X					9000 / 3	
	Coolelf GF NP (50%)	X					9000 / 3	
Tosol-Sinzez	Glystantin Alu Protect/G30 Ready Mix*	X					9000 / 3	
	Glystantin Protect Plus/G48 Ready Mix*	X	X				9000 / 5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready*	X					9000 / 3	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 (50%)*	X					9000 / 3	

Table 39:

6.5 Coolant Additives with Limited Series Approval

6.5.1 Antifreeze - Concentrates and ready mixtures on ethylene-glycol basis for series with and without light metal

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
BASF SE	Glysantin®G40 pink (concentrate)	X	X				9000 / 3	X00066724 (20 l) X00066725 (210 l) Concentration for use: 40 to 50% by volume
Bucher AG Langenthal	Motorex Coolant M 4,0 Concentrate	X	X				9000 / 3	Antifreeze protection up to -38 °C
Valvoline	ZEREX G40 (concentrate)	X	X				9000 / 3	Concentration for use: 40 to 50% by volume Material number (USA): 800180 (Drum)

Table 40:

Antifreezes - ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Bucher AG Langenthal	Motorex Coolant M 4,0 Ready to use	X	X				9000 / 3	Antifreeze protection up to -38 °C

Table 41:

6.5.2 Antifreeze – Ready mixtures based on propylene glycol for series free of light metal

Antifreeze, ready mixture

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Fleetguard	PG XL (40%) ready mixture		X	X	X		9000 / 3	

Table 42:

7 Flushing and Cleaning Specifications for Engine Coolant Circuits

7.1 General information

In the course of time, sludge deposits from aging coolant additives can accumulate in the coolant circuits. Reduced cooling capacity, clogged vent lines and drain points and dirty coolant level sight-glasses can result.

Below-standard water quality or incorrect coolant preparation can also heavily contaminate the system.

If such conditions occur, the coolant circuit is to be flushed out with fresh water, repeatedly if necessary.

If these flushing sequences are insufficient or if the system is too heavily contaminated, the coolant circuit and all affected parts must be cleaned.

Only clean, fresh water (no river or sea water) must be used for flushing.

Only products approved by MTU or corresponding products at the specified concentrations may be used for cleaning, see (→ Page 118). The specified cleaning procedure is to be complied with.

Immediately after flushing or cleaning, fill the coolant circuits with treated engine coolant as stipulated in the current MTU Fluids and Lubricants Specifications. Otherwise there is a danger of corrosion!

Important

Fluids and lubricants (e.g. treated engine coolant), used flushing water, cleaning agents and cleaning solutions can be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturer's instructions, legal requirements and technical guidelines valid in the individual countries. Considerable differences can apply from country to country so that no generally valid statement on the applicable regulations for fluids and lubricants etc. can be made in this publication.

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants / cleaning agents which it has approved.

Important

Scrap oil heat exchangers from engines with bearing or piston seizures or friction damage!

Test equipment, auxiliary materials and fluids and lubricants

MTU test kit or electric pH-value measuring instrument

Required auxiliary materials:

- Compressed air
- Superheated steam

Required fluids and lubricants:

- Fresh water
- Prepared engine coolant

7.2 Approved cleaning agents

Manufacturer	Product name	Concentration for use		Order No.
For coolant systems:				
Kluthe	Hakutex 111 ^{1, 5)}	2% by volume	Liquid	X00065751
	Hakupur 50-706-3 ¹⁰⁾	2% by volume	Liquid	X00055629
For subassemblies:				
Henkel	Bonderite C-AK FD ²⁾	1 to 10% by weight	Powder	⁷⁾
	Bonderite C-MC 11120 ³⁾	2 to 10% by weight	Powder	⁷⁾
Kluthe	Hakutex 60 MTU	100% by volume	Liquid	X00070585 (25 kg)
For coolant systems contaminated with bacteria, fungi or yeast (so-called system cleaners):				
Schülke & Mayr GmbH	Grotan WS Plus ⁵⁾	0.15% by volume	Liquid	X00065326 (10 kg)
	Grotanol SR2 ⁶⁾	0.5% by volume	Liquid	X00069827 (10 kg)
For external cooler on air side:				
Kluthe	Hakupur 50 K ⁹⁾	0.5 to 5% by volume	Liquid	X00070940 ⁷⁾
For painted, contaminated surfaces:				
Kluthe	Hakupur 449 ⁹⁾	1% by volume	Liquid	X00071179 ⁷⁾

Table 43:

¹⁾ For light lime deposits, light corrosion

²⁾ For greasy lime deposits

³⁾ Preferred for heavy lime deposits

⁴⁾ For heavy lime deposits

⁵⁾ Bacteria contamination up to 10^4

⁶⁾ Bacteria contamination up to $> 10^4$, contamination with fungi and yeast

⁷⁾ Not stocked by MTU

⁸⁾ With serious corrosion; not permitted for aluminum materials

⁹⁾ Cleaning agent for cleaning with high-pressure cleaning device (parameter: Pressure: 15 bar, gentle spray jet, cleaning agent temperature: 80 °C)

¹⁰⁾ Not suitable for galvanized surfaces

Important information

The technical data sheets and safety data sheets of the product must be observed!

7.3 Engine coolant circuits - Flushing

1. Drain engine coolant.
2. Measure pH-value of the fresh water using the MTU test kit or electric pH-value measuring device.
3. Fill coolant circuit with fresh water.

Important information

Never pour cold water into a hot engine!

4. Preheat, start and run engine until warm.
5. Run engine for approx. 30 minutes at increased speed.
6. Take flush-water sample at engine-coolant-sample extraction cock.
7. Shut down engine.
8. Drain flush water.
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
 - a) pH value difference < 1 : Fill system with treated coolant and start engine.
 - b) pH value difference > 1 : Fill system with fresh flush water and repeat flushing process.
 - c) If the pH value difference is still > 1 after 4 to 5 flushing operations: The coolant circuit must be cleaned, see (→ Page 120). The assemblies may also have to be cleaned, see (→ Page 121).

Important information

Refer to the engine operating instructions for additional information.

7.4 Engine coolant circuits – Cleaning

1. Cleaning agents for coolant circuits are prepared in warm, fresh water as a concentrated solution, see (→ Page 118).
2. In the case of powdered products, stir until the cleaning agent is completely dissolved and without sediment.
3. Pour solution together with fresh water into coolant circuit.
4. Start engine and run until warm.
5. Select temperature and duration of residence time according to the specifications of the technical data sheets of the manufacturer.
6. Shut down engine.
7. Drain off cleaning agents and flush the engine coolant circuit with fresh water.
8. Take flush-water sample at engine-coolant-sample extraction cock.
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
 - a) pH value difference < 1: Fill system with treated coolant and start engine.
 - b) pH value difference > 1: Clean assemblies, see (→ Page 121).

Important information

Refer to the engine operating instructions for additional information.

7.5 Assemblies – Cleaning

1. Remove, disassemble and clean assemblies that are exposed to heavy sludge deposits e.g. expansion tanks, preheating units, heat exchangers (coolant cooler, oil heat-exchanger, charge-air cooler, charge-air preheater, fuel preheater etc.) and lower sections of pipework.
2. Before cleaning, examine degree of contamination on water sides.
3. If greasy lime deposits are found, first degrease the water side.
4. Deposits in charge-air coolers caused by oil mist can be removed using Kluthe Hakutex 60.
5. Remove hard lime deposits with a decalcifying product. In the event of stubborn lime deposits, if necessary a 10% inhibited hydrochloric acid solution may have to be used.
6. Dissolve deposits on and in heat-exchanger elements in a heated cleaning bath. Observe the manufacturer's specifications and use only approved detergents in the permissible concentration, see (→ Page 118)

Important information

Deposits on the oil side can also be dissolved in a kerosene bath.
The dwell time in the cleaning bath depends on the type and degree of contamination, as well as the temperature and activity of the bath.

7. Clean individual components such as housings, covers, pipes, sight glasses, heat-exchanger elements with superheated steam, a nylon brush (soft) and a powerful water jet.

Important information

In order to avoid damage:
Do not use hard or sharp-edged tools (steel brushes, scrapers, etc.) (oxide protective layer).
Do not set the pressure of the water jet too high (may damage cooler fins, for example).

8. After cleaning, blow through the heat exchanger elements with low-pressure steam in the direction opposite to operational flow, rinse with clear water (until pH-value difference is < 1) and blow dry with compressed or hot air.
9. Check that all components are in perfect condition, repair or replace as necessary.
10. Flush oil and engine coolant sides of heat-exchanger elements with corrosion-inhibiting oil. This step may be omitted if the heat exchanger is installed and taken into service immediately after cleaning.
11. After installing all assemblies, flush engine coolant circuit once, see (→ Page 119).
12. Check coolant system for leaks during initial operation of engine.

Important information

For further information, see the Maintenance Manual for the engine in question.

7.6 Coolant circuits contaminated with bacteria, fungi or yeast

System cleaning

The system cleaner must flow a sufficiently long time through the complete cooling system to ensure effective cleaning and disinfection.

Therefore, the predefined amount of the approved system cleaner must be added to the contaminated coolant in the system, see (→ Page 118). Use a circulating pump to provide continuous mixture flow through the coolant system for at least 24 hours or max. 48 hours.

Flushing

When the coolant and system cleaner have been drained, the cooling circuit must be flushed with fresh water. Flushing must be carried out until no more contaminants are visible and the flushing liquid has the same pH-value as the fresh water used (max. pH-value difference < 1).

Refill

Before refilling the circuit, make sure the system is free of contaminants.

Refill must be performed directly after flushing to avoid the risk of corrosion!

8 Revision Overview

8.1 Revision overview from version A001064/08 to version A001064/09

Seq. No.	Section	Subject	Page	Action
1	2.1	Engine oils – General information	(→ Page 7)	Revised
2	3.2	Operational monitoring	(→ Page 20)	Revised
3	3.5	Fresh water requirements	(→ Page 26)	Revised
4	3.9	Limit values for coolants	(→ Page 30)	Revised
5	3.10	Coolant concentrates – Storage capability	(→ Page 31)	Revised
6	4.1	Diesel fuels – General information	(→ Page 36)	Revised
7	4.2.1	Distillate fuels according to DIN EN 590 and ASTM D975	(→ Page 41)	Revised
8	4.2.3	Chinese distillate fuels according to GB 19147-2013 and 252-2011	(→ Page 44)	Revised
9	4.2.4	Heating oil	(→ Page 45)	Revised
10	4.2.6	Aviation turbine fuel	(→ Page 48)	Revised
11	4.2.7	NATO diesel fuels	(→ Page 49)	Revised
12	4.2.9	B20 diesel fuel	(→ Page 53)	Revised
13	4.5	Unsuitable materials in diesel fuel circuit	(→ Page 64)	Revised
14	5.1	Single-grade oils – Category 1, SAE grades 30 and 40 for diesel engines	(→ Page 67)	Revised
15	5.2	Multigrade oils – Category 1, SAE grades 15W-40 for diesel engines	(→ Page 69)	Revised
16	5.3	Single-grade oils – Category 2, SAE-grades 30 and 40 for diesel engines	(→ Page 70)	Revised
17	5.4	Multigrade oils – Category 2 of SAE grades 10W-40, 15W-40 and 20W-40 for diesel engines	(→ Page 70)	Revised
18	5.5	Multigrade oils – Category 2.1 (Low SAPS oils) of SAE grades 0W-30, 10W-30, 5W-40, 10W-40 and 15W-40	(→ Page 82)	Revised
19	5.6	Multigrade oils – Category 3 of SAE grades 5W-30, 5W-40 and 10W-40 for diesel engines	(→ Page 85)	Revised

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21	6.1.1	Coolant without antifreeze – Concentrates for cooling systems containing light metal	(→ Page 96)	Revised
22	6.2.1	Coolants without antifreeze – Concentrates for cooling systems free of light metal	(→ Page 99)	Revised
23	6.3.1	Antifreeze – Concentrates for cooling systems containing light metal	(→ Page 102)	Revised
24	6.3.3	Antifreeze – Ready mixtures for cooling systems containing light metals	(→ Page 106)	Revised
25	6.4.1	Antifreeze – Concentrates for cooling systems free of light metal	(→ Page 108)	Revised
26	6.4.3	Antifreeze – Ready mixtures for cooling systems free of light metals	(→ Page 112)	Revised
27	6.5.1	Antifreeze – Concentrates and ready mixtures on ethylene-glycol basis for series with and without light metal	(→ Page 115)	Revised
28	7.2	Approved cleaning agents	(→ Page 118)	Revised

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APPENDIX 9.05

Emissions Datasheet



Contents

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94F				
Rated power [kW]	3088				
Rated speed [rpm]	1500				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Data Set No.	XZ54954100066				
Data Set Basis	NEA Singapore for ORDE				
Fuel sulphur content [ppm]	7				

Content	Page
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Not to exceed emission values	6
Cycle information for NEA Singapore for ORDE	8

PDF	Name	Project no.	Size
Configurator	Lenhof, Torsten (TARC)	Order no.	A4
Approver1	Kneifel, Alexander (TSLE)	EDS-ID	
Approver2	Kolliwer, Michael (TV)	2555-20.04.2023	
Approver3			
Approver4			
User	FN2\1170260		
Engine model 20V4000G94F		Title Emission data sheet	
Emissionstage NEA Singapore for ORDE			Sheet 1
Emissionstage basis NEA Singapore for ORDE			of 8

Description of Revision	Frequency
Data generated by EDS Creator version 1.0 and uniplot. Ref.-dataset: 420122_364_NEA_G94F_D2.nc for 294 in EDS platform.	

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General Disclaimers (valid for Measured and NTE values)

Please note that these data are physical and/or technical values only referring to and representing a normative defined operating condition. Any change in operating time and conditions will have impact on physical values and engine behavior, which must be considered and assessed within the complete propulsion system especially in regard to emission compliance and product safety.

Measurements listed in this EDS are representative of the listed engine rating at the time of testing. These measurements and results can change according to instrumentation, boundary condition, and engine to engine variability. In addition - changes to the engine family hard or software may occur which could result in changes to some of the listed values.

Emissions data measurement procedures are conducted according to applicable rules and standards as per "Emission Stage/Optimization". Potential deviations from these procedures are documented internally.

The listed emission values relate to the corresponding certification data. Seller doesn't take any responsibility or liability neither out or in connection with the contract nor on any other basis

- beyond these specified operating conditions of the engine
- and for any installation/modification of the entire propulsion system by the customer itself or any third party and the customer will indemnify MTU on first demand for any third party claim out or in connection with this.

Seller reserves the right to amend specifications and information without notice and without obligation or liability. No liability for any errors, facts or opinions is accepted. Customers must satisfy themselves as to the suitability of this product for their application. No responsibility for any loss as a result of any person placing reliance on any material contained in this data sheet will be accepted.

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When applicable, emission values are measured after combined exhaust streams.

Measured Emissions data is based on single operating points and thus cannot be used to compare to regulations which use values based on a weighted cycle.

Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures, and instrumentation. Over time deterioration may occur which may have an impact on emission levels.

The SO2 emission rates comprehend exclusively the SO2 content as found in the fuel source, oil consumption effects are not included. Variation of sulfur content in the fuel changes only the stated SO2 emissions, cross sensitivity to other emissions (e.g. particulates) is not possible.

All values based on metric units, inaccuracies for non metric values can occur, values are not binding.

Specific to gas engines: The listed emission values are based on gas composition at the time of certification measurement. Gas composition is as displayed in the EDS-document. Carbon dioxide and methane concentrations have direct influence on the corresponding displayed carbon dioxide and methane emissions.

EAT Specific Disclaimers (valid for EDS values)

NH3 emissions levels measured with AVL SESAM i60/ 4 FT Multi Component Exhaust Measurement System (FTIR) including EPA 40 CFR 1065 legislation compliant automated checks for linearity.

Generators or engines with exhaust after-treatment systems require a stabilization period of approximately 1 hour to ensure stable temperatures across SCR prior to performing an emissions test. Performing emissions measurements before a stable temperature has been achieved can result in inconsistent emission values. NOx Values only applicable if temperatures across SCR reached for DEF Dosing.

NTE Disclaimers (valid for NTE calculated values)

Calculated not to exceed values (NTE) are not proven by tests and therefore the accuracy is not guaranteed.

All emission data shown in chapters Emission Data Sheet, Not to Exceed Values, and Type Approval were gathered from a corresponding certification engine under test conditions shown above and complying to corresponding TEN data.

		PDF	Name	Project no.	Size
		Configurator	Lenhof, Torsten (TARC)	Order no.	A4
		Approver1	Kneifel, Alexander (TSLE)	EDS-ID	
		Approver2	Kolliwer, Michael (TV)	2555-20.04.2023	
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		Approver4			
		User	FN2\1170260		
		Engine model	20V4000G94F	Title	Emission data sheet
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Configuration-ID 294		Emissionstage basis NEA Singapore for ORDE			8



Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94F				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Fuel sulphur content [ppm]	7				
mg/mN ³ values base on residual oxygen value of [%]	5				

Engine raw emissions*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	3090	2317	1545	772	309
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine torque	Nm	19658	14741	9830	4915	1966
Engine torque relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1501	1501	1501	1501	1500
Engine speed relative	[-]	1	1	1	1	1
Eff. mean pressure	bar	25.91	19.43	12.96	6.48	2.59
Ambient air pressure	bar	0.991	0.993	0.99	0.983	0.982
Air pressure at humidity measurement position	bar	0.991	0.993	0.99	0.983	0.982
Air temperature at humidity measurement position	grdC	23.7	23.4	23.8	23.8	23.4
Intake air temperature	grdC	23.5	23.4	24.2	24.7	24.7
Hydrocarbon (HC) (5% O ₂)	ppm	37	40	49	85	327
Carbon monoxide (CO) (5% O ₂)	ppm	65	79	292	335	643
Filter smoke number	Bosch	0.18	0.2	0.7	0.89	0.04
Exhaust pressure at AMA measurement position	mbar	34	23	11	5	2
Exhaust temperature after ETC	grdC	453	420.8	421	378.5	259

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			Approver4			
Configuration-ID 294	Documentation	Emissionstage NEA Singapore for ORDE	User	FN2\170260	Engine model 20V4000G94F	Sheet 3 of 8
			Emissionstage basis NEA Singapore for ORDE			



Exhaust back pressure after ETC (static)	mbar	34	23	11	5	2
Exhaust back pressure after ETC (total)	mbar	52	35	16	5	0
NOX concentration corr. (5% O2)	ppm	1019	827	728	647	1081
Exhaust mass flow wet	kg/h	18499.9	15818.7	11326.3	7149.8	5283.9
Exhaust volume flow (norm)	m3/s	3.97	3.39	2.43	1.53	1.13
NOX mass flow	kg/h	19.97	12.33	7.39	3.52	2.83
CO mass flow	kg/h	0.72	0.67	1.69	1.05	0.99
HC1 mass flow	kg/h	0.22	0.18	0.15	0.14	0.26
NMHC mass flow	kg/h	0.21	0.18	0.15	0.14	0.25
NOX+HC1 mass flow	kg/h	20.18	12.51	7.54	3.66	3.09
NOX+NMHC mass flow	kg/h	20.18	12.51	7.54	3.66	3.09
SO2 mass flow	g/h	8.91	6.82	4.65	2.51	1.21
O2 mass flow	kg/h	1954	1877	1402	994	898
CO2 mass flow	kg/h	1984	1519	1033	558	268
PM mass flow	kg/h	0.056	0.052	0.134	0.105	0.018
NOX-Emissions specific	g/kWh	6.46	5.32	4.78	4.56	9.18
SO2-Emissions specific	g/kWh	0.003	0.003	0.003	0.003	0.004
CO-Emissions specific	g/kWh	0.23	0.29	1.1	1.36	3.2
HC1-Emissions specific	g/kWh	0.07	0.08	0.1	0.18	0.84
NMHC-Emissions specific	g/kWh	0.07	0.08	0.1	0.18	0.82
NOX+HC1-Emissions specific	g/kWh	6.53	5.4	4.88	4.74	10.02
NOX+NMHC-Emissions specific	g/kWh	6.53	5.4	4.88	4.74	10
CO2-Emissions specific	g/kWh	642.1	655.7	668.8	721.9	867.8
PM-Emissions specific (Meas.)	g/kWh	0.019	0.023	0.089	0.139	0.061

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Exhaust volume flow dry (based on 5% O2)	m3/s	2.46	1.89	1.29	0.7	0.34
NOX-Emissions (based on 5% O2)	mg/m3N	2306	1865	1624	1429	2350
	ppmV	1220.04	986.06	861	759.02	1248.28
NOX+HC1-Emissions (based on 5% O2)	mg/m3N	2331	1891	1656	1484	2560
NOX+NMHC-Emissions (based on 5% O2)	mg/m3N	2330	1891	1655	1483	2556
CO2-Emissions (based on 5% O2)	mg/m3N	223679	223479	222718	222190	217876
CO-Emissions (based on 5% O2)	mg/m3N	81	98.2	364.9	418	803.3
HC1-Emissions (based on 5% O2)	mg/m3N	24.4	26.7	32.3	55.5	210.4
SO2-Emissions (based on 5% O2)	mg/m3N	1	1	1	1	1
PM-Emissions (based on 5% O2)	mg/m3N	6.4	7.8	29.7	42.9	15.4
NO/NO2 ratio	[-]	24.5	20.7	16	9.3	6.7
NO2/NO ratio	[-]	0.04	0.05	0.06	0.11	0.15
Carbon dioxide (CO2)	%	7.6	6.8	6.4	5.4	3.5
Oxygen (O2)	%	10.3	11.5	12	13.3	16
Exhaust volume flow (real)	m3/s	10.527	8.686	6.384	3.842	2.287
NOX correctionfactor	[-]	0.976	0.972	0.981	0.983	0.981
Dry-wet correction factor	[-]	0.929	0.936	0.938	0.946	0.963
NMHC-Emissions (based on 5% O2)	mg/m3N	23.9	26.2	31.7	54.4	206.2

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Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94F				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Fuel sulphur content [ppm]	7				
mg/mN ³ values base on residual oxygen value of [%]	5				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	3090	2317	1545	772	309
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1501	1501	1501	1501	1500
Engine speed relative	[-]	1	1	1	1	1
Hydrocarbon (HC) (5% O ₂)	ppm	62	69	93	170	949
Carbon monoxide (CO) (5% O ₂)	ppm	110	134	555	669	1286
NOX concentration corr. (5% O ₂)	ppm	1120	1075	946	971	2054
NOX mass flow	kg/h	21.96	16.03	9.61	5.29	5.39
CO mass flow	kg/h	1.22	1.14	3.22	2.1	1.98
HC1 mass flow	kg/h	0.37	0.31	0.29	0.28	0.75
NMHC mass flow	kg/h	0.36	0.3	0.28	0.27	
NOX+HC1 mass flow	kg/h	22.33	16.34	9.89	5.57	6.14
NOX+NMHC mass flow	kg/h	22.32	16.33	9.88	5.56	
PM mass flow	kg/h	0.083	0.083	0.201	0.157	0.068
NOX-Emissions specific	g/kWh	7.11	6.92	6.22	6.84	17.44
CO-Emissions specific	g/kWh	0.4	0.49	2.08	2.72	6.4
HC1-Emissions specific	g/kWh	0.12	0.13	0.18	0.36	2.43
NMHC-Emissions specific	g/kWh	0.12	0.13	0.18	0.35	

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NOX+HC1-Emissions specific	g/kWh	7.23	7.05	6.4	7.21	19.87
NOX+NMHC-Emissions specific	g/kWh	7.22	7.05	6.4	7.2	
PM-Emissions specific (Meas.)	g/kWh	0.028	0.037	0.134	0.209	0.227
NOX-Emissions (based on 5% O2)	mg/m3N	2537	2424	2111	2143	4464
	ppmV	1342.04	1281.88	1119.3	1138.52	2371.73
NOX+HC1-Emissions (based on 5% O2)	mg/m3N	2578	2469	2172	2254	5075
NOX+NMHC-Emissions (based on 5% O2)	mg/m3N	2577	2468	2171	2252	
CO-Emissions (based on 5% O2)	mg/m3N	137.7	166.9	693.4	836.1	1606.7
HC1-Emissions (based on 5% O2)	mg/m3N	41.5	45.4	61.4	111	610.2
PM-Emissions (based on 5% O2)	mg/m3N	9.7	12.6	44.5	64.3	57
NMHC-Emissions (based on 5% O2)	mg/m3N	40.6	44.5	60.2	108.8	

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				Approver1	Kneifel, Alexander (TSLE)	EDS-ID	
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				Approver3		Title Emission data sheet	
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Cycle information for NEA Singapore for ORDE

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94F				
Serial-number	V122				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Data Set No.	XZ54954100066				
Test-Report-Number	2555-20.04.2023				
Test location	P126				
Date of test	28.03.2017				
Tester	MTU a Rolls-Royce Solution				
Date of EDS	20.04.2023				

Engine cycle emissions*

Emission	Unit	Cycle value	NEA Singapore for ORDE-Limit
CO cycle value	g/kWh	0.77	3.5
NOX+NMHC cycle value	g/kWh	5.345	6.4
Particulate (measurement) cycle value	g/kWh	0.063	0.2

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			Approver2	Koliwer, Michael (TV)	2555-20.04.2023	Title Emission data sheet
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			Approver4			
			User	FN2\170260		
Configuration-ID		Documentation	Engine model			Sheet
294			20V4000G94F			8
		Emissionstage				of
		NEA Singapore for ORDE				8
		Emissionstage basis				
		NEA Singapore for ORDE				



Rolls-Royce Solutions GmbH

Maybachplatz 1
88045 Friedrichshafen
Germany
T +49 7541 90-0

To whom it may concern

Contact: Robert Welz
e-Mail: robert.welz2@ps.rolls-royce.com

Tel. No.: +49 7541 904675
Fax No.:

Date: 23 March 2022
Ref.:

Explanation Nominal Emissions and Not to Exceed Emissions in the Emission Data Sheets

Nominal emission values are the result of one specific measurement on one single engine. These measurements have been done under standard conditions on test benches in Friedrichshafen. Because it's a single measurement of one single engine it doesn't show engine to engine variations, nor measurement to measurement variations.

Based on experience, our development team defines safety margins for each load point covering such effects. These safety margins are then added to the nominal emission values. As a result, we have the "not to exceed (NTE)" values in our EDS, which will be valid for all engines out of the series production – as long as the conditions are standard conditions.

These NTE- values will cover any tolerances, deviations etc. and therefore we consider all engines will be within the NTE- emission values under the conditions stated on the Emission Data Sheet.

Sincerely,



Digitale Unterschrift - Original abgelegt bei TSF.

i.V. Michael Koliwer
Director of PG Engineering
Rolls Royce Solutions GmbH



Digital Signature - Original filed at TSL

i.A. Robert Welz
Senior Manager of PG Engineering
Rolls Royce Solutions GmbH



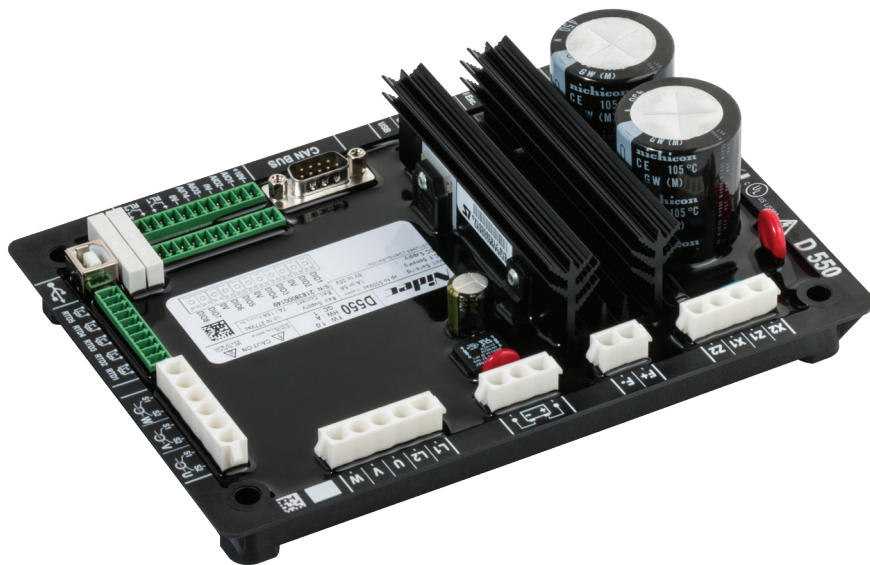
AVK-SEG (UK) Ltd – Generator Technical Submittal – E2023-2935 NTT LON1B

APPENDIX 9.06

AVR Datasheet

D550 DIGITAL AVR

FOR ALTERNATORS WITH SHUNT, AREP OR PMG EXCITATION



The D550 is a digital automatic voltage regulator (AVR) for alternators with rated field current up to 8 A at 55°C.

It offers a vast array of regulation modes suitable for all power generation applications, including grid-connected configurations.

The D550 also integrates a visual interface through the EasyReg Advanced software, which allows the user to read the configuration values and parameters. It can also be configured directly via USB without external power supply.

The D550 also includes several protections and functions to keep the alternator running in full safe operation, in particular settings to comply with public network connection instructions (grid code).

The communication port is CANJ1939 compatible.

DATASHEET

KEY FEATURES

- **Regulation modes:**
 - Voltage regulation accuracy: $\pm 0.25\%$
 - Field current (manual mode)
 - Generator power factor
 - Grid power factor
 - Generator kVAR
- **Regulation features:**
 - Voltage equalization
 - Droop management
 - Cross current compensation
 - Soft start
 - Load Acceptance Module (L.A.M.) function to assist during heavy load application events
 - Negative field forcing
- **kW, kVAR, kVA and PF calculation**
- **Protections & Limitations:**
 - Under and over field current limitation
 - Loss of field sensing
 - Generator under/over voltage
 - Loss of sensing
 - V/Hz regulation mode
 - Diode fault monitor
- **Data logger** (option)
- **Synchronization monitoring**
- **Events log**

ELECTRICAL FEATURES

- **Generator voltage measurement:**
 - 3-phase, 2-phase
 - Range: 0-230-530 VAC
 - Consumption: < 2 VA
- **Grid voltage measurement:**
 - 2-phase
 - Range: 0-230-530 VAC
 - Consumption: < 2 VA
- **Generator current measurement:**
 - 1 or 3-phase
 - Secondary range: 1 or 5 A
 - Consumption: < 2 VA
- **AC supply input:**
 - PMG, AREP, SHUNT
 - Range: 50-277 VAC
- **Excitation:**
 - Rated field current (continuous):
 - 7 A at 70°C
 - 8 A at 55°C
 - Field forcing current (10s max):
 - 15 A at 70°C
 - Recommended field resistance:
 - > 4 ohms
- **Auxiliary supply: 8-35 VDC**
 - Consumption: < 1 A
- **Frequency range: 30-400 Hz**
- **Storage temperature range:**
 - 55°C +85°C
- **Operating temperature range:**
 - 40°C +70°C

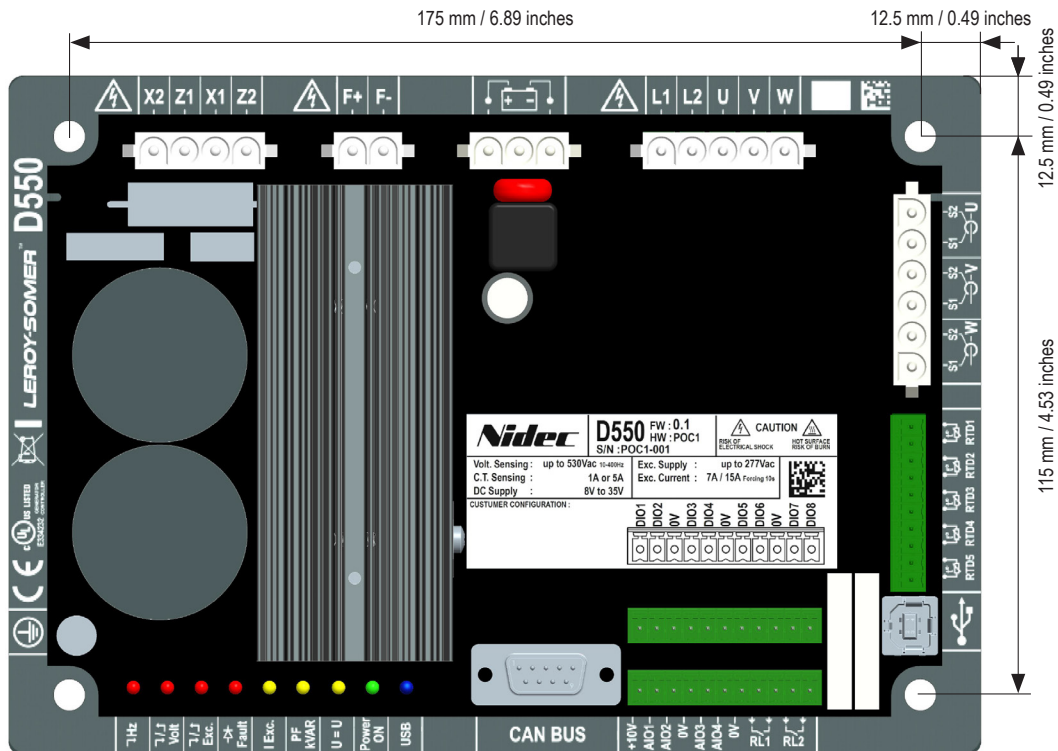
INPUTS / OUTPUTS

- **8 programmable digital inputs & outputs:**
 - Output specification: 150 mA - 30 VDC
- **4 programmable analog inputs & outputs:**
 - 4-20 mA / ± 10 V / 0-10 V / potentiometer (1 k Ω)
- **2 relay outputs:**
 - Specifications: 125 VAC - 5 A
- **5 temperature sensings:**
 - Type: Pt100/CTP
 - Programmable threshold

COMMUNICATION AND SETTINGS

- Software configuration (PC tool)
- USB port (self powered)
- CAN J1939 and Proprietary (Nidec Leroy-Somer protocol)

DIMENSIONS





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APPENDIX 9.07

Battery Datasheet

OPTIMA® YellowTop S 5,5



Battery Model: YT S 5,5

Part Number: 851 187 000 888 2

Nominal Voltage: 12 volts

NSN: 6140 01 502 4973

Description: High power, dual purpose engine start and deep cycle, sealed lead acid battery

Physical Characteristics:

Plate Design: High purity lead-tin alloy. Wound cell configuration utilizing proprietary SPIRALCELL® technology.

Electrolyte: Sulfuric acid, H₂SO₄

Case: Polypropylene

Color: Case: Light Gray
Cover: "OPTIMA" Yellow

Group Size: BCI: 31

	Standard	Metric
Length:	12.813"	325 mm
Width:	6.500"	165 mm
Height:	9.375"	238 mm (height at the top of the terminals)
Weight:	59.8 lb	26.5 kg

Terminal Configuration: SAE / BCI automotive.

Performance Data:

Open Circuit Voltage (fully charged): 13.1 volts

Internal Resistance (fully charged): 0.0025 ohms

Capacity: 75 Ah (C/20)

Reserve Capacity: BCI: 155 minutes

(25 amp discharge, 80°F (26.7°C), to 10.5 volts cut-off)

Power:

CCA (EN -18°C): 975 amps

MCA (BCI 0°C): 1125 amps

Recommended Charging:

The following charging methods are recommended to ensure a long battery life: (Always use a voltage regulated charger with voltage limits set as described below.)

Model: YT S 5,5

These batteries are designed for starting and deep cycling applications and for use in vehicles with large accessory loads.

OPTIMA® YellowTop S 5,5

Recommended Charging Information:

Alternator:	13.65 to 15.0 volts
Battery Charger (Constant Voltage):	13.8 to 15.0 volts; 10 amps maximum; 6-12 hours approximate
Float Charge:	13.2 to 13.8 volts; 1 amp maximum (indefinite time at lower voltages)
Rapid Recharge: (Constant voltage charger)	Maximum voltage 15.6 volts. No current limit as long as battery temperature remains below 50°C (125°F). Charge until current drops below 1 amp.
Cyclic or Series String Applications:	14.7 volts. No current limit as long as battery temperature remains below 50°C (125°F). When current falls below 1 amp, finish with 3 amp constant current for 1 hour. All limits must be strictly adhered to.

Recharge Time: (example assuming 100% discharge – 10.5 volts)

Current	Approx. time to 90% charge
100 amps	52 minutes
50 amps	112 minutes
25 amps	210 minutes

Recharge time will vary according to temperature and charger characteristics. When using Constant Voltage chargers, amperage will taper down as the battery becomes recharged. When amperage drops below 1 amp, the battery will be close to a full state charge.

(All charge recommendations assume an average room temperature of 25°C, 77°C)

Always wear safety glasses when working with batteries.

Always use a voltage regulated battery charger with limits set to the above ratings. Overcharging can cause the safety valves to open and battery gases to escape, causing premature end of life. These gases are flammable! You cannot replace water in sealed batteries that have been overcharged. Any battery that becomes very hot while charging should be disconnected immediately.

Not fully charging a battery can result in poor performance and a reduction in capacity.

Shipping and Transportation Information:

OPTIMA batteries can be shipped by AIR. The battery is nonspillable and is tested according to ICAO Technical Instructions DOC. 9284-AN/905 to meet the requirements of Packing Instructions No. 806 and is classified as non-regulated by IATA Special Provision A-48 and A-67 for UN2800. Terminals must be protected from short circuit.

Manufacturing Location:

OPTIMA Batteries
17500 East 22nd Avenue
Aurora, CO 80011
United States of America
Phone: 303-340-7400
Fax: 303-340-7474

BCI = Battery Council International

OPTIMA Batteries
Product Specifications: Model YT S 5,5
June 2005



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APPENDIX 9.08

ComAp Datasheet

InteliSys^{NTC} BaseBox



Order code: IS-NTC-BB

Gen-set controller

Datasheet

Product description

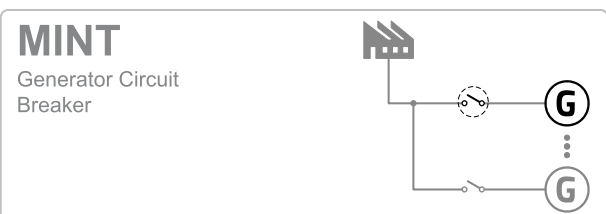
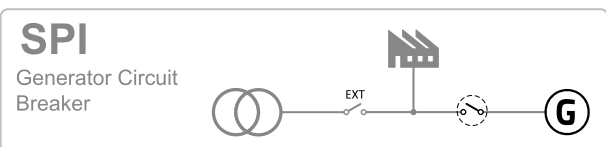
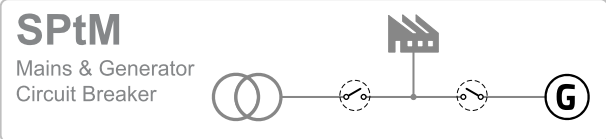
- ▶ Comprehensive paralleling gen-set controller
- ▶ Parallel operation up to 32 gen-sets
- ▶ High level control for complex systems
- ▶ CHP and gas engine controller

Key features

- ▶ Load sharing and VAr sharing via CAN
- ▶ Virtual shared inputs and outputs via CAN
- ▶ Support of wide range of applications
 - Single or multiple gen-sets in parallel to mains operation with automatic back up function, multiple island operation
- ▶ Advanced power management function
- ▶ Customizable load control in parallel to mains
- ▶ Wide range of ECU support
- ▶ Extended communication capabilities
 - Built-in web server
 - Full Modbus slave support
 - GPS and AirGate support and more
- ▶ Highly configurable
 - Timers, Extended internal PLC , Force values and more

- ▶ Compatible with ComAp's InteliVision displays
- ▶ Active e-mail messaging and SMS
- ▶ Extensive built-in protection functions
 - Standard protections
 - User configurable protection
- ▶ Extendable with ComAp's extension modules
- ▶ True RMS (TRMS) is used with Voltage, Current and Power measurement

Application overview



Technical data

Power supply

Power supply range	8-36 VDC
Power consumption	0.4 A / 8 VDC 0.15 A / 24 VDC 0.1 A / 36 VDC
RTC battery	10 years (replaceable by official service)
Fusing	2 A (without BOUT consumption)

Operating conditions

Operating temperature	-40°C to +70°C
Storage temperature	-40°C to +80°C
Operating humidity	95% w/o condensation
Vibration	5-25 Hz, ± 1.6 mm 25-100 Hz, $a=4$ g
Shocks	$a=200$ m/s ²

Voltage measurement

Measurement inputs	3 ph-n Gen voltage 3 ph-n Mains/Bus voltage
Measurement range	110V / 277V
Max allowed voltage	125 %
Accuracy	1 % of 110V / 277V
Frequency range	40-70 Hz (at accy 0.1 Hz)
Input impedance	0.6 M Ω ph-ph 0.3 M Ω ph-n

Current measurement

Measurement inputs	3 ph Gen current 1 ph Mains current
Measurement range	1 A / 5 A
Max allowed continuous current	200 % / 200 %
Accuracy	2 % of 1 A / 5 A
Input impedance	<0.1 Ω

Binary inputs

Number	16 non-isolated
Input resistance	4.7 k Ω
Close/Open indication	0-2 VDC close contact >4 VDC open contact

Binary outputs

Number	16 non-isolated
Max current	0.5 A (2 A per group)
Switching to	negative/positive supply terminal

Analog inputs

Number	4 non-isolated
Type	Switchable (Voltage, Resistance, Current)
Resolution	10 bits, max 4 decimals
Range	0-5 VDC/0-2500 Ω /0-20 mA
Input impedance	>100 k Ω / >100 k Ω /180 Ω
Accuracy	± 1 % of meas. value ± 1 mV ± 2 % of meas value ± 2 Ω ± 1 % of meas value ± 0.5 mA

Analog outputs

Number	1
Type	Switchable (Voltage, Current)
Range	0-10 VDC/0-20 mA
Max current/load	5 mA/500 Ω
Accuracy	± 0.5 % of output value ± 20 mV ± 0.5 % of output value ± 100 μ A

Magnetic pick-up

Voltage input range	2 Vpk-pk to 50 Veff
Frequency input range	4 Hz to 15 kHz
Frequency measurement tolerance	0.2 %

Voltage regulator output

Type	5 V TTL PWM / ± 10 VDC with IG-AVRi interface
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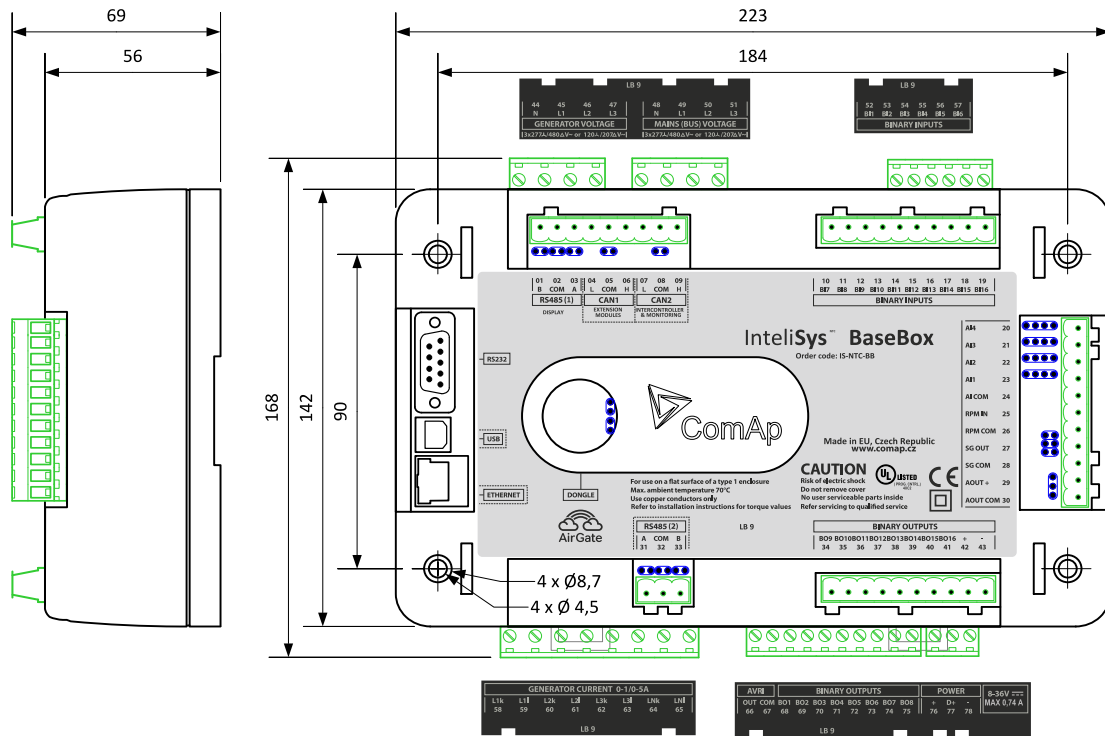
Speed governor output

Voltage output	± 10 VDC / max. 15 mA
Voltage output via resistor	± 10 VDC via 10 k Ω resistor / max. 1 mA
PWM	500-3000 Hz / 5V / max. 10mA

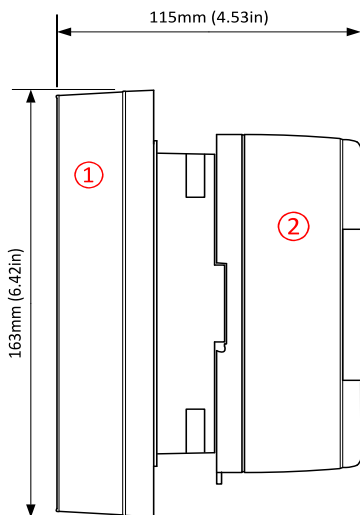
Communications

RS232	Direct/Modbus, non-isolated
RS485	Direct/Modbus, isolated
Display port	non-isolated RS485, only terminal connection
USB port	Direct, isolated
Ethernet port	LAN/Internet, Modbus TCP, SNMP, WebServer, AirGate
CAN1	External modules 250 kbps, max 200 m, Isolated
CAN2	Intercontroller and comm extensions 250/50 kbps, max 200/1000 m, Isolated

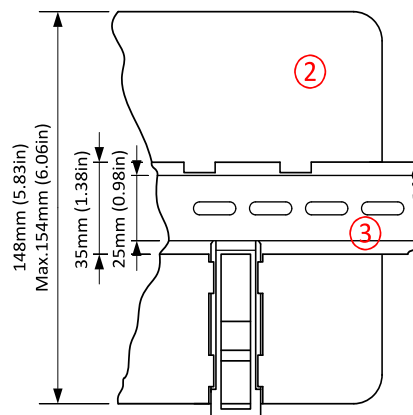
Dimensions, terminals and mounting



Panel door mounting with IntelliVision 5

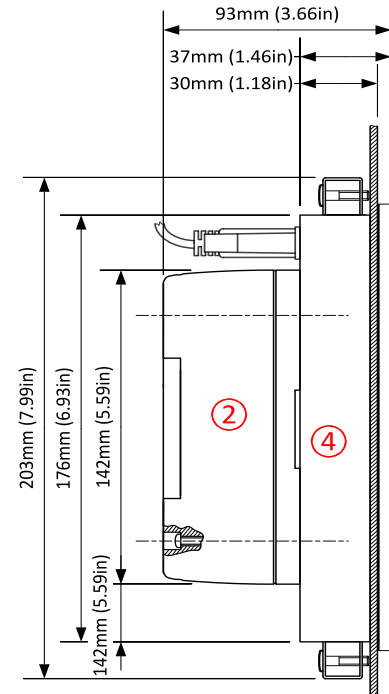


DIN-rail mounting



- ① IntelliVision5
- ② IntelSys^{NTC} BaseBox
- ③ DIN-rail
- ④ IntelliVision 8

Panel door mounting with IntelliVision 8



Note: IntelSys^{NTC} BaseBox can be mounted on a standard DIN rail or, in combination with IntelliVision 5 or IntelliVision 8, it can be door mounted. IntelliVision 5 features mounting rail for direct mounting. Mounting in combination with IntelliVision 8 uses four screws provided in the IntelSys^{NTC} BaseBox package.

Available extension modules

Product	Description	Order code
Intel IO8/8	8 Binary inputs, 8 Binary outputs and 2 Analog outputs packed in a small unit (HW switchable to IO16/0)	I-IO8/8
Intel IO8/8	HW switchable to IO16/0 - 16 Binary inputs packed in a small unit	I-IO8/8
Intel AIN8	8 Analog inputs (R, I, V) and 1 pulse/frequency input in a small unit	I-AIN8
Intel AIN8TC	8 Thermocouple Analog inputs in a small unit	I-AIN8TC
Intel AIO9/1	9 Analog inputs (4x DC, 4x thermocouples, 1x R) in a small unit	I-AIO9/1
IS-AIN8	8 Analog inputs packed in a rugged metal unit	IS-AIN8
IGS-PTM	8 Binary inputs, 8 Binary outputs, 4 Analog inputs and 1 Analog output in a unit	IGS-PTM
IGL-RA15	15 Binary LED output (3 colors) packed in a rugged metal unit	IGL-RA15
I-AOUT8	8 Analog outputs packed in a rugged metal unit	I-AOUT8
InternetBridge-NT	Multiple Internet connections (PC and Modbus) to all controllers on CAN2 or RS485	IB-NT
I-LB+	Direct connection (PC) to all controllers on CAN2 or RS485	I-LB+

Related products

Product	Description	Order code
IntelVision 5	Color 5.6" display for monitoring and control	INTELVISION 5
IntelVision 8	Color 8" display for advanced monitoring, control & trending, USB capable	INTELVISION 8
IntelVision 12Touch	Color 12" touch display for advanced monitoring, control & trending, USB capable	RD11V12TBZH
IntelVision 17Touch	Color 17" touchscreen display designed for complete monitoring and control of multiple controllers or cogeneration installation.	IV17T2
ECON-4	Digital speed governor dedicated for speed control of gas or diesel engines.	ECON-4

Functions and protections

The described product fully supports the following functions and protections as defined by ANSI (American National Standards Institute):

Description	ANSI code	Description	ANSI code
Synchronism check	25	Earth fault current	50N+64
Undervoltage	27	Overcurrent (IDMT)	51
Overload	32	Earth fault current IDMT	51N+64
Load shedding	32P	Power factor	55
Reverse power	32R	Overvoltage	59
Undercurrent	37	Gas (fuel) level	71
Excitation loss	40	Vector shift	78
Current unbalance	46	AC reclosing	79
Voltage asymmetry and phase sequence	47	Overfrequency	81H
Temperature monitoring	49T	Underfrequency	81L
Generator overcurrent	50	ROCOF	81R

Certificates and standards

This product is CE compliant.	
<ul style="list-style-type: none"> ▶ EN 60068-2-6 ed.2:2008; EN 60068-2-27 ed.2:2010; EN 60068-2-30, May 2000 ▶ EN 60068-2-64; EN 61010-1:2003 	
All certificates and standards are available on: https://webstore.iec.ch/	





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APPENDIX 9.09

ComAp HMI Datasheet

InteliVision 8



CONTROLLER COLOUR DISPLAY UNIT



Description

InteliVision 8 is a colour display unit designed as a simple, easy-to-use Plug and Play solution and delivers high visibility of all engine data, monitoring information and trend history in a bright, colorful and forward looking design. It can be used for either InteliGen^{NT}, InteliSys^{NT}, InteliMains^{NT}, InteliDrive DCU and InteliDrive Mobile.

InteliVision 8 comes with the large high-resolution colour TFT display, which helps visibility and definition of onscreen information. The control interface has user-friendly, intuitive active buttons – giving users access to more information in less time. InteliVision 8 boasts the unique TRENDS monitoring as a standard feature, helping you evaluate past events easily on one screen. It offers a site data storage using a USB stick and permits adding external pictures for customization of screens.

InteliVision 8 includes ComAp's standard communication interface using RS232/485 and CAN bus communication. Designed to be mounted in both monitoring and engine room, InteliVision 8 gives complete access to all control functions when connected to control unit.



Galvanically separated CAN and RS-485 interface



Screen editor



Tier 4



Trends



USB import & export



Front IP65



Plug and play interface



Large history



Insert images



Configurable buttons



ComAp is a member of AMPS (The Association of Manufacturers of Power generating Systems).



ComAp products meet the highest standards, with every stage of production undertaken in accordance with the ISO certification obtained in 1998.



The product has the UL Certification.

USB as data storage



InteliVision 8 makes working with your data even easier. You can export data to a USB flash drive, in order to work with data later at your computer with ease.

Data export capability:

- ▶ History
- ▶ Controller archive
- ▶ InteliVision firmware
- ▶ Trend – single export & continuous logging

The history and trend data is saved in a format that is supported by third party software. It is also possible to import trend data from a USB flash drive to InteliVision 8 and analyse them in the Trend screen.

USB as Login key



If quick, convenient access to InteliVision 8 is what you need, you can use a USB flash drive as a login key. When a user's password is saved onto a USB flash drive, simply plug it into InteliVision 8 and you are automatically logged in – no need to enter a password manually! A great idea for high security operations, as only staff with the correct USB flash drive are able to access the unit.

Configurable functional buttons



If you need quick access to frequently used functions on InteliVision 8, there are a number of user customisable buttons to which you can assign commands.

Offers fast access to frequently used functions:

- ▶ Binary signal activation
- ▶ Associate the buttons with generator or engine commands
- ▶ Fast jump to any measurement or Setpoints screen

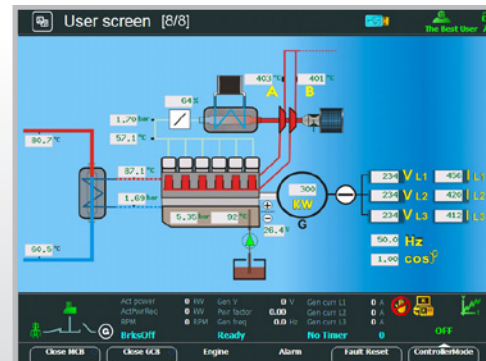
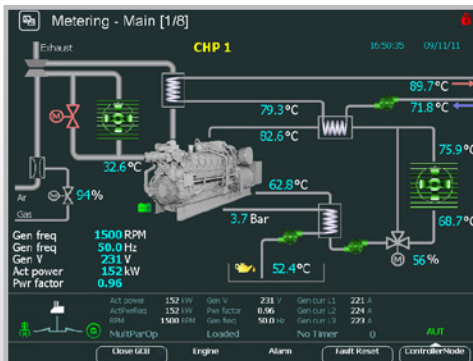
Configuration of these buttons is easy in ScreenEditor, which is part of GenConfig software application.

Import pictures and ScreenEditor

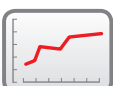


If you need to see a particular engine reading, a certain graph, or other frequently accessed information it is possible with ScreenEditor to customise InteliVision 8 to your preference. You can even add your company logo, or any other photo to further make InteliVision 8 unique to your application.

Screen examples



Trends improvement



Working with trends is now much easier. We have added new features such as:

- ▶ Faster movement through Trends
- ▶ The ability to evaluate change in trends across several screen
- ▶ Indication of remaining time for saving of trends

A major new feature is the ability to display only data from the binary signal that the user wants to see. This is a big change from the previous method of having to see all data, and find the section you need.



Benefits

- ▶ Large, colour screen with high-resolution
- ▶ PLUG and PLAY operation (auto configuration based on controller application)
- ▶ Simpler, faster and more intuitive control
- ▶ More information in less time
- ▶ TRENDS monitoring screen
- ▶ USB flash disk as file STORAGE (export trends, history and archive to USB flash disk)
- ▶ Quick AUTO login with USB stick
- ▶ User's PICTURES import to measurement screen
- ▶ Easy Drag & Drop screen CONFIGURATION by customer in new GRAPHICAL Editor
- ▶ CONFIGURABLE soft keys buttons
 - Fast jump to any Measurement or Setpoints screens
 - Binary signal activation – toggle button/pulse generator
 - Associating of genset commands
- ▶ ADAPTIVE and COLOR alarm list displaying
- ▶ Support of Tier 4 icons
- ▶ Direct connection to the controller (converters are not needed)

Features

- ▶ 8" colour TFT display with resolution 800×600 pixels
- ▶ Customized initial screen logo and the content of a controller help
- ▶ Same language support as IntelliGen^{NT}, IntelliSys^{NT}, IntelliMains^{NT}, IntelliDrive DCU and IntelliDrive Mobile
- ▶ Allows full monitoring of ONE controller (in case of more controllers on CAN it is possible to switch over among controllers monitoring by change of CAN address)
- ▶ The same dimensions as IS-Display (possible as a replacement for IG-Display LT GC, IS-Display or I-RD-CAN)
- ▶ Connection via of RS232/485 and CAN bus
- ▶ Possibility to mount IntelliGen^{NT} BaseBox, IntelliGen^{NTC} BaseBox, IntelliSys^{NTC} BaseBox or IntelliSys^{NT} BaseBox to the rear side of IntelliVision 8
- ▶ Windows CE operating system
- ▶ Operating temperature: -20 to + 70°C
- ▶ Face is sealed to IP65
- ▶ EMC, climatic and mechanical tests
- ▶ CE, UL certification

Connection Possibilities

The table shows the number of IntelliVision 8 that can be connected to each port controller.

	RS232	RS485	Display port (RS485)	CAN2
IntelliGen ^{NT}	1	0	1	4
IntelliGen ^{NT} BaseBox	1	0	2	4
IntelliGen ^{NTC} BaseBox	1	1	2	4
IntelliSys ^{NT} BaseBox	1-2*	0*-1	3	4
IntelliSys ^{NTC} BaseBox	1	1	3	4
IntelliMains ^{NT}	1	0	1	4
IntelliMains ^{NT} BaseBox	1	1	2	4
IntelliMains ^{NTC} BaseBox	1	0	2	4
IntelliDrive DCU Industrial	1	0	0	3
IntelliDrive DCU Marine	1	0	0	4
IntelliDrive Mobile	0	1	0	2

* Port is shared (can be set either as 485(2) or as RS232(2))

Order code

Controller	Order code
IntelliVision 8	INTELIVISION 8



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APPENDIX 9.10

UTI Letter



AVK

THE POWER PEOPLE

Date: 22/02/2024

To: Whom It Concerns

Subject: Uptime Institute Ratings Certification

Dear,

The **mtu** Onsite Energy DS3600 generator sets with a 2800kWe net 400V nominal nameplate rating being applied at the below referenced project can provide 2800kWe net at the below referenced site conditions. MTU products can provide power for an outage of unlimited duration.

Reference MTU Onsite Energy's standard maintenance schedule and time before overhaul (TBO) for product maintenance.

When using MTU Onsite Energy's Generator sets for Uptime Institute Ratings and applications, proper attention must be kept following all federal and local regulations. These regulations can impose operating limitation that need to be considered. Your local MTU onsite Energy distributor is knowledgeable about these regulations and can help you ensure the units are operated in the correct manner.

Customer Project: NTT LON1B

IPAS Project Number (xxxxxxx)

Site Conditions:

Ambient Temp: 42°C

Elevation above sea level: 115m

Humidity: 95%

Sincerely,

Sincerely,

MTU Onsite Energy

AVK-SEG (UK) Ltd



*AVK- Final Letter Subject to finalised site conditions and MTU factory final wording

1.0 Technical Submission Front Page

Trade Contractor:	AVK-SEG (UK) Ltd	From:	L.Spenst
Trade Contractor Sub No:	TS02	Date:	23/02/2024
Revision:	00		
Reason for Revision	First Draft		

Approval of the following equipment is required:

Equipment:	Diesel Generating Set	Make:	AVK
Equipment References:	DS1650 Generating Set	Areas Used:	
Description:	Supply and Installation of 1 no. Standby with UTI letter Rated Diesel Generating Set comprising: <ul style="list-style-type: none"> - MTU 12V4000G74F Emissions Optimised Diesel Engine - Leroy Somer LSA 52.3 S7 / 4p Brushless Synchronous Alternator - Mechanically Driven Cooling Package - ComAp IntelliSys Generator Controller 		
Planned on Site Date:			

Attached detail documents:

(Tick if included and Insert references within boxes identifying supporting documentation included within this submission)

Description	Tick	Section	Description	Tick	Doc Ref
<i>Technical submission front sheet</i>	✓	1.0	<i>Interfaces & Dependencies Schedule</i>	✓	6.0
<i>Equipment Description</i>	✓	2.0	<i>Builders Work Requirements</i>	X	7.0
<i>List of Exceptions & Clarifications</i>	X	3.0	<i>Schedule of Comments & Revision Changes</i>	X	8.0
<i>Manufacturers Documents</i>	✓	4.0	<i>Appendices</i>	✓	9.0
<i>Certified Drawings</i>	X	5.0			

Signed by:	<i>L.Spenst</i>
Date:	23/02/2024

Revision History:

Rev No.	Date	Comments
Rev 00	23/02/2024	First Draft

Note: If client sign off and/or comments have not been received within 2 weeks of the date stated on this technical submission then the products and/or services detailed in the technical submission are deemed to be accepted at status A.

2.0 – Equipment Description

2.1 Requirements

Supply of 1 no. 1625kVA/1300kWe net, performance class G3, emissions optimised (NEA/Tier II) standby rated, LV diesel generating set. Complete with mechanically driven cooling package and generator mounted controller. Generators supplied with permanent magnetic generator excitation AVR and a sub-transient reactance $X''_d < 12\%$.

2.2 Generator

MTU DS1650 diesel generating set with MTU 12V4000G74F NEA turbocharged diesel engine and Leroy Somer LSA 52.3 S7 / 4p brushless synchronous alternator.

Generating set sized to support a continuous rated load of 1625kVA/1300kW net, at 400V, 3-phase, 50Hz, 1500 rev/min, for an unlimited number of operating hours per year with varying load conditions (average load factor 100%), as stated in the UTI letter, in accordance with ISO 8528-1 and ISO 3046-1. No overload capability for this rating.

Generating set designed to performance class G3.

Generating set supplied with:

- Integrated digital automatic voltage regulator (AVR)
- Dual 24V electrical starter motor with battery charging alternator (redundant operation)
- Dual 24V low maintenance lead acid starting batteries
- 24V battery chargers
- Air, fuel and lube oil filters
- Electronic engine management
- Common rail electronic injection system
- Low lube oil pressure protection switch
- High water temperature protection switch
- Low coolant level alarm
- Common skid frame with rubber type anti-vibration pads between engine/alternator and skid to give approximately 80-85% isolation
- Thermostatically controlled water jacket heater and circulating pump
- Flanged exhaust bellows
- CE label

See the following appendices for further details:

[Appendix 9.01 – Generator Datasheet](#)

[Appendix 9.02 – Engine Datasheet](#)

[Appendix 9.03 – Alternator Datasheet](#)

2.2.1 Engine

In-line, liquid-cooled, four-stroke MTU 12V4000G74F emissions optimised turbocharged diesel engine. Electronically controlled common rail fuel injection system with low and high-pressure fuel pumps, fuel pressure accumulator, high pressure fuel lines, duplex fuel filter and fuel priming pump for initial system filling and venting.

Forced-feed lubrication system with piston cooling, lube oil circulation pump with safety valve, automatic lube oil make-up system, lube oil multi-stage filter, lube oil heat exchanger, oil filler neck and oil dipstick for measurement on non-running engine and closed crankcase venting system. Hand pump included for manual lube oil extraction.

Thermostatically controlled water jacket heater with coolant circulation pump and coolant thermostat for charge air cooling circuit.

Engine warranted to operate using the fluids and lubricants specified in Appendix 9.10 – MTU Fluids and Lubricants.

See the following appendices for further details:

[Appendix 9.02 – Engine Datasheet](#)

[Appendix 9.10 – MTU Fluids and Lubricants](#)

[Appendix 9.05 – Emissions Datasheet](#)

2.2.2 Alternator

Leroy Somer LSA 52.3 S7 / 4p brushless self-excited, self-regulating, double bearing, IP23 drip proof, class H alternator sized to support a standby rated load of 1625VA/1300kW, at 400V, 3-phase, 50Hz, 1500 rev/min, for an unlimited number of operating hours per year with varying load conditions (average load factor < 100%), as stated in the UTI letter, in accordance with ISO 8528-1 and ISO 3046-1. No overload capability for this rating.

Integrated digital type automatic voltage regulator (AVR) included to maintain alternator output voltage of 400V ±5% from no load to full load, unity to 0.8 lagging power factor, 3-phase, 50 Hz, 400V, 1500 rev/min and a total harmonic distortion (THD) of < 5%.

See the following appendices for further details:

[Appendix 9.03 – Alternator Datasheet](#)

[Appendix 9.06 – AVR Datasheet](#)

2.2.3 Radiator

The generating set is supplied with a remote radiator assembly complete with expansion tank.

Specifications:

- | | |
|------------------------------------|--------------------------------|
| • Cooling ambient design: | 42°C |
| • Coolant Type: | Glycol-Water |
| • Thermostat: | 79/92°C |
| • Fan power at site | 51.6 kW |
| • External Pressure Drop Allowance | 36.86 m ³ /s 200 Pa |

2.2.4 Starting System

The generating set starting system comprises:

- 24V 9.4kW electrical starter motor and redundant starter motor
- 24V dual set low maintenance lead acid starting batteries (each sized for maximum 3 x genset starting attempts, 6 total crank cycles of 10 seconds with redundant operation)
- Battery charging alternator
- Dual battery chargers fed from auxiliary supply

See the following appendices for further details:

[Appendix 9.07 – Battery Datasheet](#)

2.2.5 Earthing

Earthing points are provided on the generator base frame.

2.2.6 Generator Controller

The generating sets are controlled via ComAp IntelliSys controllers located within the generator control panel mounted on the bedframe of the generator set. The ComAp controller provides individual set control and monitoring. The control panel is fed from the 24V DC battery backed generator supply and is operated with an 8-inch ergonomic touch screen.

The ComAp control panel provides:

- Control of the genset in both automatic and manual mode
- Testing of the generating set both on/off load
- Display of genset measurement values (electrical and mechanical)
- Status of generating set (both current and historical)
- Time-stamped event display with log for up to defined amount of events
- Adjustment of genset parameters with appropriate user level (i.e. timer settings)
- Automatic cooldown periods with user defined time settings
- Engine oil pressure
- Engine water temperature
- Engine oil temperature
- Engine speed
- Hours run
- Number of start attempts
- Battery voltage

Event-based history (up to 1000 records) with customer-selectable list of stored values; RTC; statistic values.

See the following appendices for further details:

[Appendix 9.08 – ComAp Datasheet](#)

[Appendix 9.09 – ComAp HMI Datasheet](#)

3.0 - List of Exceptions & Clarifications

Issued separately

4.0 - Manufacturers Documents

Please see appendices.

5.0 - Certified Drawings

N/A

6.0 - Interfaces and Dependencies Schedule

Auxiliary Supply Required	Detail	Quantity Required	Provided By	Final Connection By
40A @ 400V TPNE	Maintained Generator Auxiliary Supply	1 per generating set	Others	Others
High Level Interface	Generator alarm monitoring (Modbus)	1 per generating set	Others	Others
Low Level Interface	Generator alarm monitoring (VFC's)	TBC	Others	Others

Note: The above list is based on initial design information and may be subject to change as the project progresses.

7.0 - Builders Work Requirements

N/A

8.0 – Schedule of Comments

The following table provides a schedule of all comments required against this document and details the AVK response and status of each comment.

Item	Client Comment	AVK Response	Status

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Note: Client to advise status of comment from the following list;

- Accepted (no further action)
- Rejected (refer to comments)

9.0 – Appendices

Item	Document Name
9.01	Generator Datasheet
9.02	Engine Datasheet
9.03	Alternator Datasheet
9.04	UTI Letter
9.05	Emissions Datasheet
9.06	AVR Datasheet
9.07	Battery Datasheet
9.08	ComAp Datasheet
9.09	ComAp HMI Datasheet
9.10	MTU Fluids and Lubricants

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APPENDIX 9.01

Generator Datasheet

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Diesel Generator Set

mtu 12V4000 DS1650

380V – 11 kV/50 Hz/standby power/ 12V4000G74F/water charge air cooling



Optional equipment and finishing shown. Standard may vary.

Product highlights

Benefits

- Low fuel consumption
- Optimized system integration ability
- High reliability
- High availability of power
- Long maintenance intervals

Support

- Global product support offered

Standards

- Engine-generator set is designed and manufactured in facilities certified to standards ISO 2008:9001 and ISO 2004:14001
- Generator set complies to ISO 8528
- Generator meets NEMA MG1, BS 5000, ISO, DIN EN and IEC standards
- NFPA 110

Power rating

- System ratings: 1675kVA
- Generator set complies to G3 according to ISO 8528-5
- Generator set exceeds load steps according to ISO 8528-5*

Performance assurance certification (PAC)

- Engine-generator set tested to ISO 8528-5 for transient response
- Verified product design, quality and performance integrity
- All engine systems are prototype and factory tested

Complete range of accessories available

- Control panel
- Fuel system
- Fuel connections with shut-off valve mounted to base frame
- Starting/charging system
- Exhaust system
- Mechanical radiators

Emissions

- NEA Optimised

Certifications

- CE certification option
- Unit certificate acc. to VDE-AR-N 4110

* Changes to the standard parameter sets (alternator-regulator and genset-controller) are necessary



A Rolls-Royce solution

Application data ¹⁾

Engine			Liquid capacity (lubrication)	
Manufacturer		mtu	Total oil system capacity: l	260
Model	12V4000G74F		Engine jacket water capacity: l	160
Type	4-cycle		Intercooler coolant capacity: l	40
Arrangement	12V		Combustion air requirements	
Displacement: l	57.2		Combustion air volume: m ³ /s	2.0
Bore: mm	170		Max. air intake restriction: mbar	50
Stroke: mm	210		Cooling/radiator system	
Compression ratio	16.4		Coolant flow rate (HT circuit): m ³ /hr	56
Rated speed: rpm	1500		Coolant flow rate (LT circuit): m ³ /hr	30
Engine governor	ECU 9		Heat rejection to coolant: kW	580
Max power: kWm	1575		Heat radiated to charge air cooling: kW	310
Air cleaner	dry		Heat radiated to ambient: kW	75
Fuel system			Fan power for electr. radiator (40°C): kW	55
Maximum fuel lift: m		5	Exhaust system	
Total fuel flow: l/min		16	Exhaust gas temp. (after turbocharger): °C	510
Fuel consumption ²⁾			Exhaust gas volume: m ³ /s	5.3
At 100% of power rating:	l/hr	g/kwh	Maximum allowable back pressure: mbar	85
At 75% of power rating:	377.6	199	Minimum allowable back pressure: mbar	30
At 50% of power rating:	288.9	203		
	200.2	211		

Standard and optional features

System ratings (kW/kVA)

Generator model	Voltage	NEA optimized					
		without radiator			with mechanical radiator		
		kWel	kVA*	AMPS	kWel	kVA*	AMPS
Leroy Somer LSA52.3 S7 (Low voltage Leroy Somer standard)	400 V				1340	1675	2418

* cos phi = 0.8

1 All data refers only to the engine and is based on ISO standard conditions (25°C and 100m above sea level).

2 Values referenced are in accordance with ISO 3046-1. Conversion calculated with fuel density of 0.83 g/ml. All fuel consumption values refer to rated engine power.

Standard and optional features

Engine

- 4-cycle
- Standard single stage air filter
- Oil drain extension & shut-off valve
- Closed crankcase ventilation
- Governor-electronic isochronous
- Common rail fuel injection
- NEA (ORDE) optimized engine

Generator

- 4 pole three-phase synchronous generator
- Brushless, self-excited, self-regulating, self-ventilated
- Digital voltage regulator
- Anti condensation heater
- Stator winding Y-connected, accessible neutral (brought out)
- Protection IP23
- Insulation class H, utilization acc. to H
- Radio suppression EN 55011, group 1, cl. B
- Short circuit capability 3xIn for 10sec
- Winding and bearing RTDs (without monitoring)
- Excitation by AREP
- Mounting of CT's: 2 core CT's
- Winding pitch: 2/3 winding
- Voltage setpoint adjustment $\pm 10\%$
- Meets NEMA MG-1, BS 5000, IEC 60034-1, VDE 0530, DIN EN 12601, AS 1359 and ISO 8528-3 requirements
- Leroy Somer low voltage generator
- Oversized generator

Cooling system

- Jacket water pump
- Thermostat(s)
- Water charge air cooling
- Mechanical radiator
- Electrical driven front-end cooler
- Jacket water heater

Control panel

- Unit cabling with coded plugs for easy connection of customer-specific controls (V0)
- Pre-wired control cabinet for easy application of customized controller (V1+)
- Island operation (V2)
- Complete system metering
- Digital metering
- Engine parameters
- Generator protection functions
- Engine protection
- SAE J1939 engine ECU communications
- Parametrization software
- Multilingual capability
- Multiple programmable contact inputs
- Multiple contact outputs
- Event recording
- IP 54 front panel rating with integrated gasket
- Different expansion modules
- Remote annunciator
- Daytank control
- Generator winding temperature monitoring
- Generator bearing temperature monitoring
- Modbus TCP-IP

Connectivity

The engine system automatically collects and transfers engine data to the manufacturer from time to time. The data is used by the manufacturer for the purposes of product

development and improvement as well as service optimization. Users can log in or register via <https://mtu-go.com> and also gain insight into the data.

- Represents standard features
- Represents optional features

Standard and optional features

Fuel system

- Flexible fuel connectors mounted to base frame
- Fuel filter with water separator
- Fuel cooler integrated into cooling equipment

Starting/charging system

- 24V starter
- Redundant starting system
- Starter batteries, cables, rack, disconnect switch (lockable)
- Battery charger
- Alternator

Mounting system

- Welded base frame
- Resilient engine and generator mounting
- Modular base frame design
- Base frame mounting on foundation/base plate with using clamping brackets

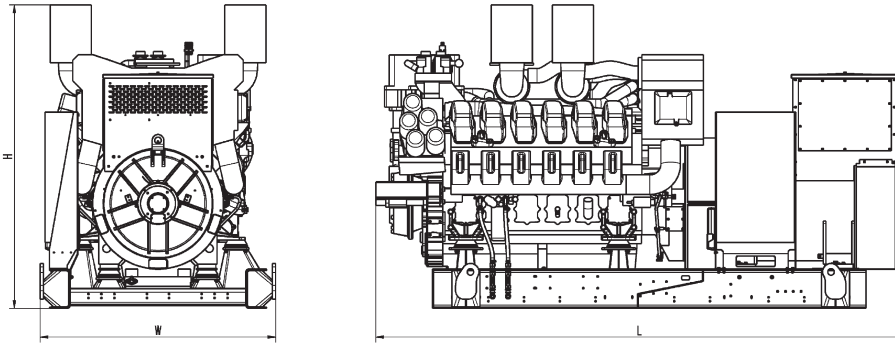
Exhaust system

- Exhaust bellows with connection flange

Represents standard features

Represents optional features

Weights and dimensions



Drawing above for illustration purposes only, based on a standard open power 400 Volt engine-generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (LxWxH)	Weight (dry/less tank)
Open power unit (OPU)	4059 x 1810 x 2330 mm	10654 kg

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific engine-generator set.

APPENDIX 9.02

Engine Datasheet

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- Product Data -

Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

Reference conditions

No.	Description	Index	Value	Unit
6	Intake air temperature		25	°C
7	Charge-air coolant temperature		45	°C
8	Barometric pressure		1000	mbar
9	Site altitude above sea level		100	m
10	Raw-water inlet temperature		-	°C

BL Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

DL Reference value: continuous power
Engine power that can be run continuously under standard conditions

> Actual value must be greater than specified value
< Actual value must be less than specified value

X Applicable
The module is valid for this product type

□ Non-applicable
The module is not valid for this product type

N Value not named
The value has not yet been named or will not be named

□ Adequate verification not yet available (tolerance +/- 10%)
□ Adequate verification not yet available (tolerance +/- 5%)

A Design value
Value required for the design of an external system (plant)

R Guideline value
Typical average value as information – only suitable for design purposes to a limited extent

L Limit value
A value representing the lower limit/minimum value or upper limit/maximum value that may not be exceeded. Not suitable for design purposes



Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

0. Data-relevant engine design configuration

No.	Description	Index	Value	Unit
8	Engine rated speed switchable (1500/1800 rpm)		-	-
12	Engine with sequential turbocharging (turbochargers with cut-in/cut-out control)		-	-
13	Engine without sequential turbocharging (turbochargers without cut-in/cut-out control)		X	-

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

[DL] Reference value: continuous power
Engine power that can be run continuously under standard conditions

[>] Actual value must be greater than specified value
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[X] Applicable
The module is valid for this product type

[] Non-applicable
The module is not valid for this product type

[N] Value not named
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Value required for the design of an external system (plant)

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Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

1. Power-related data

No.	Description	Index	Value	Unit
1	Engine rated speed	A	1500	rpm
2	Reduction gear - Output speed	A	-	rpm
3	Mean piston speed		10.5	m/s
5	Fuel stop power ISO 3046	A	1575	kW
9	Mean effective pressure (MEP) (Fuel stop power ISO 3046)		22.0	bar
18	Performance map No.		-	-
38	Performance map No. (cont.)		-	-
20	Performance map, amendment index		-	-

BL Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

DL Reference value: continuous power
Engine power that can be run continuously under standard conditions

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< Actual value must be less than specified value

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□ Adequate verification not yet available (tolerance +/- 5%)

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Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

2. General Conditions (for maximum power)

No.	Description	Index	Value	Unit
46	Individual power calculation (ESCM) required for maximum power		X	-
1	Intake air depression (new filter)	A	15	mbar
2	Intake air depression, max.	L	50	mbar
3	Exhaust back pressure	A	30	mbar
4	Exhaust back pressure, max.	L	85	mbar
5	Fuel temperature at fuel feed connection	R	25	°C
9	Fuel temperature at fuel feed connection, max. (w/o power reduction)	L	55	°C
10	Fuel temperature at fuel feed connection, max.	L	55	°C
18	Fuel temperature at fuel feed connection, min.	L	-	°C

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

[DL] Reference value: continuous power
Engine power that can be run continuously under standard conditions

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[<] Actual value must be less than specified value

[X] Applicable
The module is valid for this product type

[] Non-applicable
The module is not valid for this product type

[N] Value not named
The value has not yet been named or will not be named

[*] Adequate verification not yet available (tolerance +/- 10%)
[] Adequate verification not yet available (tolerance +/- 5%)**

[A] Design value
Value required for the design of an external system (plant)

[R] Guideline value
Typical average value as information – only suitable for design purposes to a limited extent

[L] Limit value
A value representing the lower limit/minimum value or upper limit/maximum value that may not be exceeded. Not suitable for design purposes



Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

3. Consumption

No.	Description	Index	Value	Unit
17	Specific fuel consumption (be) - 100 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	-	g/kWh
18	Specific fuel consumption (be) - 75 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	-	g/kWh
19	Specific fuel consumption (be) - 50 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	-	g/kWh
20	Specific fuel consumption (be) - 25 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	-	g/kWh
21	Specific fuel consumption (be) - FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	-	g/kWh
56	Specific fuel consumption (be) - 100 % FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	199	g/kWh
57	Specific fuel consumption (be) - 75 % FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	203	g/kWh
58	Specific fuel consumption (be) - 50 % FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	211	g/kWh
59	Specific fuel consumption (be) - 25 % FSP (+ 5 %; EN 590; 42.8 MJ/kg)	R	230	g/kWh
73	No-load fuel consumption	R	30.0	kg/h
92	Lube oil consumption after 100 h of operation (B = fuel consumption per hour) Guideline value does not apply for the design of EGAT systems. Please consult the Applications Center with regard to the layout of EGA systems.	R	0.3	% of B
62	Lube oil consumption after 100 h of operation, max. (B = fuel consumption per hour)	L	1.0	% of B

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on
some applications (stabilization reserve)

[DL] Reference value: continuous power
Engine power that can be run continuously under standard
conditions

[>] Actual value must be greater than specified value
[<] Actual value must be less than specified value

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[] Non-applicable
The module is not valid for this product type

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[*] Adequate verification not yet available (tolerance +/-10%)
[]** Adequate verification not yet available (tolerance +/-5%)

[A] Design value
Value required for the design of an external system
(plant)

[R] Guideline value
Typical average value as information – only suitable
for design purposes to a limited extent

[L] Limit value
A value representing the lower limit/minimum value or
upper limit/maximum value that may not be
exceeded. Not suitable for design purposes



Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

4. Model-related data (basic design)

No.	Description	Index	Value	Unit
1	Naturally aspirated engine		-	-
2	Engine with exhaust turbocharger (ETC)		-	-
3	Engine with exhaust turbocharger (ETC) and intercooler		X	-
4	Exhaust piping, non-cooled		X	-
5	Exhaust piping, liquid-cooled		-	-
33	Working method: four-cycle, diesel, single-acting		X	-
34	Combustion method: direct injection		X	-
36	Cooling system: conditioned water		X	-
37	Direction of rotation: c.c.w. (facing driving end)		X	-
6	Number of cylinders		12	-
7	Cylinder configuration: V angle		90	degrees (°)
8	Cylinder configuration: in-line vertical		-	-
10	Bore		170	mm
11	Stroke		210	mm
12	Displacement, cylinder		4.77	liter
13	Displacement, total		57.2	liter
14	Compression ratio		16.4	-
40	Cylinder heads: single-cylinder		X	-
41	Cylinder liners: wet, replaceable		X	-
42	Piston design: composite piston		-	-
49	Piston design: solid-skirt piston		X	-
21	Number of piston compression rings		2	-
22	Number of piston oil control rings		1	-

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

[DL] Reference value: continuous power
Engine power that can be run continuously under standard conditions

[>] Actual value must be greater than specified value
[<] Actual value must be less than specified value

[X] Applicable
The module is valid for this product type

[] Non-applicable
The module is not valid for this product type

[N] Value not named
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[*] Adequate verification not yet available (tolerance +/-10%)
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[A] Design value
Value required for the design of an external system (plant)

[R] Guideline value
Typical average value as information – only suitable for design purposes to a limited extent

[L] Limit value
A value representing the lower limit/minimum value or upper limit/maximum value that may not be exceeded. Not suitable for design purposes



Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

24	Number of inlet valves, per cylinder		2	-
25	Number of exhaust valves, per cylinder		2	-
15	Number of turbochargers		4	-
16	Number of L.P. turbochargers		4	-
17	Number of H.P. turbochargers		-	-
18	Number of intercoolers		1	-
19	Number of L.P. intercoolers		1	-
20	Number of H.P. intercoolers		-	-
28	Standard flywheel housing flange (engine main PTO)		00	SAE
50	Static bending moment at standard flywheel housing flange, max.	L	15	kNm
51	Dynamic bending moment at standard flywheel housing flange, max.	L	75	kNm
43	Flywheel interface (DISC)		21	-

[BL] Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

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Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWel]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

5. Combustion air / exhaust gas

No.	Description	Index	Value	Unit
8	Charge-air pressure before cylinder - CP	R	-	bar abs
27	Charge-air pressure before cylinder - FSP	R	3.1	bar abs
9	Combustion air volume flow - CP	R	-	m ³ /s
10	Combustion air volume flow - FSP	R	2.0	m ³ /s
11	Exhaust volume flow (at exhaust temperature) - CP	R	-	m ³ /s
12	Exhaust volume flow (at exhaust temperature) - FSP	R	5.3	m ³ /s
13	Exhaust temperature before turbocharger - CP	R	-	°C
14	Exhaust temperature before turbocharger - FSP	R	665	°C
15	Exhaust temperature after turbocharger - CP	R	-	°C
16	Exhaust temperature after turbocharger - FSP	R	510	°C
17	Exhaust temperature after engine - CP	R	-	°C
18	Exhaust temperature after engine - FSP	R	510	°C

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Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

6. Heat dissipation

No.	Description	Index	Value	Unit
9	Heat dissipated by engine coolant - CP with oil heat	R	-	kW
11	Heat dissipation by engine coolant - CP with oil heat, with charge-air heat	A	-	kW
60	Heat dissipated by engine coolant - CP (high-temperature circuit)	R	-	kW
61	Heat dissipated by engine coolant - CP (low-temperature circuit)	R	-	kW
13	Heat dissipated by engine coolant - CP without oil heat, with charge-air heat	R	-	kW
15	Heat dissipated by engine coolant - CP with oil heat, without charge-air heat	R	-	kW
16	Heat dissipated by engine coolant - FSP with oil heat, without charge-air heat	R	580	kW
17	Heat dissipated by engine coolant - CP without oil heat, without charge-air heat	R	-	kW
22	Heat dissipated by oil - CP	R	-	kW
24	Charge-air and oil heat dissipation - CP	R	-	kW
26	Charge-air heat dissipation - CP	R	-	kW
27	Charge-air heat dissipation - FSP	R	310	kW
38	Heat dissipated by exhaust gas - CP	R	-	kW
31	Heat dissipated by return fuel flow - CP	R	-	kW
32	Heat dissipated by return fuel flow - FSP	R	5	kW
33	Radiation and convection heat, engine - CP	R	-	kW
34	Radiation and convection heat, engine - FSP	R	75	kW
35	Radiation and convection heat, genset - CP (engine + generator + 10m insulated exhaust pipework)	R	-	kW

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

7. Coolant system (high-temperature circuit)

No.	Description	Index	Value	Unit
17	Coolant temperature (at engine outlet to cooling equipment)	A	100	°C
57	Coolant temperature differential after/before engine, from	R	9	K
58	Coolant temperature differential after/before engine, to	R	11	K
23	Coolant temperature differential after/before engine	L	13	K
20	Coolant temperature after engine, limit 1	L	102	°C
21	Coolant temperature after engine, limit 2	L	104	°C
25	Coolant antifreeze content, max.	L	50	%
30	Cooling equipment: coolant flow rate	A	56	m³/h
31	Coolant pump: pressure differential	R	2.5	bar
35	Coolant pump: inlet pressure, min.	L	0.5	bar
36	Coolant pump: inlet pressure, max.	L	2.5	bar
39	Engine: coolant pressure differential with thermostat	R	2.0	bar
41	Pressure loss in off-engine cooling system, max.	L	0.7	bar
72	Pressure loss in off-engine cooling system, min.	L	0.55	bar
43	Pressure loss in off-engine cooling system, max. without thermostat	L	0.7	bar
70	Pressure loss in off-engine cooling system, min. without thermostat	L	0.55	bar
45	Flow resistance (X) coefficient engine w/ thermostat, w/o cooling equipment	R	0.8	mbar/(m³/h)²
47	Breather valve (expansion tank) opening pressure (excess pressure)	R	1.0	bar
54	Cooling equipment: height above engine, max.	L	15	m

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

53	Cooling equipment: operating pressure	A	2.5	bar
73	Coolant level in expansion tank, below min. alarm	L	-	-
74	Coolant level in expansion tank, below min. shutdown	L	X	-
50	Thermostat, starts to open	R	79	°C
51	Thermostat, bypass closed	R	92	°C
52	Thermostat, fully open	R	92	°C
48	Breather valve (expansion tank) opening pressure (depression)	R	-0.1	bar
49	Pressure in cooling system, max.	L	5.0	bar

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

8. Coolant system (low-temperature circuit)

No.	Description	Index	Value	Unit
53	Coolant temperature (at engine outlet to cooling equipment)	R	58	°C
9	Coolant temperature before intercooler (at engine inlet from cooling equipment)	A	45	°C
14	Coolant temperature before intercooler, limit 1	L	75	°C
61	Coolant temperature before intercooler, shutdown	L	-	°C
15	Coolant temperature before intercooler, limit 2	L	-	°C
54	Coolant temperature differential after/before intercooler, min.	L	8	K
55	Coolant temperature differential after/before intercooler, max.	L	15	K
13	Coolant antifreeze content, max.	L	50	%
17	Charge-air temperature after intercooler, max.	L	80	°C
76	Temperature differential between intake air and charge-air coolant before intercooler	A	20	K
75	Temperature differential between intake air and charge-air coolant before intercooler, max.	L	22	K
45	Charge-air temperature after intercooler, max. for compliance with "TA-Luft" at CP	L	-	°C
56	Coolant pump: flow rate	A	30	m³/h
20	Cooling equipment: coolant flow rate	A	30	m³/h
21	Intercooler: coolant flow rate	R	30	m³/h
22	Coolant pump: pressure differential	R	1.4	bar
24	Coolant pump: inlet pressure, min.	L	0.5	bar
25	Coolant pump: inlet pressure, max.	L	2.5	bar
29	Pressure loss in off-engine cooling system, max.	L	0.7	bar
62	Pressure loss in off-engine cooling system, min.	L	0.55	bar

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

31	Pressure loss in off-engine cooling system, max. without thermostat	L	0.7	bar
63	Pressure loss in off-engine cooling system, min. without thermostat	L	0.55	bar
43	Cooling equipment: height above engine, max.	L	15	m
36	Breather valve (expansion tank) opening pressure (excess pressure)	R	1.0	bar
37	Breather valve (expansion tank) opening pressure (depression)	R	-0.1	bar
42	Cooling equipment: operating pressure	A	2.5	bar
67	Coolant level in expansion tank, below min. alarm	L	-	-
68	Coolant level in expansion tank, below min. shutdown	L	X	-
39	Thermostat, starts to open	R	38	°C
40	Thermostat, bypass closed	R	51	°C
41	Thermostat, fully open	R	51	°C

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

10. Lube oil system

No.	Description	Index	Value	Unit
1	Lube oil operating temp. before engine, from	R	88	°C
2	Lube oil operating temp. before engine, to	R	98	°C
3	Lube oil operating temp. after engine, from	R	98	°C
4	Lube oil operating temp. after engine, to	R	108	°C
5	Lube oil temperature before engine, limit 1	L	99	°C
6	Lube oil temperature before engine, limit 2	L	101	°C
7	Lube oil operating pressure before engine (measuring block)	R	5.9	bar
8	Lube oil operating press. bef. engine, from	R	5.0	bar
9	Lube oil operating press. bef. engine, to	R	7.0	bar
10	Lube oil pressure before engine, alarm	L	-	bar
33	Lube oil pressure before engine, limit 1 (speed-related value, consult Rolls-Royce Solutions GmbH)	L	3.5	bar
11	Lube oil pressure before engine, shutdown	L	-	bar
34	Lube oil pressure before engine, limit 2 (speed-related value, consult Rolls-Royce Solutions GmbH)	L	3.2	bar
17	Lube oil pump(s): oil flow, total	R	625	liter/min
19	Lube oil fine filter (main circuit): number of units		1	-
20	Lube oil fine filter (main circuit): number of elements per unit		5	-
21	Lube oil fine filter (main circuit): particle retention	R	0.014	mm
32	Lube oil fine filter (main circuit): pressure differential, max.	L	1.5	bar
35	Lube oil fine filter (main circuit): make (standard): MANN & HUMMEL		X	-

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

11. Fuel system

No.	Description	Index	Value	Unit
1	Fuel pressure at engine fuel feed connection, min. (when engine is starting)	L	-0.1	bar
2	Fuel pressure at engine fuel feed connection, max. (when engine is starting)	L	1.5	bar
57	Fuel pressure at engine fuel feed connection, min. (when engine is running)	L	-0.3	bar
65	Fuel pressure at engine fuel feed connection, max. (when engine is running)	L	0.5	bar
4211	Max. fuel supply volume Normal mode	A	12.1	liter/min
4212	Fuel supply volume, max. Fault mode	A	22.6	liter/min
4	Fuel pressure before injection pump, from (high-pressure pump)	R	6.0	bar
5	Fuel pressure before injection pump, to (high-pressure pump)	R	7.5	bar
6	Fuel pressure before injection pump, min. (high-pressure pump)	L	5.0	bar
7	Fuel pressure before injection pump with engine not running, max. (high-pressure pump)	L	1.5	bar
4213	Max. fuel return volume Normal mode	A	3.8	liter/min
4214	Fuel return volume, max. Fault mode	A	22.3	liter/min
10	Fuel pressure at return connection on engine, max.	L	0.5	bar
12	Fuel temperature differential before/after engine	R	30	K
38	Fuel temperature after high-pressure pump, alarm	L	95	°C
15	Fuel prefilter: number of units	A	-	-
16	Fuel prefilter: number of elements per unit	A	-	-

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

17	Fuel prefilter: particle retention	A	-	mm
29	Fuel prefilter: make (standard): MANN & HUMMEL		-	-
18	Fuel fine filter (main circuit): number of units	A	1	-
19	Fuel fine filter (main circuit): number of elements per unit	A	1	-
20	Fuel fine filter (main circuit): particle retention	A	0.005	mm
21	Fuel fine filter (main circuit): pressure differential, max.	L	1.0	bar
32	Fuel fine filter (main circuit): make (standard): MANN & HUMMEL		X	-

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

12. General operating data

No.	Description	Index	Value	Unit
1	Cold start capability: air temperature (w/o starting aid, w/o preheating) - (case A)	R	10	°C
2	Additional condition (to case A): engine coolant temperature	R	10	°C
3	Additional condition (to case A): lube oil temperature	R	10	°C
4	Additional condition (to case A): lube oil viscosity	R	15W40	SAE
9	Cold start capability: air temperature (w/o starting aid, w/ preheating) - (case C)	R	0	°C
10	Additional condition (to case C): engine coolant temperature	R	40	°C
11	Additional condition (to case C): lube oil temperature	R	-10	°C
12	Additional condition (to case C): lube oil viscosity	R	15W40	SAE
21	Coolant preheating, heater performance (standard)	R	9	kW
22	Coolant preheating, preheating temperature, min.	L	32	°C
3506	Coolant preheating, preheating temperature, max.	L	55	°C
23	Lube oil priming pump: flow rate	R	N	liter/min
24	Lube oil priming pump: pressure	R	N	bar
25	Lube oil priming pump: rated power	R	N	kW
26	Lube oil priming pump: cut-in interval pump cut-in every ... minutes	R	N	min
27	Lube oil priming pump: cut-in duration	R	N	min
28	Breakaway torque (without driven machinery) coolant temperature +5°C	R	1650	Nm
30	Breakaway torque (without driven machinery) coolant temperature +40°C	R	1300	Nm
29	Cranking torque at firing speed (without driven machinery) coolant temperature +5°C	R	900	Nm

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Exhaust Regulations NEA Singapore for ORDE;

31	Cranking torque at firing speed (without driven machinery) coolant temperature +40°C	R	660	Nm
96	Starting is blocked if the engine coolant temperature is below		0	°C
92	Run-up period to rated speed (without driven machinery)	R	N	s
93	Run-up period to rated speed (with driven machinery) (* at general conditions)	R	6	s
37	High idling speed, max. (static)	L	1700	rpm
38	Limit speed for overspeed alarm / emergency shutdown	L	1950	rpm
39	Limit speed for overspeed alarm	L	1950	rpm
42	Firing speed, from	R	80	rpm
43	Firing speed, to	R	120	rpm
44	Engine coolant temperature before starting full-load operation, recommended min. (for emergency/standby sets with coolant preheating the minimum preheating temperature referred to extended property No.22 is sufficient)	R	60	°C
3515	Minimum continuous load (operation > 10h)	R	30	kW/cyl
49	Extended low or no-load operation possible (consultation required)		X	-
50	Engine mass moment of inertia (without flywheel)	R	9.7	kgm ²
52	Standard flywheel mass moment of inertia	R	10.25	kgm ²
51	Engine mass moment of inertia (with standard flywheel)	R	19.95	kgm ²
69	Speed droop (with electronic governor) adjustable, from	R	0	%
70	Speed droop (with electronic governor) adjustable, to	R	8	%
95	Number of starter ring-gear teeth on engine flywheel		182	-

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Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

13. Starting (electric)

No.	Description	Index	Value	Unit
2309	Manufacturer		Delco	-
4101	Type		50MT	-
2310	Number of starter		2	-
2312	Starter electrically redundant		-	-
2313	Rated power per starter	R	9	kW
2314	Starter, rated voltage	R	24	VDC
2315	Rated short-circuit current per starter	L	1900	A
2316	Power consumption per starter (at an engine speed of 100 rpm)	R	580	A
2317	Internal resistance of power supply + line resistance per starter	A	0.008	Ω
2318	Manufacturer		Bosch	-
4118	Type		HEP	-
2319	Number of starter		2	-
2320	Starter electrically redundant		-	-
2321	Rated power per starter	R	11.3	kW
2322	Starter, rated voltage	R	24	VDC
2323	Rated short-circuit current per starter	L	2190	A
2324	Power consumption per starter (at an engine speed of 100 rpm)	R	750	A
2325	Internal resistance of power supply + line resistance per starter	A	0.0047	Ω
2326	Manufacturer		Prestolite	-
4119	Type		S-152	-
2327	Number of starter		1	-
2328	Starter electrically redundant		-	-

BL Reference value: fuel stop power
Maximum engine power that cannot be run continuously on some applications (stabilization reserve)

DL Reference value: continuous power
Engine power that can be run continuously under standard conditions

> Actual value must be greater than specified value
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X Applicable
The module is valid for this product type

Non-applicable
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N Value not named
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Name	12V4000G74F	Speed [rpm]	1500
Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

2329	Rated power per starter	R	15	kW
2330	Starter, rated voltage	R	24	VDC
2331	Rated short-circuit current per starter	L	3000	A
2332	Power consumption per starter (at an engine speed of 100 rpm)	R	1400	A
2333	Internal resistance of power supply + line resistance per starter	A	0.0049	Ω
2334	Manufacturer		Prestolite	-
4120	Type		S-152	-
2335	Number of starter		2	-
2336	Starter electrically redundant		X	-
2337	Rated power per starter	R	15	kW
2338	Starter, rated voltage	R	24	VDC
2339	Rated short-circuit current per starter	L	3000	A
2340	Power consumption per starter (at an engine speed of 100 rpm)	R	1400	A
2341	Internal resistance of power supply + line resistance per starter	A	0.0049	Ω
3374	Manufacturer		Prestolite	-
4121	Type		MS7	-
3375	Number of starter		2	-
3376	Starter electrically redundant		-	-
3377	Rated power per starter	R	9	kW
3378	Starter, rated voltage	R	24	VDC
3379	Rated short-circuit current per starter	L	1900	A
3380	Power consumption per starter (at an engine speed of 100 rpm)	R	530	A
3383	Internal resistance of power supply + line resistance per starter	A	0.005	Ω
4104	Manufacturer		Prestolite	-

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Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
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		Nominal power [kWeI]	-
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Exhaust Regulations NEA Singapore for ORDE;

4105	Type		M128R	-
4106	Number of starter		2	-
4107	Starter electrically redundant		-	-
4108	Rated power per starter	R	9.4	kW
4109	Starter, rated voltage	R	24	VDC
4110	Rated short-circuit current per starter	L	2000	A
4111	Power consumption per starter (at an engine speed of 100 rpm)	R	600	A
4112	Power consumption per starter (at an engine speed of 100 rpm, SAE0)	R	-	A
4113	Power consumption per starter (at an engine speed of 100 rpm, SAE1)	R	-	A
4114	Internal resistance of power supply + line resistance per starter	A	0.008	Ω
2347	Generally valid data for starter		X	-
2342	Rated starting-attempt Duration (at +20°C ambient temperature with battery full)	R	5	s
2343	Interval between starts (at rated starting-attempt duration), min.	L	20	s
2345	Maximum acceptable starting-attempt duration	L	15	s
2344	Interval between starts (when starting-attempt duration > rated starting- attempt duration)	R	60	s
2346	Starting attempts within 30 minutes (at +20°C ambient temperature with battery full), max.	L	6	-
3565	Disengagement of starter pinion at engine Speed Note: Exceeding the guideline value of the disengagement speed will reduce the life cycle of the starter depending on how often and how much the speed has been exceeded	R	400	rpm
3566	Disengagement of starter pinion at engine speed, max.	L	500	rpm

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Maximum engine power that cannot be run continuously on
some applications (stabilization reserve)

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Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

15. Starting (pneumatic/oil pressure starter)

No.	Description	Index	Value	Unit
35	Pneumatic starter: make Gali		-	-
36	Pneumatic starter: make TDI		X	-
5	Starting air pressure before starter motor, min.	R	8	bar
6	Starting air pressure before starter motor, max.	R	9	bar
7	Starting air pressure before starter motor, min.	L	8	bar
8	Starting air pressure before starter motor, max.	L	9	bar
18	Start attempt duration (engine preheated)	R	3	s
19	Start attempt duration (engine not preheated)	R	5	s
20	Start attempt duration, max.	L	-	s
114	Air consumption/start attempt (engine preheated) Engine without generator Control with engine controller	R	1.1	m ³ n
115	Air consumption/start attempt (engine not preheated) Engine without generator Control with engine controller	R	1.2	m ³ n
116	Air consumption with external control for air-starter (per second)	R	0.6	m ³ n
23	Starting air tank for 3 start attempts (max. 40 bar) (engine preheated)	R	-	liter
24	Starting air tank for 3 start attempts (max. 30 bar) (engine preheated)	R	-	liter
25	Starting air tank for 6 start attempts (max. 40 bar) (engine preheated)	R	-	liter
26	Starting air tank for 6 start attempts (max. 30 bar) (engine preheated)	R	-	liter
27	Starting air tank for 10 start attempts (max. 40 bar) (engine preheated)	R	-	liter

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Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

28	Starting air tank for 10 start attempts (max. 30 bar) (engine preheated)	R	-	liter
29	Starting air tank for 3 start attempts (max. 40 bar) (engine not preheated)	R	N	liter
30	Starting air tank for 3 start attempts (max. 30 bar) (engine not preheated)	R	N	liter
31	Starting air tank for 6 start attempts (max. 40 bar) (engine not preheated)	R	N	liter
32	Starting air tank for 6 start attempts (max. 30 bar) (engine not preheated)	R	N	liter
33	Starting air tank for 10 start attempts (max. 40 bar) (engine not preheated)	R	N	liter
34	Starting air tank for 10 start attempts (max. 30 bar) (engine not preheated)	R	N	liter
101	Hydraulic starter: make Huegli		X	-
102	Starting oil pressure before starter motor, min.	R	107	bar
103	Starting oil pressure before starter motor, max.	R	207	bar
104	Starting oil pressure before starter motor, min.	L	107	bar
105	Starting oil pressure before starter motor, max.	L	207	bar
107	Start attempt duration (engine not preheated)	R	N	s
108	Start attempt duration, max.	L	N	s
109	Hydraulic oil consumption / start attempt (engine preheated)	R	N	liter
110	Hydraulic oil consumption / start attempt (engine not preheated)	R	N	liter
111	Minimum specification of hydraulic oil viscosity	R	MilSpec 5606	-

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Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

16. Inclinations - standard oil system (ref.: waterline)

No.	Description	Index	Value	Unit
15	Longitudinal inclination, continuous max. driving end down (Option: max. operating inclinations)	L	5	degrees (°)
16	Longitudinal inclination, temporary max. driving end down (Option: max. operating inclinations)	L	-	degrees (°)
17	Longitudinal inclination, continuous max. driving end up (Option: max. operating inclinations)	L	5	degrees (°)
18	Longitudinal inclination, temporary max. driving end up (Option: max. operating inclinations)	L	-	degrees (°)
19	Transverse inclination, continuous max. (Option: max. operating inclinations)	L	10	degrees (°)
20	Transverse inclination, temporary max. (Option: max. operating inclinations)	L	-	degrees (°)

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Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

18. Capacities

No.	Description	Index	Value	Unit
1	Engine coolant capacity (without cooling equipment)	R	160	liter
10	Intercooler coolant capacity	R	40	liter
11	On-engine fuel capacity	R	7	liter
14	Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	260	liter
20	Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	200	liter
28	Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	160	liter
29	Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	200	liter

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

19. Masses / dimensions

No.	Description	Index	Value	Unit
9	Engine mass, dry (basic engine configuration acc. to scope of supply specification)	R	6200 *	kg

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Application Group	3D	Nominal power [kW]	1575
Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

21. Exhaust emissions

No.	Description	Index	Value	Unit
2005	Emissions data sheet: NEA Singapore for ORDE		X	-

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Dataset	Ref. 25°C/45°C	Nominal power [bhp]	2112
		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

22. Acoustics

No.	Description	Index	Value	Unit
101	Exhaust noise, unsilenced - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	-	dB(A)
201	Exhaust noise, unsilenced - CP (sound power level LW, ISO 6798, +3dB(A) tolerance)	R	-	dB(A)
102	Exhaust noise, unsilenced - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +3dB(A) tolerance)	R	113	dB(A)
202	Exhaust noise, unsilenced - FSP (sound power level LW, ISO 6798, +3dB(A) tolerance)	R	125	dB(A)
103	Exhaust noise, unsilenced - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	-	-
203	Exhaust noise,unsilenced - CP (sound power level LW, ISO 6798) Spectrum No.	R	-	-
104	Exhaust noise, unsilenced - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	733657e	-
204	Exhaust noise,unsilenced - FSP (sound power level LW, ISO 6798) Spectrum No.	R	N	-
109	Engine surface noise with attenuated intake noise (filter) - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	-	dB(A)
209	Engine surface noise with attenuated intake noise (filter) - CP (sound power level LW, ISO 6798, +2dB(A) tolerance)	R	-	dB(A)

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
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Exhaust Regulations NEA Singapore for ORDE;

110	Engine surface noise with attenuated intake noise (filter) - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	103	dB(A)
210	Engine surface noise with attenuated intake noise (filter) - FSP (sound power level LW, ISO 6798, +2dB(A) tolerance)	R	121	dB(A)
111	Engine surface noise with attenuated intake noise (filter) - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	-	-
211	Engine surface noise with attenuated intake noise (filter) - CP (sound power level LW, ISO 6798) Spectrum No.	R	-	-
112	Engine surface noise with attenuated intake noise (filter) - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	733671e	-
212	Engine surface noise with attenuated intake noise (filter) - FSP (sound power level LW, ISO 6798) Spectrum No.	R	N	-
131	Engine surface noise, without intake noise - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798, +2dB(A) tolerance)	R	-	dB(A)
231	Engine surface noise, without intake noise - CP (sound power level LW, ISO 6798, +2dB(A) tolerance)	R	-	dB(A)
133	Engine surface noise, without intake noise - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	-	-
233	Engine surface noise, without intake noise - CP (sound power level LW, ISO 6798) Spectrum No.	R	-	-
117	Intake noise, unsilenced - CP (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	-	dB(A)

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- Product Data -

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		Nominal power [kVA]	-
		Nominal power [kWeI]	-
		Frequency [Hz]	50

Exhaust Regulations NEA Singapore for ORDE;

217	Intake noise, unsilenced - CP (sound power level LW, ISO 6798)	R	-	dB(A)
119	Intake noise, unsilenced - FSP (free-field sound-pressure level Lp, 1m distance, ISO 6798) Spectrum No.	R	-	-
219	Intake noise, unsilenced - CP (sound power level LW, ISO 6798) Spectrum No.		-	-
125	Structure borne noise at engine mounting brackets in vertical direction above resilient engine mounts - CP Spectrum No.	R	-	-
126	Structure borne noise at engine mounting brackets in vertical direction above resilient engine mounts - FSP Spectrum No.	R	733709e	-
127	Structure born noise, vertically below the resilient engine mounts - CP Spectrum No.	R	-	-

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APPENDIX 9.03

Alternator Datasheet

Uncontrolled when Printed

ALTERNATOR TECHNICAL DESCRIPTION
LSA 52.3 S7 / 4p

LS Reference: BM322-07-2023-1 1

Date: 18.07.2023 V6.09h - 03/2023 1
Project Manager : MB.17.07.2023 2
bernd.mahrla@mail.nidec.com
+49 69 780 708 11
Nidec Deutschland GmbH Electric Power Generation BM
Eschborner Landstraße 166 - 60489 Frankfurt am Main

Main data C 1

Generator type: **LSA 52.3 S7 / 4p** 2
Power: 1 675 kVA 1 340 kWe 1 390 kWm 2
Voltage: 400 V Star serial 1
Rated voltage range: +5/-5% 1
Power factor - Lagging: 0,8 1
Frequency: 50 Hz 1
Speed: 1 500 rpm 1
Nominal current: 2 418 A 2
Winding type: p2/3 1
Classes (Insulation / Temperature Rise): H / H (Std-by) 1
Ambient temperature: 40 °C 1
Altitude: 150 m 1

Installation IEC Quantity 2 2

Client: Rolls-Royce Solutions GmbH 1
Project: BCDM Project 1
Site: to define 1
Prime mover: Reciprocating engine 1
Manufacturer: MTU 1
Type: 12V4000 2
Duty: Peak Rating 1
Industry: Construction 1

Mechanical construction IM1201 1

Type of construction: Single bearing 1
Mounting arrangement: Horizontal Axis 1
Direction of rotation: Clockwise (seen when facing the drive end - DE) 1
Bearing type: Anti-friction 1
Bearing Lubrication: Regreasable 1
Bearing insulation: Not insulated 1
Flector type: SAE 21 1
Balancing - Class (ISO 21940-11): Without key - G2,5 (std) 1
Flange: SAE 00 1
Shaft height: 500 mm 1
Width: 750 mm 1

Additional specificities 1

Stabilized Runaway speed: 1 800 rpm - 2 min. 1

ALTERNATOR TECHNICAL DESCRIPTION
LSA 52.3 S7 / 4p

LS Reference: **BM322-07-2023-1** 1

Cooling Method **IC01** 1

Degree of protection:	IP23	1
Coolant:	Air / Temperature: 35 °C	1
Air quality:	Clean	1
Ventilation (internal):	Self-ventilated	1
Filters:	Without	1
Ducting for air inlet:	No	1
Ducting for air outlet:	No	1

Comments: oversizing for requested x"d included

Connection, Excitation & Regulation 1

Parallel operation:	With mains (3F) - From measuring CT	1
Excitation:	Self-excited - Brushless - Type: PMG	1
Sustained 3-phase Isc:	> 3 x FLC for 10s.	1
AVR type:	Leroy Somer - D550 - Digital	1
AVR location:	In terminal box	1
Alternator Voltage sensing:	In terminal box	1
Additional features:	Three-phase sensing	1
	Diode failure detector	1

Terminal box 1

Power connection:	4 connectors (brought out neutral)	1
Main terminal box location:	1 terminal box on the top	1
Line side outlet:	Upwards	1
Gland plate:	Non magnetic, Undrilled	1
Auxiliaries	In main terminal box	1

Comments: cable outlet upwards with arrangement of the AVR (on the TB front face) and auxiliary terminal connections on the right or left-hand side (looking at the drive shaft end of the generator)

Protection and measurement accessories 1

Temperature detection 1

Stator windings:	6 x PT100 RTDs (3 wires)	1
Guide bearing - NDE:	1 x PT100 RTD (3 wires)	1

Anti-condensation heating 1

Voltage: 230 V - 1Ph / Power: 500 W

Transformers (Client use) 1

LS Supply	<i>Transformers' curve & test report required</i>		1
Set of 3 x CTs (measuring and/or protection):	I Primary / I Secondary / Power / Class		
Neutral side	S1	3000 / 5A / 10VA / Cl. 0,5	2
	S2	3000 / 5A / 10VA / Cl. 5P5	2

Comments:

Various items 1

Paint:	C3M-P - Polyurethane - RAL 7001	1
Documentation:	PDF manual	1
Documentation Language:	English	1
Nameplate	Sticker	1

Controls 1

Standards:	IEC	1
QUAL/INES/006 001 => 101	Measurement of winding resistance	1
QUAL/INES/006 021 => 128	Insulation check on sensors (when fitted)	1
QUAL/INES/006 002 => 102&103	Voltage balance and phase order check	1
QUAL/INES/006 007 => 109	Overspeed test (according to test bench limitation)	1
QUAL/INES/006 009 => 111	High potential test	1
QUAL/INES/006 010 => 112	Insulation resistance measurement	1

**ALTERNATOR TECHNICAL DESCRIPTION
LSA 52.3 S7 / 4p**

LS Reference: BM322-07-2023-1 1

ALTERNATOR ELECTRICAL DATA
LSA 52.3 S7 / 4P

LS Reference: **BM322-07-2023-1**

Date: 18.07.2023

V6.09h - 03/2023

Main data:

Power:	1 675 kVA	1 340 kWe	1 390 kWm	2
Voltage:	400 V	Frequency:	50 Hz	1
Rated voltage range:	+5% / -5%	Speed:	1500 rpm	1
Power factor - Lagging:	0,8	Phases	3	1
Nominal current:	2 418 A	Connexion	Star serial	1
Insulation / Temperature rise:	H / H (Std-by)	Winding type:	p2/3	1
Cooling:	IC01	Winding:	- 6 Wires	1
Ambient temperature:	35 °C	Overspeed (rpm)	1800	1
Altitude:	150 m	Total Harmonic Distortion (THD) < 3,5%		1
Duty: Peak Rating				

Efficiency (Base 1340 kWe)

	25%	50%	75%	100%	110%	IEC
Power factor - Lagging: 0,8	94,6	96,4	96,6	96,4		2
Power factor - Lagging: 1	95,1	97,1	97,5	97,5		2

Reactances (%) - (Base 1675 kVA)

Unitary impedance (1 per unit) = 0,095522 ohms

	Unsaturated		Saturated		Unsaturated		Saturated	
	Direct axis	Xd	Xd	Xd	Quadrature axis	Xq	Xq	Xq
Synchronous reactance	Xd	286	218	Xq	146	111		
Transient reactance	X'd	25,9	22,0	X'q	146	111		
Subtransient reactance	X''d	13,2	11,3	X''q	13,8	11,7		
Negative sequence reactance	X2	13,5	11,5					
X0	2,0	Zero sequence reactance						
XI	6,6	Stator leakage reactance						
Xr	20,7	Rotor leakage reactance						
Kc	0,46	Short-circuit ratio						

Time constants (s)

	Direct axis	Quadrature axis
Open circuit transient time constant	T'do	2,87
Short-circuit transient time constant	T'd	0,260
Open circuit subtransient time constant	T''do	0,043
Subtransient time constant	T''d	0,022
Ta	0,028	Armature winding short circuit time constant

Resistances (%)

Ra	1,5	Armature resistance	R0	0,7	Zero sequence resistance
X/R	7,3	X/R ratio (without unit)	R2	2,7	Negative sequence resistance

Voltage accuracy: 0,25%

Maximum inrush current for a voltage dip of 15%: 1269 kVA

when starting an AC motor having a starting power factor between 0 and 0.4

Rating is provided for the specified temperature rise, by resistance measurement according to IEC60034-1

According to: I.E.C. 60034.1 - 60034.2 - NEMA MG 1-32

Products and materials shown in this catalogue may, at any time, be modified in order to follow the latest technological developments.

ALTERNATOR MAIN CURVES
LSA 52.3 S7 / 4P

LS Reference: BM322-07-2023-1

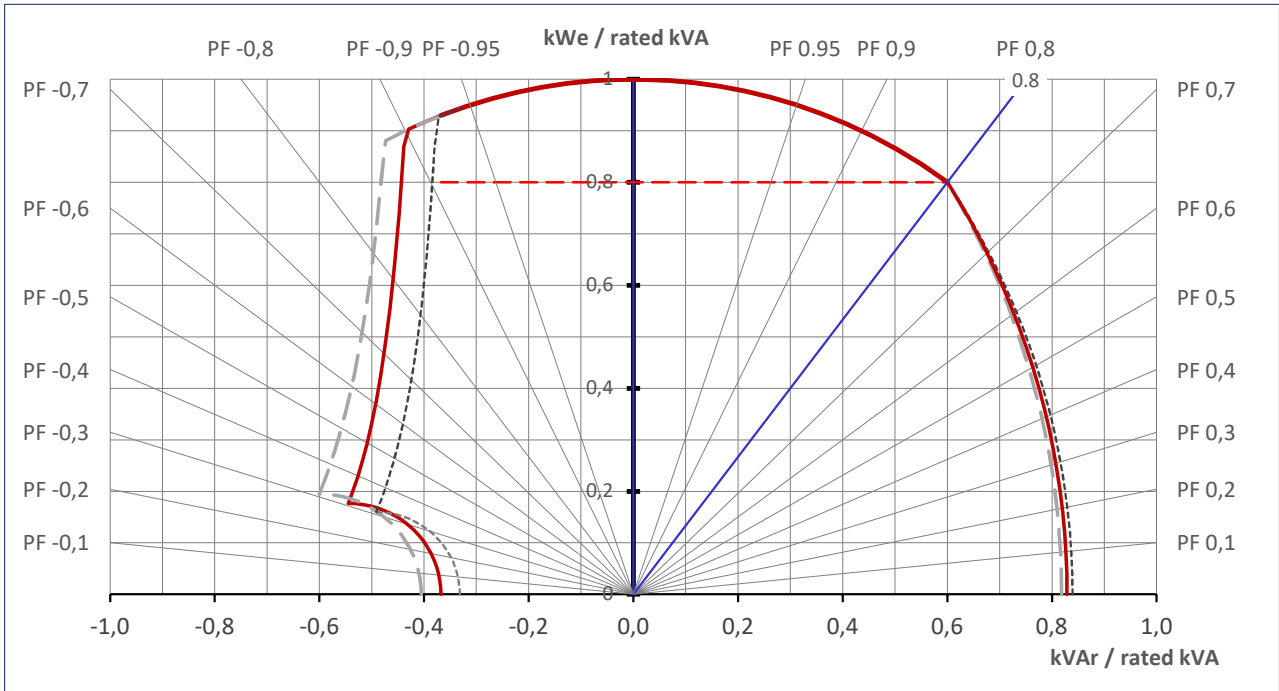
Date: 18.07.2023

1675kVA - 400V - 50 Hz

V6.09h - 03/2023

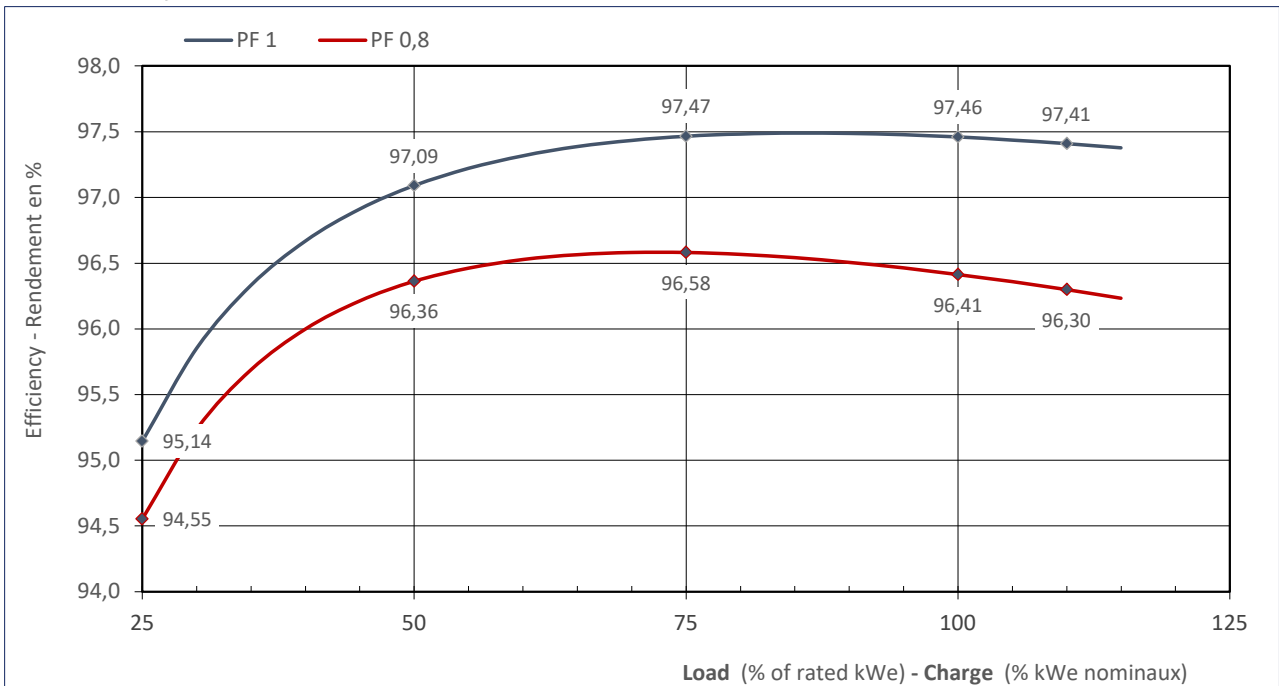
Capability Curve

---	Umax	+ 5%	420	V
—	Un		400	V
---	Umin	- 5%	380	V



Efficiency Curves

According to: IEC

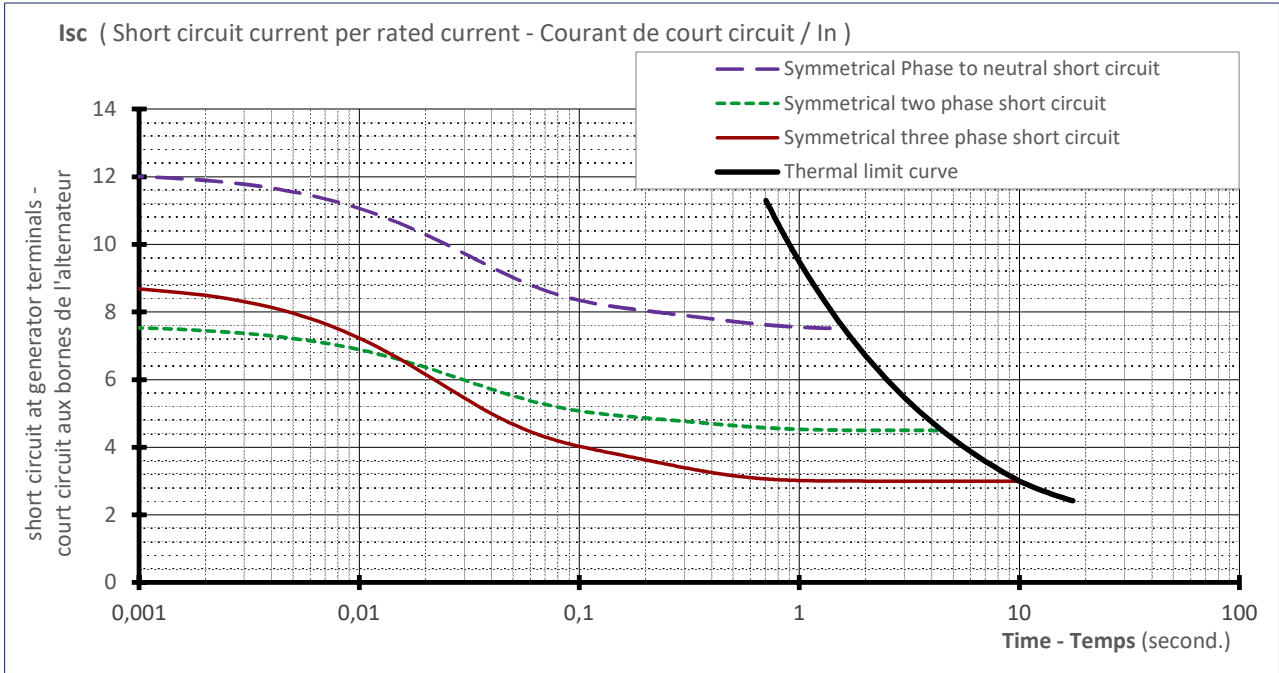


ALTERNATOR MAIN CURVES
LSA 52.3 S7 / 4P

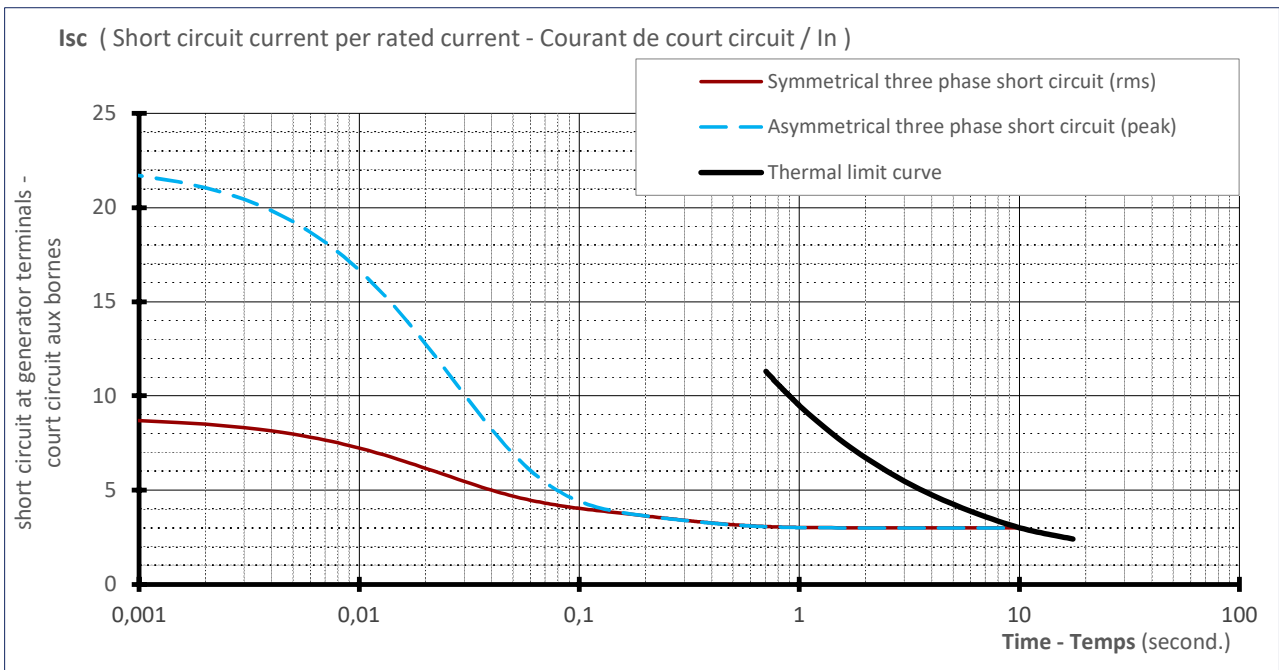
LS Reference: BM322-07-2023-1

Stator Current decrement curves

Symmetrical phase to neutral short-circuit		initial	29 038	A	12 x In	
Symmetrical two phase short-circuit		max	18 207	A	7,5 x In	In = 2418 A
Symmetrical three phase short-circuit		value	20 990	A	8,7 x In	
Thermal Limit						



Asymmetrical three phase short-circuit		IP	51 988	A	21,5 x In
--	--	----	--------	---	-----------

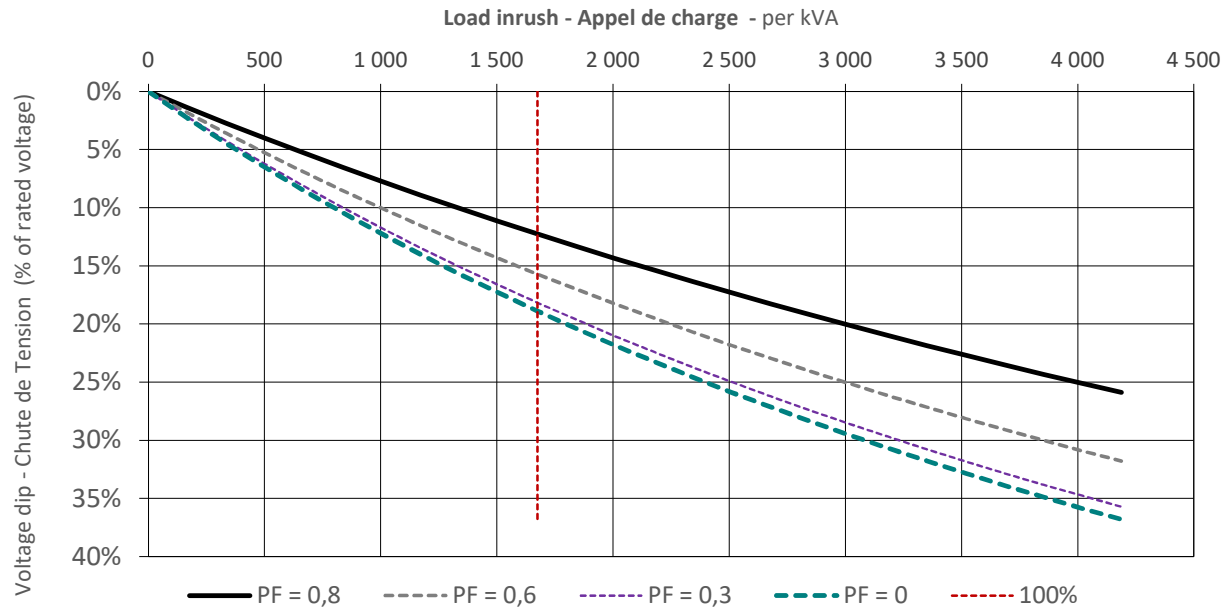


ALTERNATOR MAIN CURVES
LSA 52.3 S7 / 4P

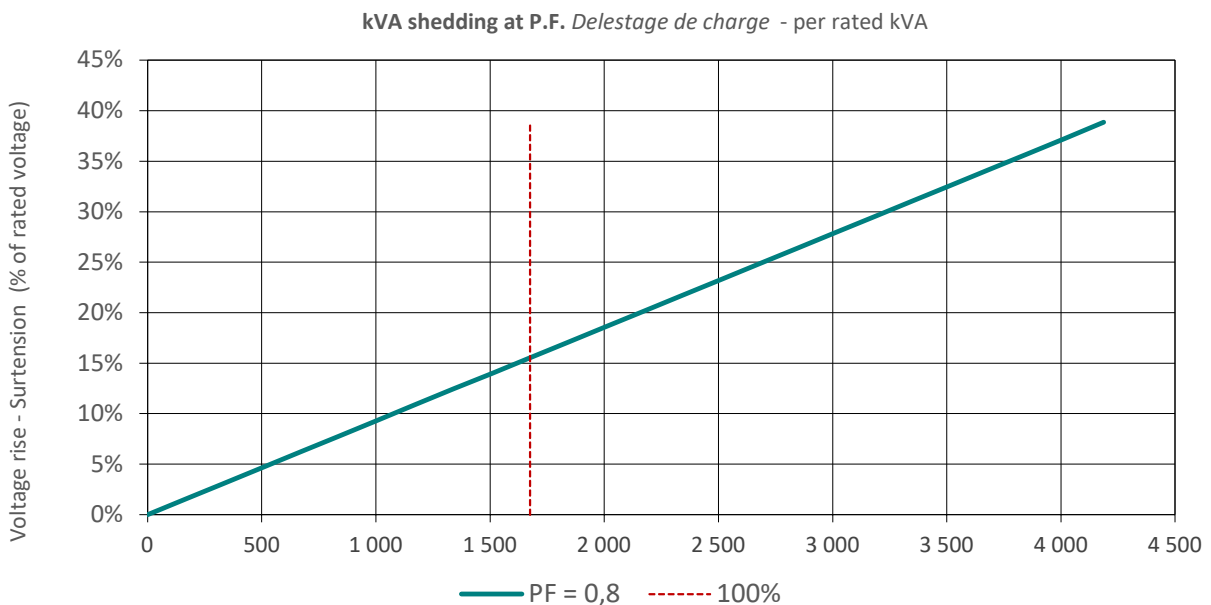
LS Reference: BM322-07-2023-1

Transient Voltage Variation

Transient voltage dip curve versus load impact



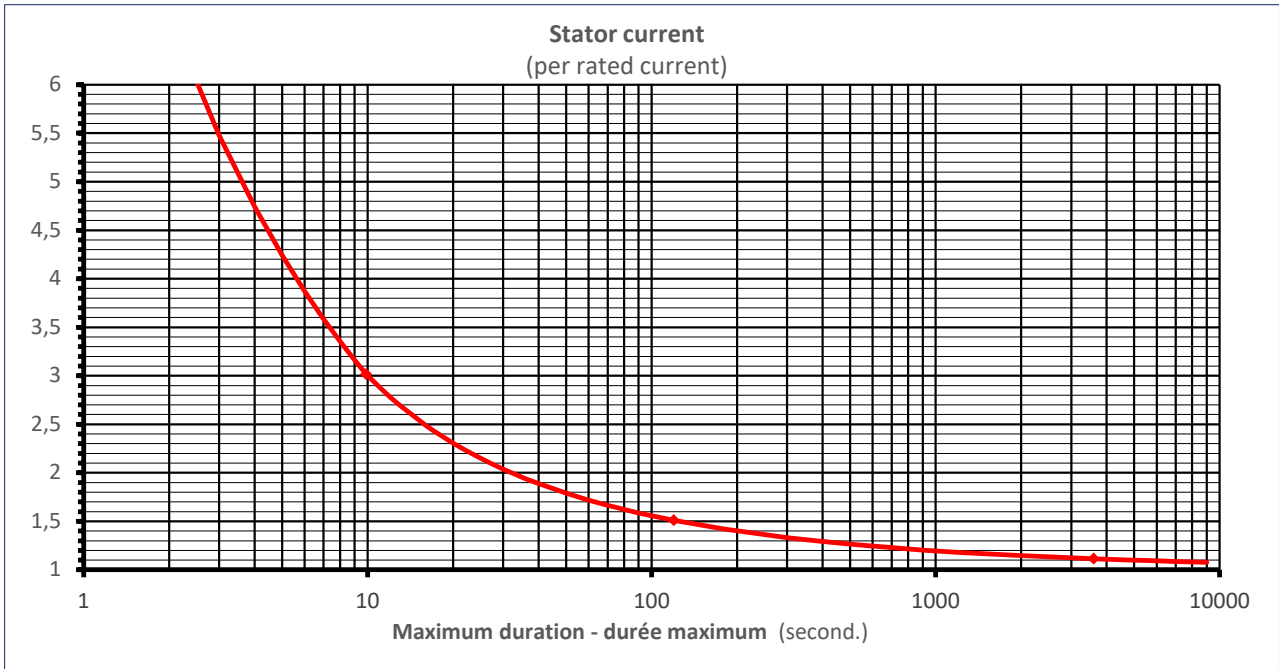
Transient voltage rise curve versus load rejection



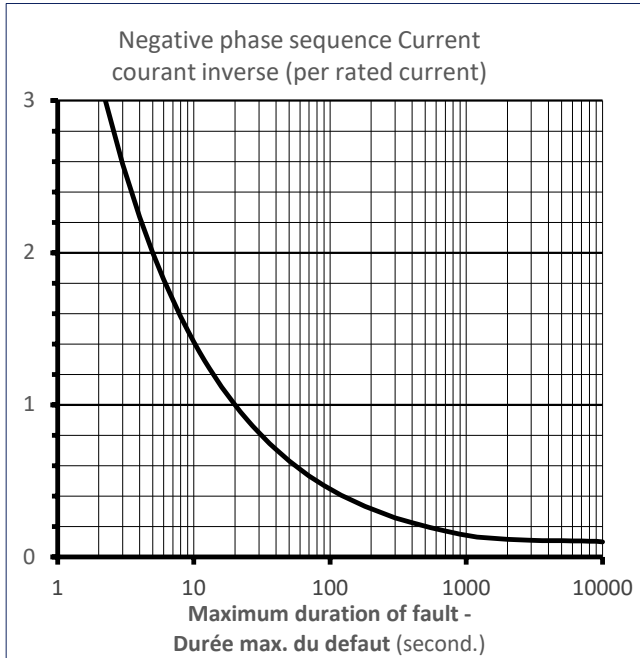
ALTERNATOR MAIN CURVES
LSA 52.3 S7 / 4P

LS Reference: BM322-07-2023-1

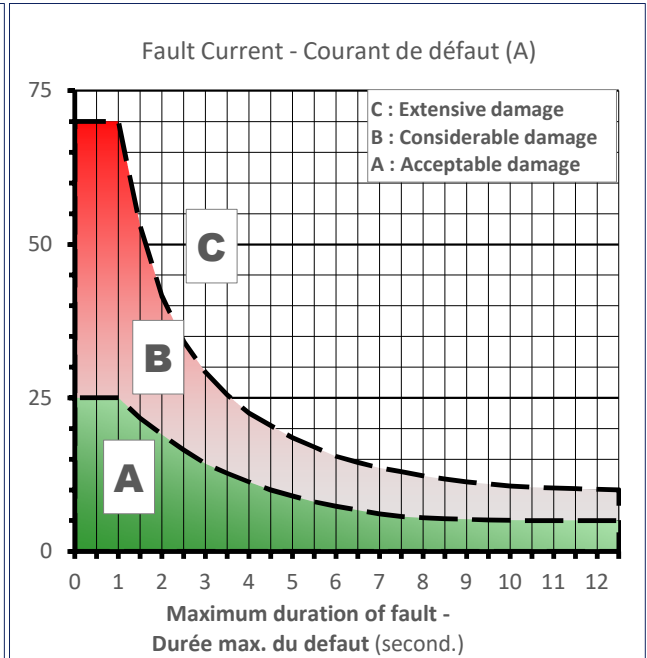
Thermal Damage Curve



Unbalance Load Curve



Stator Earth Fault Current



APPENDIX 9.04

UTI Letter

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Rolls-Royce Solutions GmbH

Maybachplatz 1
88045 Friedrichshafen
Germany
T +49 7541 90-0

AVK Solutions Ireland Ltd
39 Orion Business Campus,
NW Business Park
Ballycoolin, D15 XV07

Contact: TBC
e-Mail: TBC

Tel. No.: +49 7541 904675
Fax No.:

Date: 16 August 2023
Ref.: XXXXX

NTT

Dear Sirs,

For your Data Center Project “NTT”, you provided us certain information regarding the project’s power requirements and site conditions, including the project’s estimated “design load” as defined by the Uptime Institute.

Based on our analysis of the information you provided, we can confirm that the Rolls Royce Solutions GenSet Type **mtu** 12V4000 DS1650 generator sets can continuously support your data center’s estimated design load of 1625 kVA /1300kWe at the site conditions referenced below and satisfy the Uptime Institute Tier III/IV Engine Generator Requirements for data center applications.

Please note that while using **mtu** generator sets for data center applications subject to Uptime Institute ratings or classifications, you still must follow all federal, state, and local regulations for the employment of such generator sets, including specifically US Environmental Protection Agency (“EPA”) regulations regarding continuous usage of diesel engines. These regulations may impose operating limitations that need to be accounted for while managing your site. Your local **mtu** distributor is knowledgeable about these regulations and can provide you with information regarding the operation of your **mtu** generator sets within applicable federal, state, and local regulatory guidelines.

Please also note that while **mtu** 12V4000 DS1650 generator sets are capable of continuously supporting your project’s power requirements based on the estimated design load information you provided, routine preventive maintenance of these generator sets still is required and must be performed by the operator to ensure uninterrupted power. Please refer to **mtu** maintenance schedule and time before overhaul (TBO) for the 12V4000 DS1650 generator sets for further information.



Customer Project:	NTT	
IPAS Project Number:	XXXX	
Generator	LSA 52.3 S7	
Voltage	400V	
Power factor	0.8	
Site Conditions:	Ambient Temp:	42°C
	Elevation above sea level:	100m
	Humidity:	95%

Sincerely,

i.V.
Director of PG Engineering
Rolls Royce Solutions GmbH

i.A.
Senior Manager of PG Engineering
Rolls Royce Solutions GmbH

APPENDIX 9.05

Emissions Datasheet

Uncontrolled when Printed



Contents

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	12V4000G74F				
Rated power [kW]	1575				
Rated speed [rpm]	1500				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Data Set No.	XZ59454101168				
Data Set Basis	NEA Singapore for ORDE				
Fuel sulphur content [ppm]	5				

Content	Page
Disclaimer	2
Emission data sheet (EDS)	3
Not to exceed emission values	5

Description of Revision	Frequency	All industrial property rights reserved. Disclosure, reproduction or use for any other purpose is prohibited unless our express permission has been given. Any infringement results in liability to pay damages.	PDF	Name	Project no. 012280080	Size A4
			Configurator	Lenhof, Torsten (TARC)	Order no. Vantage Dub11 (DS1650)	
			Approver1	Schmid, Tobias (TSLE)	EDS-ID 2945-04.09.2023	
			Approver2	Breuer, Joerg (TVA)		
			Approver3			
			Approver4			
Data generated by EDS Creator version 1.0 and uniplot. Ref.-dataset: 412385_010_mit Partikel_D2.nc for 259 in EDS platform.			User	FN2\1170260	Title Emission data sheet	
Emissionstage NEA Singapore for ORDE			Engine model 12V4000G74F	Sheet 1		
Configuration-ID 259	Documentation	Emissionstage basis NEA Singapore for ORDE	of 6			



General Disclaimers (valid for Measured and NTE values)

Please note that these data are physical and/or technical values only referring to and representing a normative defined operating condition. Any change in operating time and conditions will have impact on physical values and engine behavior, which must be considered and assessed within the complete propulsion system especially in regard to emission compliance and product safety.

Measurements listed in this EDS are representative of the listed engine rating at the time of testing. These measurements and results can change according to instrumentation, boundary condition, and engine to engine variability. In addition - changes to the engine family hard or software may occur which could result in changes to some of the listed values.

Emissions data measurement procedures are conducted according to applicable rules and standards as per "Emission Stage/Optimization". Potential deviations from these procedures are documented internally.

The listed emission values relate to the corresponding certification data. Seller doesn't take any responsibility or liability neither out or in connection with the contract nor on any other basis

- beyond these specified operating conditions of the engine
- and for any installation/modification of the entire propulsion system by the customer itself or any third party and the customer will indemnify MTU on first demand for any third party claim out or in connection with this.

Seller reserves the right to amend specifications and information without notice and without obligation or liability. No liability for any errors, facts or opinions is accepted. Customers must satisfy themselves as to the suitability of this product for their application. No responsibility for any loss as a result of any person placing reliance on any material contained in this data sheet will be accepted.

Seller reserves all rights in the information contained in this data sheet. It shall not be reproduced, made available to a third party or otherwise used in any way whatsoever.

When applicable, emission values are measured after combined exhaust streams.

Measured Emissions data is based on single operating points and thus cannot be used to compare to regulations which use values based on a weighted cycle.

Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures, and instrumentation. Over time deterioration may occur which may have an impact on emission levels.

The SO2 emission rates comprehend exclusively the SO2 content as found in the fuel source, oil consumption effects are not included. Variation of sulfur content in the fuel changes only the stated SO2 emissions, cross sensitivity to other emissions (e.g. particulates) is not possible.

All values based on metric units, inaccuracies for non metric values can occur, values are not binding.

Specific to gas engines: The listed emission values are based on gas composition at the time of certification measurement. Gas composition is as displayed in the EDS-document. Carbon dioxide and methane concentrations have direct influence on the corresponding displayed carbon dioxide and methane emissions.

EAT Specific Disclaimers (valid for EDS values)

NH3 emissions levels measured with AVL SESAM i60/ 4 FT Multi Component Exhaust Measurement System (FTIR) including EPA 40 CFR 1065 legislation compliant automated checks for linearity.

Generators or engines with exhaust after-treatment systems require a stabilization period of approximately 1 hour to ensure stable temperatures across SCR prior to performing an emissions test. Performing emissions measurements before a stable temperature has been achieved can result in inconsistent emission values. NOx Values only applicable if temperatures across SCR reached for DEF Dosing.

NTE Disclaimers (valid for NTE calculated values)

Calculated not to exceed values (NTE) are not proven by tests and therefore the accuracy is not guaranteed.

All emission data shown in chapters Emission Data Sheet, Not to Exceed Values, and Type Approval were gathered from a corresponding certification engine under test conditions shown above and complying to corresponding TEN data.

		PDF	Name	Project no. 012280080	Size
		Configurator	Lenhof, Torsten (TARC)	Order no. Vantage Dub11 (DS1650)	A4
		Approver1	Schmid, Tobias (TSLE)	EDS-ID	
		Approver2	Breuer, Joerg (TVA)	2945-04.09.2023	
		Approver3			
		Approver4			
		User	FN2\1170260		
		Engine model	12V4000G74F	Title	Emission data sheet
Description of Revision		All industrial property rights reserved. Disclosure, reproduction or use for any other purpose is prohibited unless our express permission has been given. Any infringement results in liability to pay damages.			Sheet
Frequency		Emissionstage NEA Singapore for ORDE			2
Data generated by EDS Creator version 1.0 and uniplot. Ref.-dataset: 412385_010_mit Partikel_D2.nc for 259 in EDS platform.		Emissionstage basis NEA Singapore for ORDE			of
Configuration-ID	Documentation				6
259					



Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	12V4000G74F				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN ³ values base on residual oxygen value of [%]	15				

Engine raw emissions*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	1575	1181	787	394	158
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1500	1501	1501	1501	1500
Engine speed relative	[-]	1	1	1	1	1
Filter smoke number	[-]	0.36	0.57	0.76	0.88	1.02
Exhaust temperature after ETC	grdC	531.3	495.6	464	373.1	284.7
Exhaust back pressure after ETC (static)	mbar	80	68	56	49	46
Exhaust mass flow wet	kg/h	8016	6736	5164	3589	3043
NOX-Emissions specific	g/kWh	6.37	5.34	4.81	4.97	7.34
CO-Emissions specific	g/kWh	0.97	1.03	0.88	1.4	2.4
HC1-Emissions specific	g/kWh	0.12	0.15	0.2	0.44	0.6
NMHC-Emissions specific	g/kWh	0.12	0.15	0.2	0.43	0.59
NOX+HC1-Emissions specific	g/kWh	6.49	5.49	5.02	5.41	7.95
NOX+NMHC-Emissions specific	g/kWh	6.49	5.49	5.01	5.4	7.93
CO2-Emissions specific	g/kWh	627.6	636.5	658.8	712.8	992.4

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Data generated by EDS Creator version 1.0 and inplot. Ref.-dataset: 412385_010_mit Partikel_D2.nc for 259 in EDS platform.				Configurator	Lenhof, Torsten (TARC)	Order no. Vantage Dub11 (DS1650)	
				Approver1	Schmid, Tobias (TSLE)	EDS-ID 2945-04.09.2023	
				Approver2	Breuer, Joerg (TVA)		
				Approver3			
Configuration-ID 259		Documentation		User	FN2\170260	Title Emission data sheet	Sheet 3 of 6
		Emissionstage NEA Singapore for ORDE	Engine model 12V4000G74F	Emissionstage basis NEA Singapore for ORDE			



PM-Emissions specific (Meas.)	g/kWh	0.034	0.06	0.093	0.185	0.368
NOX-Emissions (based on 15% O2)	mg/m3N	923	762	660	625	652
NOX+HC1-Emissions (based on 15% O2)	mg/m3N	939	783	686	676	702
NOX+NMHC-Emissions (based on 15% O2)	mg/m3N	939	782	685	675	701
CO2-Emissions (based on 15% O2)	mg/m3N	84445	84339	83919	83282	81916
CO-Emissions (based on 15% O2)	mg/m3N	130.3	136.3	111.8	163.6	197.7
HC1-Emissions (based on 15% O2)	mg/m3N	16	20.1	25.8	51.3	49.8
PM-Emissions (based on 15% O2)	mg/m3N	4.6	7.9	11.9	21.6	30.4
Oxygen (O2)	%	8.7	10	11.1	13.3	16

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			Configurator	Lenhof, Torsten (TARC)	Order no. Vantage Dub11 (DS1650)	
Data generated by EDS Creator version 1.0 and uniplot. Ref.-dataset: 412385_010_mit Partikel_D2.nc for 259 in EDS platform.			Approver1	Schmid, Tobias (TSLE)	EDS-ID	Title Emission data sheet
			Approver2	Breuer, Joerg (TVA)	2945-04.09.2023	
			Approver3			
			Approver4			
Configuration-ID 259	Documentation	Emissionstage NEA Singapore for ORDE	User	FN2\1170260	Engine model 12V4000G74F	Sheet 4
		Emissionstage basis NEA Singapore for ORDE				of 6



Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	12V4000G74F				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN ³ values base on residual oxygen value of [%]	15				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	1575	1181	787	394	158
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1500	1501	1501	1501	1500
Engine speed relative	[-]	1	1	1	1	1
NOX-Emissions specific	g/kWh	8.28	6.94	6.26	7.46	13.95
CO-Emissions specific	g/kWh	1.65	1.75	1.67	2.8	4.79
HC1-Emissions specific	g/kWh	0.2	0.26	0.38	0.88	1.75
NMHC-Emissions specific	g/kWh	0.2	0.25	0.38	0.86	
NOX+HC1-Emissions specific	g/kWh	8.49	7.2	6.64	8.34	15.7
NOX+NMHC-Emissions specific	g/kWh	8.48	7.19	6.64	8.32	
PM-Emissions specific (Meas.)	g/kWh	0.051	0.095	0.14	0.278	1.361
NOX-Emissions (based on 15% O2)	mg/m3N	1200	991	858	937	1239
NOX+HC1-Emissions (based on 15% O2)	mg/m3N	1228	1025	907	1040	1383
NOX+NMHC-Emissions (based on 15% O2)	mg/m3N	1227	1025	906	1038	

Description of Revision	Frequency	<p>All industrial property rights reserved. Disclosure, reproduction or use for any other purpose is prohibited unless our express permission has been given. Any infringement results in liability to pay damages.</p>	PDF	Name	Project no. 012280080	Size A4
			Configurator	Lenhof, Torsten (TARC)	Order no. Vantage Dub11 (DS1650)	
			Approver1	Schmid, Tobias (TSLE)	EDS-ID 2945-04.09.2023	
			Approver2	Breuer, Joerg (TVA)		
			Approver3			
			User	FN2\170260		
			Engine model 12V4000G74F		Title Emission data sheet	
			Emissionstage NEA Singapore for ORDE			Sheet 5
Configuration-ID 259	Documentation		Emissionstage basis NEA Singapore for ORDE			of 6

Data generated by EDS Creator version 1.0 and inplot.
Ref.-dataset: 412385_010_mit Partikel_D2.nc for 259 in EDS platform.



CO-Emissions (based on 15% O2)	mg/m3N	221.5	231.7	212.5	327.3	395.3
HC1-Emissions (based on 15% O2)	mg/m3N	27.3	34.2	48.9	102.7	144.3
PM-Emissions (based on 15% O2)	mg/m3N	6.9	12.7	17.8	32.4	112.4

Description of Revision		Frequency	All industrial property rights reserved. Disclosure, reproduction or use for any other purpose is prohibited unless our express permission has been given. Any infringement results in liability to pay damages.	PDF	Name	Project no. 012280080	Size A4
Data generated by EDS Creator version 1.0 and uniplot. Ref.-dataset: 412385_010_mit Partikel_D2.nc for 259 in EDS platform.				Configurator	Lenhof, Torsten (TARC)	Order no. Vantage Dub11 (DS1650)	
				Approver1	Schmid, Tobias (TSLE)	EDS-ID 2945-04.09.2023	
				Approver2	Breuer, Joerg (TVA)	Title Emission data sheet	
				Approver3			
Approver4							
Configuration-ID 259		Documentation		User	FN2\170260		
				Engine model 12V4000G74F			
				Emissionstage NEA Singapore for ORDE			Sheet 6
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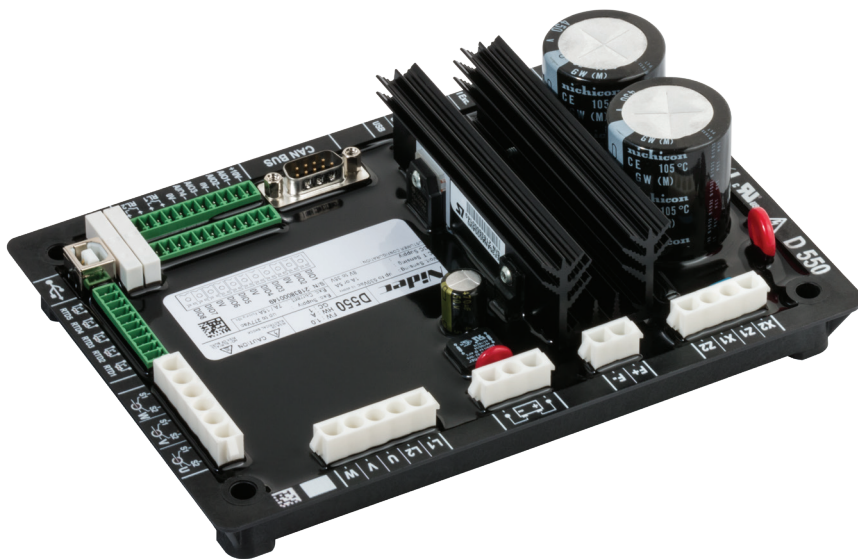
APPENDIX 9.06

AVR Datasheet

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D550 DIGITAL AVR

FOR ALTERNATORS WITH SHUNT, AREP OR PMG EXCITATION



The D550 is a digital automatic voltage regulator (AVR) for alternators with rated field current up to 8 A at 55°C.

It offers a vast array of regulation modes suitable for all power generation applications, including grid-connected configurations.

The D550 also integrates a visual interface through the EasyReg Advanced software, which allows the user to read the configuration values and parameters. It can also be configured directly via USB without external power supply.

The D550 also includes several protections and functions to keep the alternator running in full safe operation, in particular settings to comply with public network connection instructions (grid code).

The communication port is CANJ1939 compatible.

DATASHEET

KEY FEATURES

- **Regulation modes**
 - Voltage
 - Field current (manual mode)
 - Generator power factor
 - Grid power factor
 - Generator kVAr
- **Regulation features**
 - Voltage equalization
 - Droop management
 - Cross current compensation
 - Soft start
 - Load Acceptance Module (L.A.M.) function to assist during heavy load application events
 - Negative field forcing
- **kW, kVAr, kVA & PF calculation**
- **Protections & Limitations**
 - Under and over field current limitation
 - Loss of field sensing
 - Generator under/over voltage
 - Loss of sensing
 - V/Hz regulation mode
 - Diode fault monitor
- **Data logger** (option)
- **Synchronization monitoring**
- **Events log**

ELECTRIC FEATURES

- **Generator voltage measurement**
 - 3-phase, 2-phase
 - Range: 0-230-530 VAC
 - Consumption: < 2 VA
- **Grid voltage measurement**
 - 2-phase
 - Range: 0-230-530 VAC
 - Consumption: < 2 VA
- **Generator current measurement**
 - 1 or 3-phase
 - Secondary range: 1 or 5 A
 - Consumption: < 2 VA
- **AC supply input**
 - PMG, AREP, SHUNT
 - Range: 50-277 VAC
- **Excitation**
 - Rated field current (continuous):
7 A at 70°C
8 A at 55°C
 - Field forcing current (10s max):
15 A at 70°C
 - Recommended field resistance:
> 4 ohms
- **Auxiliary supply: 8-35 VDC**
 - Consumption: < 1 A
- **Frequency range: 30-400 Hz**
- **Storage temperature: -55°C +85°C**
- **Operating temperature: -40°C +70°C**

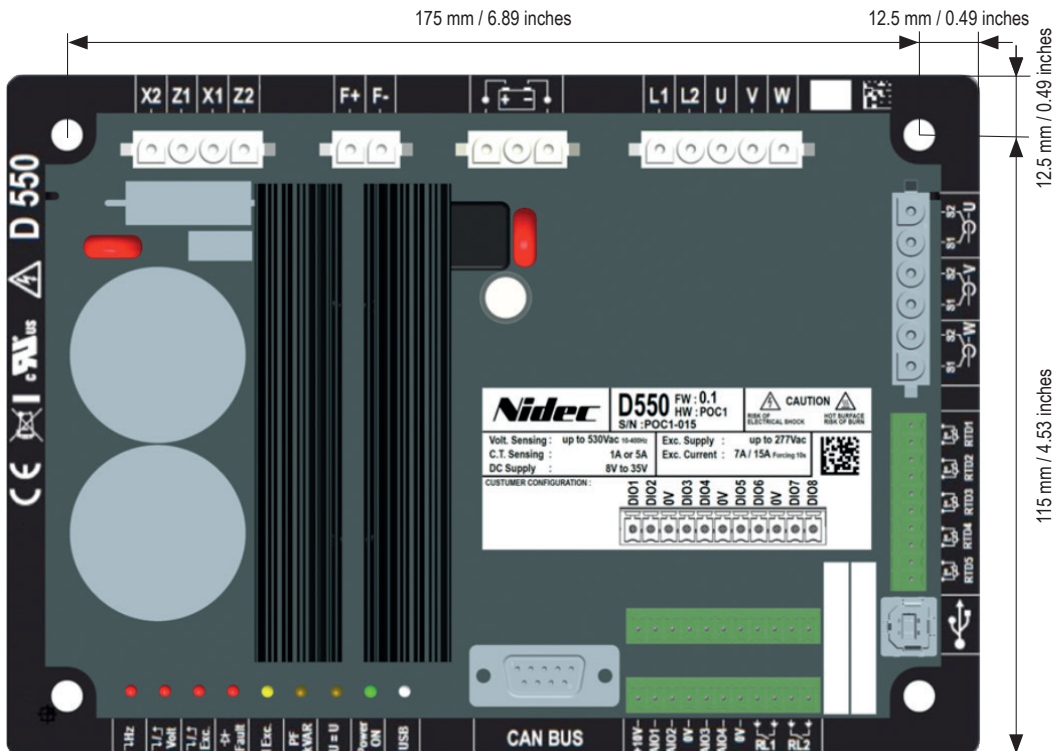
INPUTS / OUTPUTS

- **8 programmable digital inputs & outputs**
 - Output specification: 150 mA - 30 VDC
- **4 programmable analog inputs & outputs**
 - 4-20 mA / ±10 V / 0-10 V / potentiometer (1 kΩ)
- **2 relay outputs**
 - Specifications: 125 VAC - 5 A
- **5 temperature sensings**
 - Type: Pt100/CTP
 - Programmable threshold

COMMUNICATION & SETTINGS

- Software configuration (PC tool)
- USB port (self powered)
- CAN J1939 and Proprietary (Leroy-Somer protocol)

DIMENSIONS



Same footprint as Leroy-Somer D510C

APPENDIX 9.07

Battery Datasheet

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OPTIMA® YellowTop S 5,5



Battery Model: YT S 5,5

Part Number: 851 187 000 888 2

Nominal Voltage: 12 volts

NSN: 6140 01 502 4973

Description: High power, dual purpose engine start and deep cycle, sealed lead acid battery

Physical Characteristics:

Plate Design: High purity lead-tin alloy. Wound cell configuration utilizing proprietary SPIRALCELL® technology.

Electrolyte: Sulfuric acid, H₂SO₄

Case: Polypropylene

Color: Case: Light Gray
Cover: "OPTIMA" Yellow

Group Size: BCI: 31

	Standard	Metric
Length:	12.813"	325 mm
Width:	6.500"	165 mm
Height:	9.375"	238 mm (height at the top of the terminals)
Weight:	59.8 lb	26.5 kg

Terminal Configuration: SAE / BCI automotive.

Performance Data:

Open Circuit Voltage (fully charged): 13.1 volts

Internal Resistance (fully charged): 0.0025 ohms

Capacity: 75 Ah (C/20)

Reserve Capacity: BCI: 155 minutes
(25 amp discharge, 80°F (26.7°C), to 10.5 volts cut-off)

Power:

CCA (EN -18°C): 975 amps

MCA (BCI 0°C): 1125 amps

Recommended Charging:

The following charging methods are recommended to ensure a long battery life: (Always use a voltage regulated charger with voltage limits set as described below.)

Model: YT S 5,5

These batteries are designed for starting and deep cycling applications and for use in vehicles with large accessory loads.

OPTIMA® YellowTop S 5,5

Recommended Charging Information:

Alternator:	13.65 to 15.0 volts
Battery Charger (Constant Voltage):	13.8 to 15.0 volts; 10 amps maximum; 6-12 hours approximate
Float Charge:	13.2 to 13.8 volts; 1 amp maximum (indefinite time at lower voltages)
Rapid Recharge: (Constant voltage charger)	Maximum voltage 15.6 volts. No current limit as long as battery temperature remains below 50°C (125°F). Charge until current drops below 1 amp.
Cyclic or Series String Applications:	14.7 volts. No current limit as long as battery temperature remains below 50°C (125°F). When current falls below 1 amp, finish with 3 amp constant current for 1 hour. All limits must be strictly adhered to.

Recharge Time: (example assuming 100% discharge – 10.5 volts)

Current	Approx. time to 90% charge
100 amps	52 minutes
50 amps	112 minutes
25 amps	210 minutes

Recharge time will vary according to temperature and charger characteristics. When using Constant Voltage chargers, amperage will taper down as the battery becomes recharged. When amperage drops below 1 amp, the battery will be close to a full state charge.

(All charge recommendations assume an average room temperature of 25°C, 77°C)

Always wear safety glasses when working with batteries.

Always use a voltage regulated battery charger with limits set to the above ratings. Overcharging can cause the safety valves to open and battery gases to escape, causing premature end of life. These gases are flammable! You cannot replace water in sealed batteries that have been overcharged. Any battery that becomes very hot while charging should be disconnected immediately.

Not fully charging a battery can result in poor performance and a reduction in capacity.

Shipping and Transportation Information:

OPTIMA batteries can be shipped by AIR. The battery is nonspillable and is tested according to ICAO Technical Instructions DOC. 9284-AN/905 to meet the requirements of Packing Instructions No. 806 and is classified as non-regulated by IATA Special Provision A-48 and A-67 for UN2800. Terminals must be protected from short circuit.

Manufacturing Location:

OPTIMA Batteries
17500 East 22nd Avenue
Aurora, CO 80011
United States of America
Phone: 303-340-7400
Fax: 303-340-7474

BCI = Battery Council International

OPTIMA Batteries
Product Specifications: Model YT S 5,5
June 2005

APPENDIX 9.08

ComAp Datasheet

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InteliSys^{NTC} BaseBox



Order code: IS-NTC-BB

Gen-set controller

Datasheet

Product description

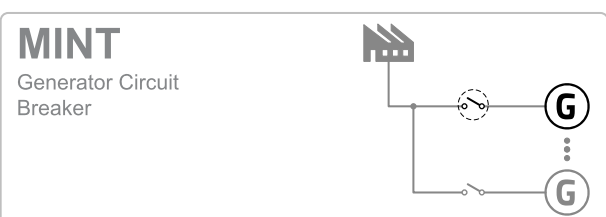
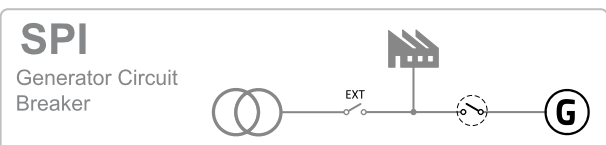
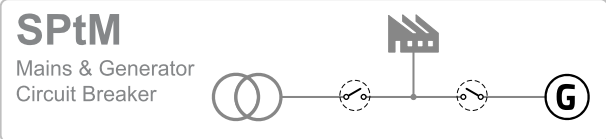
- ▶ Comprehensive paralleling gen-set controller
- ▶ Parallel operation up to 32 gen-sets
- ▶ High level control for complex systems
- ▶ CHP and gas engine controller

Key features

- ▶ Load sharing and VAr sharing via CAN
- ▶ Virtual shared inputs and outputs via CAN
- ▶ Support of wide range of applications
 - Single or multiple gen-sets in parallel to mains operation with automatic back up function, multiple island operation
- ▶ Advanced power management function
- ▶ Customizable load control in parallel to mains
- ▶ Wide range of ECU support
- ▶ Extended communication capabilities
 - Built-in web server
 - Full Modbus slave support
 - GPS and AirGate support and more
- ▶ Highly configurable
 - Timers, Extended internal PLC , Force values and more

- ▶ Compatible with ComAp's InteliVision displays
- ▶ Active e-mail messaging and SMS
- ▶ Extensive built-in protection functions
 - Standard protections
 - User configurable protection
- ▶ Extendable with ComAp's extension modules
- ▶ True RMS (TRMS) is used with Voltage, Current and Power measurement

Application overview



Technical data

Power supply

Power supply range	8-36 VDC
Power consumption	0.4 A / 8 VDC 0.15 A / 24 VDC 0.1 A / 36 VDC
RTC battery	10 years (replaceable by official service)
Fusing	2 A (without BOUT consumption)

Operating conditions

Operating temperature	-40°C to +70°C
Storage temperature	-40°C to +80°C
Operating humidity	95% w/o condensation
Vibration	5-25 Hz, ± 1.6 mm 25-100 Hz, $a=4$ g
Shocks	$a=200$ m/s ²

Voltage measurement

Measurement inputs	3 ph-n Gen voltage 3 ph-n Mains/Bus voltage
Measurement range	110V / 277V
Max allowed voltage	125 %
Accuracy	1 % of 110V / 277V
Frequency range	40-70 Hz (at accy 0.1 Hz)
Input impedance	0.6 M Ω ph-ph 0.3 M Ω ph-n

Current measurement

Measurement inputs	3 ph Gen current 1 ph Mains current
Measurement range	1 A / 5 A
Max allowed continuous current	200 % / 200 %
Accuracy	2 % of 1 A / 5 A
Input impedance	<0.1 Ω

Binary inputs

Number	16 non-isolated
Input resistance	4.7 k Ω
Close/Open indication	0-2 VDC close contact >4 VDC open contact

Binary outputs

Number	16 non-isolated
Max current	0.5 A (2 A per group)
Switching to	negative/positive supply terminal

Analog inputs

Number	4 non-isolated
Type	Switchable (Voltage, Resistance, Current)
Resolution	10 bits, max 4 decimals
Range	0-5 VDC/0-2500 Ω /0-20 mA
Input impedance	>100 k Ω / >100 k Ω /180 Ω
Accuracy	± 1 % of meas. value ± 1 mV ± 2 % of meas value ± 2 Ω ± 1 % of meas value ± 0.5 mA

Analog outputs

Number	1
Type	Switchable (Voltage, Current)
Range	0-10 VDC/0-20 mA
Max current/load	5 mA/500 Ω
Accuracy	± 0.5 % of output value ± 20 mV ± 0.5 % of output value ± 100 μ A

Magnetic pick-up

Voltage input range	2 Vpk-pk to 50 Veff
Frequency input range	4 Hz to 15 kHz
Frequency measurement tolerance	0.2 %

Voltage regulator output

Type	5 V TTL PWM / ± 10 VDC with IG-AVRi interface
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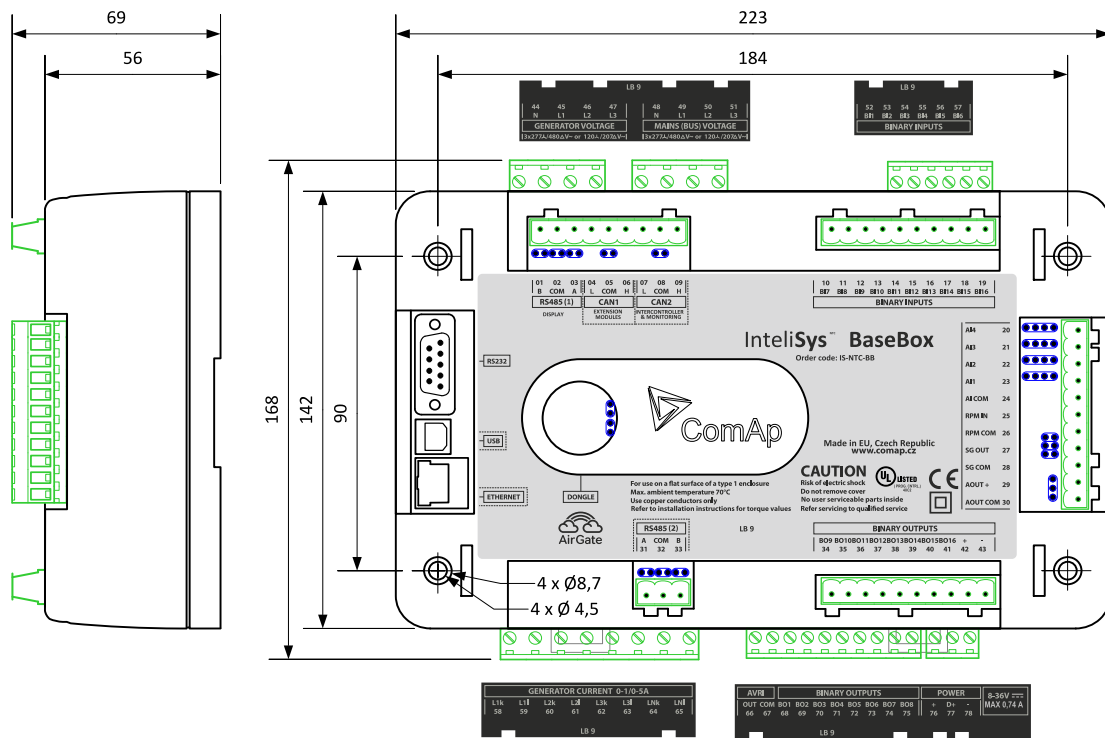
Speed governor output

Voltage output	± 10 VDC / max. 15 mA
Voltage output via resistor	± 10 VDC via 10 k Ω resistor / max. 1 mA
PWM	500-3000 Hz / 5V / max. 10mA

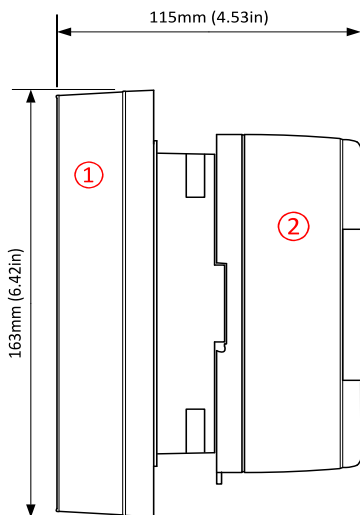
Communications

RS232	Direct/Modbus, non-isolated
RS485	Direct/Modbus, isolated
Display port	non-isolated RS485, only terminal connection
USB port	Direct, isolated
Ethernet port	LAN/Internet, Modbus TCP, SNMP, WebServer, AirGate
CAN1	External modules 250 kbps, max 200 m, Isolated
CAN2	Intercontroller and comm extensions 250/50 kbps, max 200/1000 m, Isolated

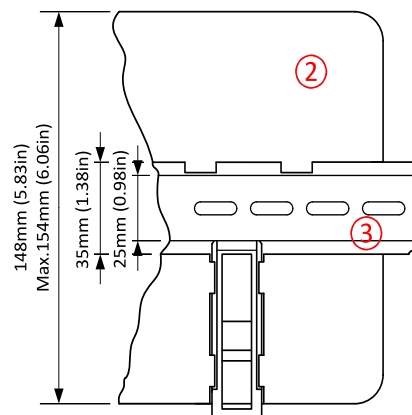
Dimensions, terminals and mounting



Panel door mounting with IntelliVision 5

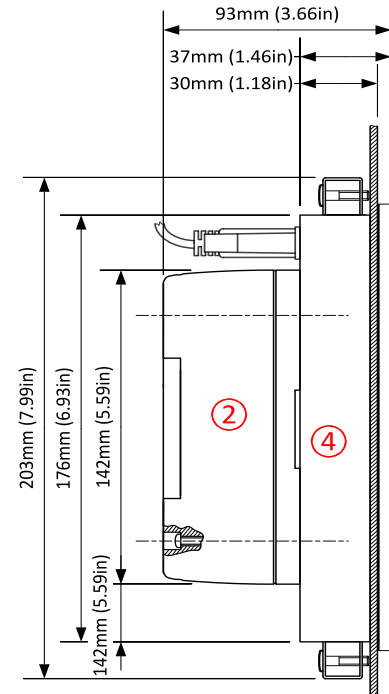


DIN-rail mounting



- ① IntelliVision5
- ② IntelSys^{NTC} BaseBox
- ③ DIN-rail
- ④ IntelliVision 8

Panel door mounting with IntelliVision 8



Note: IntelSys^{NTC} BaseBox can be mounted on a standard DIN rail or, in combination with IntelliVision 5 or IntelliVision 8, it can be door mounted. IntelliVision 5 features mounting rail for direct mounting. Mounting in combination with IntelliVision 8 uses four screws provided in the IntelSys^{NTC} BaseBox package.

Available extension modules

Product	Description	Order code
Intel IO8/8	8 Binary inputs, 8 Binary outputs and 2 Analog outputs packed in a small unit (HW switchable to IO16/0)	I-IO8/8
Intel IO8/8	HW switchable to IO16/0 - 16 Binary inputs packed in a small unit	I-IO8/8
Intel AIN8	8 Analog inputs (R, I, V) and 1 pulse/frequency input in a small unit	I-AIN8
Intel AIN8TC	8 Thermocouple Analog inputs in a small unit	I-AIN8TC
Intel AIO9/1	9 Analog inputs (4x DC, 4x thermocouples, 1x R) in a small unit	I-AIO9/1
IS-AIN8	8 Analog inputs packed in a rugged metal unit	IS-AIN8
IGS-PTM	8 Binary inputs, 8 Binary outputs, 4 Analog inputs and 1 Analog output in a unit	IGS-PTM
IGL-RA15	15 Binary LED output (3 colors) packed in a rugged metal unit	IGL-RA15
I-AOUT8	8 Analog outputs packed in a rugged metal unit	I-AOUT8
InternetBridge-NT	Multiple Internet connections (PC and Modbus) to all controllers on CAN2 or RS485	IB-NT
I-LB+	Direct connection (PC) to all controllers on CAN2 or RS485	I-LB+

Related products

Product	Description	Order code
IntelVision 5	Color 5.6" display for monitoring and control	INTELVISION 5
IntelVision 8	Color 8" display for advanced monitoring, control & trending, USB capable	INTELVISION 8
IntelVision 12Touch	Color 12" touch display for advanced monitoring, control & trending, USB capable	RD11V12TBZH
IntelVision 17Touch	Color 17" touchscreen display designed for complete monitoring and control of multiple controllers or cogeneration installation.	IV17T2
ECON-4	Digital speed governor dedicated for speed control of gas or diesel engines.	ECON-4

Functions and protections

The described product fully supports the following functions and protections as defined by ANSI (American National Standards Institute):

Description	ANSI code	Description	ANSI code
Synchronism check	25	Earth fault current	50N+64
Undervoltage	27	Overcurrent (IDMT)	51
Overload	32	Earth fault current IDMT	51N+64
Load shedding	32P	Power factor	55
Reverse power	32R	Overvoltage	59
Undercurrent	37	Gas (fuel) level	71
Excitation loss	40	Vector shift	78
Current unbalance	46	AC reclosing	79
Voltage asymmetry and phase sequence	47	Overfrequency	81H
Temperature monitoring	49T	Underfrequency	81L
Generator overcurrent	50	ROCOF	81R

Certificates and standards

This product is CE compliant.	
<ul style="list-style-type: none"> ▶ EN 60068-2-6 ed.2:2008; EN 60068-2-27 ed.2:2010; EN 60068-2-30, May 2000 ▶ EN 60068-2-64; EN 61010-1:2003 	
All certificates and standards are available on: https://webstore.iec.ch/	



APPENDIX 9.09

ComAp HMI Datasheet

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InteliVision 8



CONTROLLER COLOUR DISPLAY UNIT



Description

InteliVision 8 is a colour display unit designed as a simple, easy-to-use Plug and Play solution and delivers high visibility of all engine data, monitoring information and trend history in a bright, colorful and forward looking design. It can be used for either InteliGen^{NT}, InteliSys^{NT}, InteliMains^{NT}, InteliDrive DCU and InteliDrive Mobile.

InteliVision 8 comes with the large high-resolution colour TFT display, which helps visibility and definition of onscreen information. The control interface has user-friendly, intuitive active buttons – giving users access to more information in less time. InteliVision 8 boasts the unique TRENDS monitoring as a standard feature, helping you evaluate past events easily on one screen. It offers a site data storage using a USB stick and permits adding external pictures for customization of screens.

InteliVision 8 includes ComAp's standard communication interface using RS232/485 and CAN bus communication. Designed to be mounted in both monitoring and engine room, InteliVision 8 gives complete access to all control functions when connected to control unit.



Galvanically separated CAN and RS-485 interface



Screen editor



Tier 4



Trends



USB import & export



Front IP65



Plug and play interface



Large history



Insert images



Configurable buttons



ComAp is a member of AMPS (The Association of Manufacturers of Power generating Systems).



ComAp products meet the highest standards, with every stage of production undertaken in accordance with the ISO certification obtained in 1998.



The product has the UL Certification.

USB as data storage



InteliVision 8 makes working with your data even easier. You can export data to a USB flash drive, in order to work with data later at your computer with ease.

Data export capability:

- ▶ History
- ▶ Controller archive
- ▶ InteliVision firmware
- ▶ Trend – single export & continuous logging

The history and trend data is saved in a format that is supported by third party software. It is also possible to import trend data from a USB flash drive to InteliVision 8 and analyse them in the Trend screen.

USB as Login key



If quick, convenient access to InteliVision 8 is what you need, you can use a USB flash drive as a login key. When a user's password is saved onto a USB flash drive, simply plug it into InteliVision 8 and you are automatically logged in – no need to enter a password manually! A great idea for high security operations, as only staff with the correct USB flash drive are able to access the unit.

Configurable functional buttons



If you need quick access to frequently used functions on InteliVision 8, there are a number of user customisable buttons to which you can assign commands.

Offers fast access to frequently used functions:

- ▶ Binary signal activation
- ▶ Associate the buttons with generator or engine commands
- ▶ Fast jump to any measurement or Setpoints screen

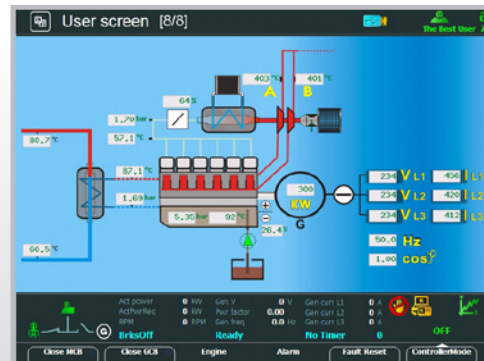
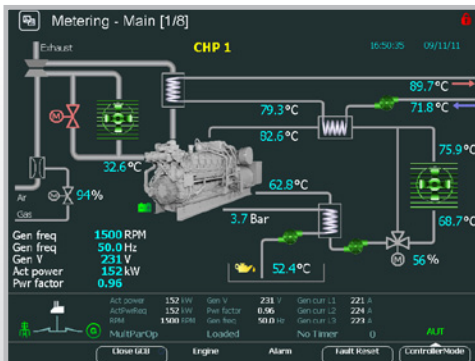
Configuration of these buttons is easy in ScreenEditor, which is part of GenConfig software application.

Import pictures and ScreenEditor

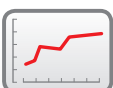


If you need to see a particular engine reading, a certain graph, or other frequently accessed information it is possible with ScreenEditor to customise InteliVision 8 to your preference. You can even add your company logo, or any other photo to further make InteliVision 8 unique to your application.

Screen examples



Trends improvement



Working with trends is now much easier. We have added new features such as:

- ▶ Faster movement through Trends
- ▶ The ability to evaluate change in trends across several screen
- ▶ Indication of remaining time for saving of trends

A major new feature is the ability to display only data from the binary signal that the user wants to see. This is a big change from the previous method of having to see all data, and find the section you need.



Benefits

- ▶ Large, colour screen with high-resolution
- ▶ PLUG and PLAY operation (auto configuration based on controller application)
- ▶ Simpler, faster and more intuitive control
- ▶ More information in less time
- ▶ TRENDS monitoring screen
- ▶ USB flash disk as file STORAGE (export trends, history and archive to USB flash disk)
- ▶ Quick AUTO login with USB stick
- ▶ User's PICTURES import to measurement screen
- ▶ Easy Drag & Drop screen CONFIGURATION by customer in new GRAPHICAL Editor
- ▶ CONFIGURABLE soft keys buttons
 - Fast jump to any Measurement or Setpoints screens
 - Binary signal activation – toggle button/pulse generator
 - Associating of genset commands
- ▶ ADAPTIVE and COLOR alarm list displaying
- ▶ Support of Tier 4 icons
- ▶ Direct connection to the controller (converters are not needed)

Features

- ▶ 8" colour TFT display with resolution 800×600 pixels
- ▶ Customized initial screen logo and the content of a controller help
- ▶ Same language support as IntelliGen^{NT}, IntelliSys^{NT}, IntelliMains^{NT}, IntelliDrive DCU and IntelliDrive Mobile
- ▶ Allows full monitoring of ONE controller (in case of more controllers on CAN it is possible to switch over among controllers monitoring by change of CAN address)
- ▶ The same dimensions as IS-Display (possible as a replacement for IG-Display LT GC, IS-Display or I-RD-CAN)
- ▶ Connection via of RS232/485 and CAN bus
- ▶ Possibility to mount IntelliGen^{NT} BaseBox, IntelliGen^{NTC} BaseBox, IntelliSys^{NTC} BaseBox or IntelliSys^{NT} BaseBox to the rear side of IntelliVision 8
- ▶ Windows CE operating system
- ▶ Operating temperature: -20 to + 70°C
- ▶ Face is sealed to IP65
- ▶ EMC, climatic and mechanical tests
- ▶ CE, UL certification

Connection Possibilities

The table shows the number of IntelliVision 8 that can be connected to each port controller.

	RS232	RS485	Display port (RS485)	CAN2
IntelliGen ^{NT}	1	0	1	4
IntelliGen ^{NT} BaseBox	1	0	2	4
IntelliGen ^{NTC} BaseBox	1	1	2	4
IntelliSys ^{NT} BaseBox	1-2*	0*-1	3	4
IntelliSys ^{NTC} BaseBox	1	1	3	4
IntelliMains ^{NT}	1	0	1	4
IntelliMains ^{NT} BaseBox	1	1	2	4
IntelliMains ^{NTC} BaseBox	1	0	2	4
IntelliDrive DCU Industrial	1	0	0	3
IntelliDrive DCU Marine	1	0	0	4
IntelliDrive Mobile	0	1	0	2

* Port is shared (can be set either as 485(2) or as RS232(2))

Order code

Controller	Order code
IntelliVision 8	INTELIVISION 8

APPENDIX 9.10

MTU Fluids and Lubricants

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Fluids and Lubricants Specifications

Diesel engine-generator sets
with **Series 2000 and 4000 MTU engines**

A001064/09E

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1 Preface

1.1 General information

Used symbols and means of representation

The following instructions are highlighted in the text and must be observed:

Important

This field contains product information which is important or useful for the user. It refers to instructions, work and activities that have to be observed to prevent damage or destruction to the material.

Note:

A note provides special instructions that must be observed when performing a task.

Fluids and lubricants

The service life, operational reliability and function of the drive systems are largely dependent on the fluids and lubricants employed. The correct selection and treatment of these fluids and lubricants are therefore extremely important.

Test standard	Designation
DIN	Federal German Standards Institute
EN	European Standards
ISO	International Standards Organization
ASTM	American Society for Testing and Materials
IP	Institute of Petroleum

Applicability of this document

These Fluids and Lubricants Specifications define the fluids and lubricants for diesel engine-generator sets from MTU Onsite Energy with the following MTU engines:

- Series 2000Gx5
- Series 2000Gx6
- Series 4000Gx3, application groups 3B, 3D, 3E, 3F, 3G
- Series 4000Gx4

Note: Please ignore references to other series in this document.

Up-to-dateness of this document

The Fluids and Lubricants Specifications are revised or supplemented as required. Before using them, make sure you have the latest version (publication number A001064/..). The latest version is available at: www.mtuonsiteenergy.com in the area "Parts and Service" under "MTU ValueCare for Diesel Generator Sets" > "Technical Documentation".

Warranty

Use of the approved fluids and lubricants, either under the brand name or in accordance with the specifications given in this publication, constitutes part of the warranty conditions.

The supplier of the fluids and lubricants is responsible for the worldwide standard quality of the named products.

Important

Fluids and lubricants for diesel engine-generator sets can be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturers' instructions, legal requirements and technical guidelines valid in the individual countries. Great differences can apply from country to country and a generally valid guide to applicable regulations for fluids and lubricants is therefore not possible within this publication.

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants which it has approved.

MTU Onsite Energy recommends consultation with the suppliers of all fluids and lubricants to request the relevant safety data sheets prior to storing, handling and using these fluids and lubricants.

Safe disposal

Important

To prevent environmental pollution and infringements of statutory requirements, used fluids and lubricants must be disposed of in accordance with local regulations.
Never dispose of or burn the used oil in the fuel tank.

The regulations for the disposal of fluids and lubricants differs from place to place. Environmental protection is one of the fundamental corporate objectives of MTU Onsite Energy. We therefore recommend the recycling of fluids and lubricants wherever possible. If recycling is not possible, MTU Onsite Energy recommends consulting the local waste-disposal authorities before disposing of fluids and lubricants to determine the best option. Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants which it has approved.

Registered trademarks

All brand names are registered trademarks of the manufacturer concerned.

Preservation

The document "Preservation and Re-preservation Specifications" (publication number A001070/..) contains all information on:

- Preservation
- Re-preservation and de-preservation
- Permissible preservatives

The latest version is available at: www.mtuonsiteenergy.com in the area "Parts and Service" under "MTU ValueCare for Diesel Generator Sets" > "Technical Documentation".

2 Lubricants

2.1 Engine oils – General information

Important

Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the combustion engine!

Requirements of the engine oils for MTU approval

MTU conditions for the approval of engine oils for diesel engines are defined in the MTU standards and available under these numbers:

- MTL 5044: Engine oils for diesel engines; Requirements
- MTL 5051: Initial operation and corrosion inhibitor oil for internal preservation of engines

Manufacturers of engine oils are notified in writing if their product is approved.

Approved engine oils are divided into the following MTU quality groups:

- Oil category 1: Standard quality / Single and multigrade oils
- Oil category 2: Higher quality / Single and multigrade oils
- Oil category 2.1: Multigrade oils with a low ash-forming additive content (low SAPS oils)
- Oil category 3: Highest quality / Multigrade oils
- Oil category 3.1: Multigrade oils with a low ash-forming additive content (low SAPS oils)

Low SAPS oils are oils with a low sulfur and phosphor content and an ash-forming additive content of $\leq 1\%$.

They are only approved if the sulfur content in the fuel does not exceed 50 mg/kg. When using diesel particulate filters, it is advisable to use these oils to avoid fast coating of the filter with ash particles.

Selection of a suitable engine oil is based on fuel quality, projected oil drain interval and on-site climatic conditions. At present there is no international industrial standard which alone takes into account all these criteria.

Important

The use of engine oils not approved by MTU can mean that statutory emission limits can no longer be observed. This can be a punishable offense.

Important

Mixing different engine oils is strictly prohibited!

Changing to another oil grade can be done together with an oil change. The remaining oil quantity in the engine oil system is not critical in this regard.

This procedure also applies to MTU's own engine oils in the regions Europe, Middle East, Africa, America and Asia.

Important

When changing to an engine oil in Category 3, note that the improved cleaning effect of these engine oils can result in the loosening of engine contaminants (e.g. carbon deposits).

It may be necessary therefore to reduce the oil change interval and oil filter service life (one time during change).

Special features

MTU engine oils for diesel engines

At MTU, the following single and multigrade oils are available in the individual regions:

Manufacturer & sales region	Product name	SAE grade	Oil category	Part No.
MTU Friedrichshafen Europe Middle East Africa	Diesel Engine Oil DEO SAE 15W-40	15W-40	2	20 l canister: X00070830 210 l barrel: X00070832 IBC: X00070833 Loose items: X00070835 (only on request)
	Power Guard® DEO SAE 40	40	2	20 l canister: X00062816 210 l barrel: X00062817 IBC: X00064829
MTU America America	Power Guard® SAE 15W-40 Off Highway Heavy Duty	15W-40	2.1	5 gallons: 800133 55 gallons: 800134 IBC: 800135
	Power Guard® SAE 40 Off Highway Heavy Duty	40	2	5 gallons: 23532941 55 gallons: 23532942
MTU Asia Asia	Diesel Engine Oil DEO SAE 15-W40	15W-40	2	18 l canister: 64247/P 200 l barrel: 65151/D
MTU Asia China	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 64242/P 205 l barrel: 65151/D
	Diesel Engine Oil - DEO 10W-40	10W-40	2	20 l canister: 60606/P
	Diesel Engine Oil - DEO 5W-30	5W-30	3	20 l canister: 60808/P
MTU Asia Indonesia	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 64242/P 205 l barrel: 65151/D
MTU India Pvt. Ltd. India	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 63333/P 205 l barrel: 65151/P
	Diesel Engine Oil - DEO 40	40	2	20 l canister: 73333/P 205 l barrel: 75151/D

Restrictions for certain applications

- Series 2000 Gx6
- Series 4000 Gx3, application groups 3F, 3G

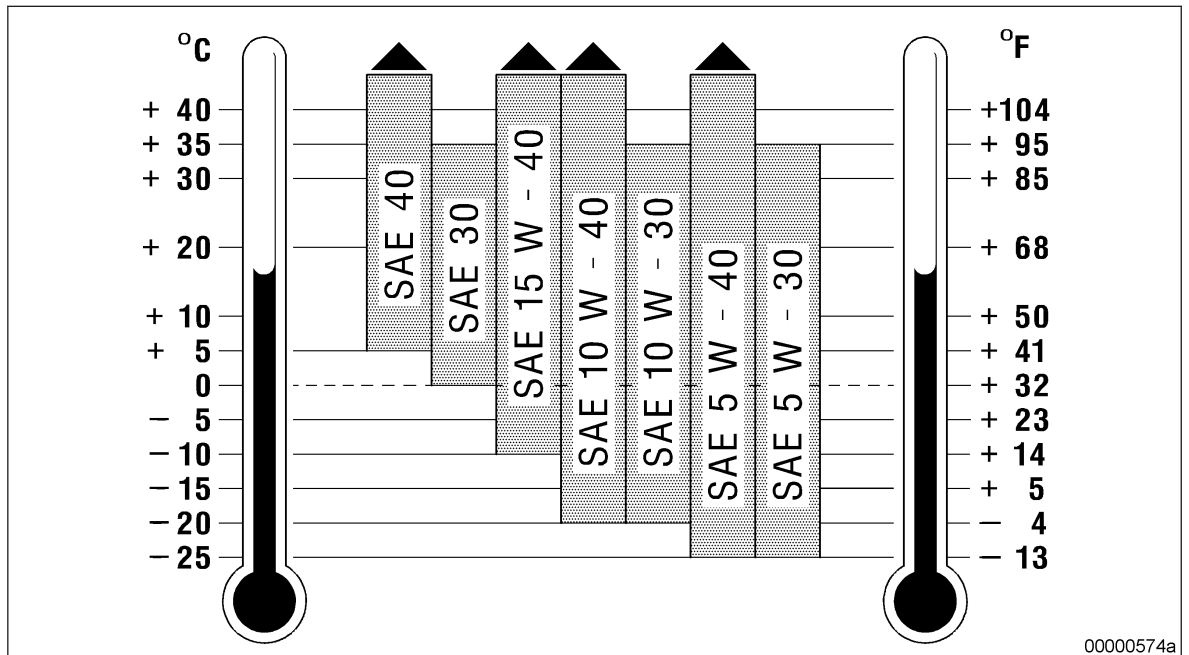
Important

Oils in oil category 1 must not be used!

Selection of viscosity grades

Selection of the viscosity grade is based primarily on the ambient temperature at which the engine is to be started and operated. If the relevant performance criteria are observed the engines can be operated both with single grade and multigrade oils, depending on the application. Guide values for the temperature limits of the individual viscosity classes, see (→ Figure 1).

If the prevailing temperature is too low, the engine oil must be preheated.



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Figure 1: Viscosity grade chart

Oil drain intervals for diesel engines

Engine oil drain intervals depend on the engine-oil quality, its conditioning, the operating conditions and the fuel used.

The intervals quoted (Table) are guide values based on operational experience and are valid for applications with a standard load profile.

Transmission fluid change intervals

Oil category	Without centrifugal oil filter	With centrifugal oil filter or by-pass filter
1	250 operating hours	500 operating hours
2	500 operating hours	1000 operating hours
2.1 ¹⁾	500 operating hours	1000 operating hours
3	750 operating hours	1500 operating hours
3.1 ¹⁾	750 operating hours	1500 operating hours

Table 1:

¹⁾ = To be used in conjunction with fuels with max. 50 mg/kg sulfur content.

Important

The oil drain intervals in the table (→ Table 1) are recommended guide values when using diesel fuels with < 0.5 % sulfur content. The defined limit values for the used oil (→ Table 2) must be observed. The numbers of operating hours quoted for oils must be confirmed by means of oil analysis.

The oil drain intervals must be determined by oil analysis if one or more of the following difficult operating conditions are encountered:

- Extreme climatic conditions
- High engine startup frequency
- Frequent and prolonged idling or low-load operation
- High fuel sulfur content of 0.5 to 1.5% by weight (see "Use of High-Sulfur Fuel")

For applications involving low runtimes, the engine oil must be changed every two years at the latest irrespective of its category.

Where engine oils with higher-grade corrosion-inhibiting characteristics are in use (→ Page 13), a change must be carried out every 3 years at the latest.

In individual cases the service life of the engine oil can be optimized by regular laboratory analysis and appropriate engine inspections in consultation with the MTU service point responsible:

- The first oil sample should be taken from the engine as a “basic sample” after the engine has run for approximately 1 hour after being filled with fresh oil.
- Further samples are to be analyzed at specific intervals (see "Laboratory Analysis").
- The appropriate engine inspections are to be carried out before and after the oil analyses.
- After completion of all analyses, and depending on the findings, special agreements can be reached for individual cases.
- Oil samples must always be taken under the same conditions and at the point provided for that purpose (see Operating Instructions).

Special additives

Engine oils approved have been specially developed for diesel engines and have all necessary properties. Further additives are therefore superfluous and may even be harmful.

Laboratory analysis

Spectrometric oil analysis

Analysis of the engine oil's additive-metal content is carried out by the MTU laboratory to determine the brand of oil.

MTU does not generally analyze the oil's wear-metal contents in order to determine the degree of engine wear. These content levels are very much dependent on the following factors, among others:

- Individual engine equipment status
- Tolerance scatter
- Operating conditions
- Duty profile
- Fluids and lubricants
- Miscellaneous assembly materials

Unambiguous conclusions as to the wear status of the engine components involved are therefore not possible. This means that no limit values can be given for wear-metal contents.

Used-oil analysis

In order to check the used oil, it is recommended that regular oil analyses be carried out. Oil samples should be taken and analyzed at least once per year and during each oil change and under certain conditions, depending on application and the engine's operating conditions, sampling / analysis should take place more frequently.

The specified test methods and limit values (Analytical Limit Values for Used Diesel Engine Oils) (→ Table 2) indicate when the results of an individual oil sample analysis are to be regarded as abnormal.

An abnormal result requires immediate investigation and remedy of the abnormality.

The limit values relate to individual oil samples. When these limit values are reached or exceeded, an immediate oil change is necessary. The results of the oil analysis do not necessarily give an indication of the wear status of particular components.

In addition to the analytical limit values, the engine condition, its operating condition and any operational faults are decisive factors with regard to oil changes.

Some of the signs of oil deterioration are:

- Abnormally heavy deposits or precipitates in the engine or engine-mounted parts such as oil filters, centrifugal oil filters or separators, especially in comparison with the previous analysis
- Abnormal discoloration of components

Analytical limit values for used diesel engine oils

Characteristics of the engine oil	Test method	Limit values	
Viscosity at 100 °C max. mm ² /s	ASTM D445 DIN 51562	SAE 30 SAE 5W-30 SAE 10W-30	15.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	19.0
SAE 30 SAE 5W-30 SAE 10W-30		9.0	
SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40		10.5	
min. mm ² /s			
Flashpoint °C (COC)	ASTM D92 DIN EN ISO 2592	Min. 190	
Flashpoint °C (PM)	ASTM D93 ISO 2719	min. 140	
Soot content (by weight %)	DIN 51452 CEC-L-82-A-97	Max. 3.0 (Oil category 1) Max. 3.5 (Oil category 2, 2.1, 3 and 3.1)	
Total base number (mg KOH/g)	ASTM D2896 ISO 3771 DIN 51639	Min. 50% of new-oil value	
Proportion of water (vol. %)	ASTM D6304 EN 12937 ISO 6296	max. 0.2	
Oxidation (A/cm) ¹⁾	DIN 51453 ¹⁾	Max. 25	
Ethylene glycol (mg/kg)	ASTM D2982	max. 100	

Table 2:

¹⁾ = only possible if there are no ester compounds

Use of high-sulfur diesel fuel

The following measures must be taken in the case of diesel fuels with a sulfur content above 0.5%:

- Use of an engine oil with a total base number (TBN) of more than 8 mgKOH/g
- Shorten oil draining intervals (see oil change intervals)
- Series 4000: TBO (Time Between Overhaul) for cylinder head: Shorten time between overhauls (→ Page 36)

Figure (→ Figure 2) shows the recommended minimum total base numbers for new and used oils depending on the sulfur content of the diesel fuel.

For the total base numbers (TBN) of the approved engine oil, see (→ Page 13).

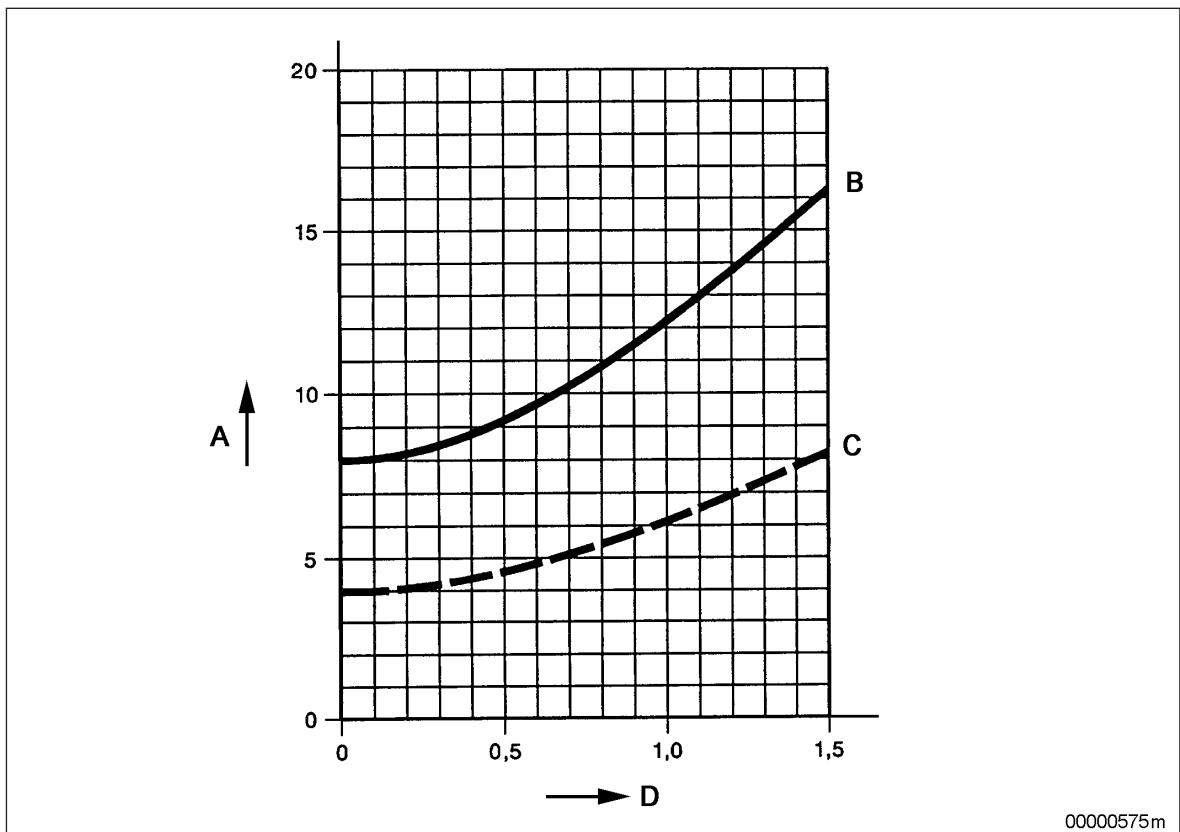


Figure 2: Engine oil Total Base Numbers depending on the Diesel Fuel's Sulfur Content

- | | |
|---|--|
| A Total base number in mgKOH/g, ISO 3771 | C Minimum total base number for used oil |
| B Recommended minimum total base number for fresh oil | D Sulfur content of fuel in % weight |

Use of low-sulfur diesel fuel

The use of diesel fuels with low sulfur content (< 0.5%) does not influence the oil drain intervals.

Minimum requirements for operational checks

Oil analyses can be carried out using the MTU Test Kit. The Test Kit contains all the equipment required as well as instructions for use.

The following checks can be performed:

- Determination of oil dispersing capacity (spot test)
- Determination of diesel fuel content in oil
- Determination of water content in oil

Test Package for North America

The MTU Advanced Fluid Management System is available in North America, which contributes to preventive maintenance through innovative diagnostics.

MTU Advanced Fluid Management System for engine oils, see (→ Page 16).

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TIM-ID: 0000060885 - 005

2.2 Series-based usability for engine oils

Series-based usability of engine oils in MTU oil categories

Series	Approved engine oils		
	MTU oil category 1	MTU oil category 2 and 2.1 (Low Saps)	MTU oil category 3 and 3.1 (Low Saps)
2000Gx5	<ul style="list-style-type: none"> • Single-grade oils (→ Page 67) • Multigrade oils (→ Page 69) 	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)
2000Gx6	Not approved	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)
4000Gx3, application groups 3B, 3D, 3E	<ul style="list-style-type: none"> • Single-grade oils (→ Page 67) • Multigrade oils (→ Page 69) 	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)
4000Gx3, application groups 3F, 3G	Not approved	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)
4000Gx4	<ul style="list-style-type: none"> • Single-grade oils (→ Page 67) • Multigrade oils (→ Page 69) 	<ul style="list-style-type: none"> • Single-grade oils (→ Page 70) • Multigrade oils (→ Page 73) • Multigrade oils (Low SAPS) (→ Page 82) 	<ul style="list-style-type: none"> • Multigrade oils (→ Page 85) • Multigrade oils (Low SAPS) (→ Page 90)

2.3 Fluorescent dyestuffs for detecting leaks in the lube oil circuit

The fluorescent dyestuffs listed below are approved for detection of leaks in the lube oil circuit.

Manufacturer	Product name	Concentration for use	Part No.	Container size	Storage stability ¹⁾
Chromatech Europe B.V.	D5 1000A Chromatint Fluorescent Yellow 175	0.04 % - 0.07 %	X00067084	16 kg	2 years
Cimcool, Cincinnati	Producto YFD-100	0.5 % - 1.0 %		5 gallons (canister) 55 gallons (barrel)	6 months

Table 3:

¹⁾ = ex works delivery, based on original and hermetically sealed containers in frost-free storage (> 5 °C).

The fluorescence (light-yellow color tone) of both dyestuffs is made visible with a UV lamp (365 nm).

2.4 Lubricating greases

Requirements

The MTU conditions for lubricating-grease approval are specified in the MTU Factory Standard MTL 5050, which can be ordered under this reference number.

Grease manufacturers are notified in writing if their product is approved by MTU.

Lubricating greases for general applications

Lithium-saponified greases are to be used for all lubrication points with the exception of:

- Emergency-air shutoff flaps fitted between turbocharger and charge-air cooler (see Special-purpose lubricants)
- Coupling internal centering

Lubricating greases for applications at high temperatures

High-temperature grease (up to 250 °C) must be used for emergency-air shutoff flaps located between turbocharger and intercooler:

- Aero Shell Grease 15
- Optimol Inertox Medium

General purpose greases suffice for emergency-air shutoff flaps located before the turbocharger or after the intercooler.

Greases for internal centerings of couplings

Greases for internal centerings:

- Esso Unirex N3 (stable up to approx. 160 °C)

Special-purpose lubricants

Oil for turbochargers

Exhaust turbochargers with integrated oil supply are generally connected to the engine oil system.

For ABB turbochargers which are not connected to the engine lube oil system, mineral-based turbine oils with viscosity grade ISO-VG 68 must be used.

Lubricating greases for curved tooth couplings

Depending on the application, the following lubricants have been approved for curved tooth couplings:

- - Klüber: Structovis BHD MF (highly viscous lubricating oil)
- - Klüber: Klüberplex GE11-680 (adhesive transmission lubricant)

Guidelines on use and service life are contained in the relevant Operating Instructions and Maintenance Schedules.

2.5 MTU Advanced Fluid Management System for engine oils – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following:

- Optimized oil change intervals
- Extended engine service life
- Detection of minor problems before they become major problems
- Maximization of diesel engine-generator set's reliability
- Higher resale value of diesel engine-generator set

For full information on the MTU Advanced Fluid Management System available in North America, please contact an authorized MTU Onsite Energy service partner.

The following test packages from MTU Advanced Fluid Management System can be ordered from authorized MTU Onsite Energy service partners in North America:

- BMP32
Extended test – monitoring of wear and contamination
- AMP51R
Extended Test Plus – extension of the oil change intervals

The following engine oil parameters can be determined:

Engine oil parameters	BMP32	AMP51R
24 elementary metals *	✓	✓
percent water *	✓	✓
Viscosity at 40 °C for ISO engine oils	✓	✓
Viscosity at 100 °C for SAE engine oils	✓	✓
Percent fuel dilution **	✓	✓
Percent soot **	✓	✓
Oxidation/nitration	-	✓
Total base number **	-	✓
Total acid number	-	✓

* Samples of non-engine oils submitted with Order No. BMP32, are only examined spectrometrically for metals and the proportion of water and viscosity are determined.

** Samples of non-engine oils submitted with Order No. AMP51R are not examined for fuel dilution, soot content and base number.

The MTU Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Samples must be taken:

- While the engine is operating under normal conditions or immediately after stopping the engine while the engine is still at operating temperature
- Every 250 hours at the same point
- By means of suction pump via dipstick tube or sampling cock in filter return

Note: The software offered by MTU for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The MTU Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

3 Coolants

3.1 Coolants – General information

Coolant

Definition

Coolant = coolant additive (concentrate) + fresh water to predefined mixing ratio
Ready for use in engine

The corrosion-inhibiting effect of coolant is only ensured with the coolant circuit fully filled.

Apart from that, only the corrosion inhibitors approved for internal preservation of the coolant circuit provide proper corrosion protection when the medium was drained. This means that after draining the coolant the cooling circuit must be preserved if no more coolant is to be filled. The procedure is described in the Preservation and Represervation Specifications for MTU Onsite Energy (publication number A001070/..).

Coolants must be prepared from suitable fresh water and an MTU-approved coolant additive. Conditioning of the coolant takes place outside the engine.

Important

Mixtures of various coolant additives and supplementary additives (also in coolant filters and filters downstream of plant components) are not permitted!

The conditions for the approval of coolant additives are specified in the following MTU works standards (MTL):

- MTL 5048: Corrosion inhibiting antifreeze
- MTL 5049: Water-soluble corrosion inhibitor

Coolant manufacturers are informed in writing if their product is approved by MTU.

To prevent cooling system damage:

- When topping up (following loss of coolant) it must be ensured that not only water but also concentrate is added. The specified antifreeze and/or corrosion inhibitor concentration must be maintained.
- Flushing with water is required at every change to a different coolant product. For flushing and cleaning specifications for engine coolant circuits, see (→ Page 117).
- The corrosion inhibitor concentration must not exceed 55 % by volume (max. antifreeze) corrosion inhibitor. Concentrations in excess of this reduce antifreeze protection and heat dissipation. Only exception: BASF G206 (special application)
- The coolant must not contain any oil or copper residue (in solid or dissolved form).
- The majority of corrosion inhibitors currently approved for internal coolant circuit preservation are water-soluble and do not provide antifreeze protection. Make sure that the engine is stored safe from frost, because a certain amount of coolant remains in the engine after draining.
- A coolant circuit can not usually be drained completely, i.e. residual quantities of used coolant or fresh water from a flushing procedure remain in the engine. These residual quantities can result in the dilution of a coolant to be filled (mixed from a concentrate or use of a ready mixture). This dilution effect is higher the more add-on components there are on the engine. Check the coolant concentration in the coolant circuit and adapt it if necessary.

Important

All coolants approved in these Fluids and Lubricants Specifications generally relate only to the coolant circuit of MTU engines. In the case of complete propulsion plants, the operating fluids approvals of the component manufacturer must be observed!

Important

For corrosion-related reasons, it is not permissible to operate an engine with pure water without the addition of an approved corrosion inhibitor!

Special features

MTU coolants

The following coolant additives are available from MTU:

Manufacturer & sales region	Product name	Type
MTU Friedrichshafen and MTU Asia Europe Middle East Africa Asia	Antifreeze	
	Coolant AH 100 Antifreeze Concentrate	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l)
	Coolant AH 50/50 Antifreeze Premix	X00070528 (20 l) X00070530 (210 l) X00700527 (1000 l) (sales region: England)
	Coolant AH 40/60 Antifreeze Premix	X00070533 (20 l) X00070531 (210 l) X00700532 (1000 l) (sales region: England, Spain)
	Coolant RM 30 Readmix Coolant 40/60	X00073922 (20 l) X00073916 (205 l) X00073923 (1000 l)
	Coolant AH 35/65 Antifreeze Premix	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant without antifreeze	
	Coolant CS 100 Corrosion Inhibitor Concentrate	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l)
	Coolant CS 10/90 Corrosion Inhibitor Premix	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)

Manufacturer & sales region	Product name	Type
MTU America America	Antifreeze	
	Power Cool [®] Off-Highway Coolant 50/50 Premix	23533531 (5 gallons) 23533532 (55 gallons)
	Power Cool [®] Universal 50/50 mix	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
	Power Cool [®] Universal 35/65 mix	800085 (5 gallons) 800086 (55 gallons)
	Power Cool [®] 3 149 Concentrate	23528572 (55 gallons) 23528571 (1000 l)
	Coolant without antifreeze	
	Power Cool [®] Plus 6000 Concentrate	23533526 (1 gallon) 23533527 (5 gallons) colored green

Note

For ready mixtures, the proportion of coolant additive (concentrate) is always named first.

Example:

- Coolant AH 40/60 Antifreeze Premix = 40 % coolant additive by volume / 60 % fresh water by volume

3.2 Operational monitoring

Inspection of the fresh water and continuous monitoring of the coolant are essential for trouble-free engine operation. Fresh water and coolant should be inspected at least once per year and with each fill-up. Inspections can be carried out using the MTU Test Kit which contains the necessary equipment, chemicals and instructions for use.

The following tests can be conducted with the MTU Test Kit:

- Determination of total hardness (°d)
- pH value
- Chloride content of fresh water
- Corrosion-inhibiting oil content
- Determination of antifreeze content
- Determination of the concentration of coolant without antifreeze

Orders for fresh water and coolant analysis may be placed with MTU. Samples of min. 0.25 l must be supplied.

Important information

In the 4000-04-05 Series, an additional exhaust gas cooler is installed and the cooling system reacts more sensitively. A regular check of the coolant is therefore very important to ensure trouble-free engine operation. This check must be carried out annually or after 3000 operating hours and every time the coolant is filled.

The concentration, pH value and silicon content (only with coolant that contain Si) must be within the values specified in the MTU Fluids and Lubricants Specifications.

Important information

Due to thermal stress of the coolant in plants with preheating, a semi-annual analysis of the coolant is recommended.

Permissible concentrations

	Minimum				Maximum
Emulsifiable corrosion inhibitor oils without antifreeze	1% by volume	-	-	-	2% by volume
Antifreeze on ethylene glycol basis	35% by volume	40% by volume	45% by volume	50% by volume	55% by volume
with antifreeze protection up to*	-20 °C	-25 °C	-31 °C	-37 °C	-45 °C
Antifreeze on propylene glycol-basis	35% by volume	-	-	-	50% by volume
with antifreeze protection up to*	-18 °C	-	-	-	-32 °C
BASF G206	65% by volume for application at outside temperatures of up to -65 °C in arctic regions				

Table 4:

* = antifreeze specifications determined as per ASTM D 1177

Operational monitoring for permissible concentrations, coolant without antifreeze

Permissible concentration range	Manufacturer	Brand name vol%	Reading on hand refractometer ¹ at 20 °C (= degrees Brix)					
			7	8	9	10	11	12
9 to 11% by volume	MTU Friedrichshafen	Coolant CS 100 Corrosion Inhibitor Concentrate	3.5	4.0	4.5	5.0	5.5	6.0
		Coolant CS 10/90 Corrosion Inhibitor Premix	3.5	4.0	4.5	5.0	5.5	6.0
	MTU America	Power Cool® Plus 6000	3.5	4.0	4.5	5.0	5.5	6.0
	Arteco	Freecor NBI	Please use test kit of manufacturer					
	BASF SE	Glysacorr G93 green	3.5	4.0	4.5	5.0	5.5	6.0
	BP Lubricants	Castrol Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Manufacturing IL Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	Chevron	Texcool A -200	Please use test kit of manufacturer					
	Detroit Diesel Corporation	Power Cool Plus 6000	4.9	5.6	6.3	7.0	7.7	8.4
	Drew Marine	Drewgard XTA	3.5	4.0	4.5	5.0	5.5	6.0
	ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	Ginouves	York 719	3.5	4.0	4.5	5.0	5.5	6.0
	Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	4.9	5.6	6.3	7.0	7.7	8.4
	Valvoline	Zerex G-93	3.5	4.0	4.5	5.0	5.5	6.0
7 to 11% by volume	Arteco	Havoline Extended Life Corrosion Inhibitor XLI [EU 32765]	2.6	3.0	3.4	3.7	4.1	4.4
	Nalco	Alfloc (Maxitreat) 3443	1.75	2.0	2.25	2.5	2.75	3.0
		Alfloc (Maxitreat) 3477	1.75	2.0	2.25	2.5	2.75	3.0
	PrixMax Australia Pty. Ltd.	PrixMax RCP	2.6	3.0	3.4	3.7	4.1	4.4
Total	WT Supra	2.6	3.0	3.4	3.7	4.1	4.4	
5 to 6% by volume	Fleetguard	DCA-4L	Please use test kit of manufacturer					
	Detroit Diesel Corporation	Power Cool 3000						
	Penray	Pencool 3000						

Permissible concentration range	Manufacturer	Brand name vol%	Reading on hand refractometer ¹⁾ at 20 °C (= degrees Brix)					
			7	8	9	10	11	12
3 to 4% by volume	Detroit Diesel Corporation	Power Cool 2000	Please use test kit of manufacturer					
	Nalco	Alfloc 2000						
		Nalco 2000						
		Nalcool 2000						
		Trac 102						
Penray	Pencool 2000							

Table 5:

¹⁾ = concentration determination by means of suitable hand refractometer

Calibrate the hand refractometer with clean water at coolant temperature. The coolant temperature should be 20 °C. Observe the specifications of the manufacturer.

Operational monitoring of permissible concentrations, antifreeze on ethylene glycol basis

The concentration is determined using a suitable glycol refractometer and direct reading of the scale value in % by vol.

Calibration table for antifreeze for special applications

Reading on hand refractometer at 20 °C (= degrees Brix)		Corresponds to a concentration of
I. Propylene glycol antifreeze	II. BASF G206	
26.3	24.8	35% by volume
26.9	25.5	36% by volume
27.5	26.1	37% by volume
28.2	26.7	38% by volume
28.8	27.4	39% by volume
29.5	28.0	40% by volume
30.1	28.6	41% by volume
30.8	29.2	42% by volume
31.3	29.8	43% by volume
31.9	30.4	44% by volume
32.5	30.9	45% by volume
33.1	31.5	46% by volume
33.7	32.1	47% by volume
34.2	32.6	48% by volume
34.8	33.2	49% by volume
35.3	33.8	50% by volume
	34.4	51% by volume

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Reading on hand refractometer at 20 °C (= degrees Brix)		Corresponds to a concentration of
I. Propylene glycol antifreeze	II. BASF G206	
	34.9	52% by volume
	35.5	53% by volume
	36.1	54% by volume
	36.7	55% by volume
	37.2	56% by volume
	37.8	57% by volume
	38.3	58% by volume
	38.9	59% by volume
	39.4	60% by volume
	39.9	61% by volume
	40.5	62% by volume
	41.0	63% by volume
	41.5	64% by volume
	42.0	65% by volume

Table 6:

3.3 Series-based usability of coolant additives

All details are based on the coolant circuit on the engine side, no allowance is made for external add-on components.

Important

In the case of an engine coolant circuit with no light metal elements but with external add-on components containing light metal (e.g. cooling system or preheater), the coolant approvals for cooling systems containing light metal shall apply. If you have any doubts about a coolant application, consult your contact person at MTU.

For details and special information, see section “Coolants” (→ Page 17)

Any deviating special agreements between the customer and MTU-Friedrichshafen shall remain valid.

Series	Cooling system containing light metals	Coolant without antifreeze
2000Gx5 2000Gx6	Yes	<ul style="list-style-type: none"> • Concentrates for cooling systems containing light metal, see (→ Page 96) • Ready mixtures for cooling systems containing light metal, see (→ Page 98)
4000Gx3 4000Gx4	No *	<ul style="list-style-type: none"> • Concentrates for cooling systems containing light metal, see (→ Page 99) • Ready mixtures for cooling systems containing light metal, see (→ Page 101)

Series	Cooling system containing light metals	Antifreeze	
2000Gx5 2000Gx6	Yes	<ul style="list-style-type: none"> • Concentrates for cooling systems containing light metal, see (→ Page 102) • Concentrates for special applications, see (→ Page 105) • Ready mixtures for cooling systems containing light metal, see (→ Page 106) 	<ul style="list-style-type: none"> • Concentrates based on ethylene glycol (suitable for series with and without light metal), see (→ Page 115)
4000Gx3 4000Gx4	No *	<ul style="list-style-type: none"> • Concentrates for cooling systems containing light metal, see (→ Page 108) • Concentrates for special applications, see (→ Page 111) • Ready mixtures for cooling systems containing light metal, see (→ Page 112) 	<ul style="list-style-type: none"> • Ready mixture based on propylene glycol for series free of light metal, see (→ Page 116)

* In the case of an engine coolant circuit with no light metal elements but with external add-on components containing light metal (e.g. cooling system or preheater), the coolant approvals for cooling systems containing light metal shall apply.

3.4 Unsuitable materials in the coolant circuit

Components made of copper, zinc and brass materials

Unless various preconditions are observed, components made of copper, zinc and brass materials in the coolant circuit can cause an electrochemical reaction in conjunction with base metals (e.g. aluminum). As a result, components made of base metals are subject to corrosion or even corrosive pitting. The coolant circuit becomes leaky at these points.

Requirements

Based on current knowledge, the following materials and coatings must not be used in an engine coolant circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- No galvanized surfaces
The entire cooling system must be free of zinc components. This also applies to coolant supply and drain lines as well as to storage containers.
- No copper-based alloys as material with the use of coolant containing nitrite, with the exception of the following two alloys:
 - CuNi10Fe1Mn corresponds to CW-352-H
 - CuNi30Mn1Fe corresponds to CW-354-H
- Do not use components containing brass in the coolant circuit (e.g. coolers made of CuZn30) if exposed to ammoniacal solutions (e.g. amines, ammonium, ...) and solutions containing nitrite or sulfide. Stress-corrosion cracking is possible in the presence of tensile stress and a critical potential area. "Solutions" refer to cleaning agents, coolants and similar substances.

Non-metallic materials

- Do not use EPDM or silicone elastomers if emulsifiable corrosion inhibitor oils are used or other oils are introduced to the coolant circuit.

Coolant filter / filter downstream of plant components

- If such filters are used, only products that do not contain additives may be used.
Supplementary additives such as silicates, nitrites etc. can diminish the protective effect or service life of a coolant and, possibly, attack the materials installed in the coolant circuit.

Information:

In case of doubt about the use of materials on the engine and add-on components / components in coolant circuits, consultation with the respective MTU specialist department must be held.

3.5 Fresh water requirements

For preparation of coolant without antifreeze protection

Only clean, clear water with values in accordance with those in the following table must be used for preparing the coolant. If the limit values for the water are exceeded, de-mineralized water can be added to reduce the hardness or mineral content.

Parameters	Minimum	Maximum
Sum of alkaline earth metals *) (Water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH value at 20 °C	5.5	8,0
Chloride ions		100 mg/l
Sulphate ions		100 mg/l
Anions total		200 mg/l
Bacteria		10 ³ CFU (colony forming unit)/ml
Fungi, yeasts	are not permitted!	

*) Common designations for water hardness in various countries:

1 mmol/l = 5.6°d = 100 mg/kg CaCO₃

- 1°d = 17.9 mg/kg CaCO₃, USA hardness
- 1°d = 1.79° French hardness
- 1°d = 1.25° English hardness

3.6 Antifreeze

The preceding MTU Fluids and Lubricants Specifications used the designation "Corrosion inhibiting anti-freeze". This designation will be replaced with immediate effect to "Antifreeze".

Antifreezes are necessary for engines without heating facilities and operating in areas where below-freezing temperatures may occur.

Most of the antifreezes approved at MTU are based on ethylene glycol.

Exceptions:

- Ready mixture Fleetguard PG XL based on propylene glycol (→ Page 116)
- Concentrate BASF G206 as a mixture of ethylene glycol and propylene glycol

Provided that they are used in approved concentrations, antifreezes approved by MTU provide effective protection against corrosion, see section "Operational monitoring" (→ Page 20).

The antifreeze concentration must be determined not only in accordance with the minimum anticipated temperatures but also with the corrosion protection requirements.

Important

For the coolant additives approved for the individual series, see (→ Page 24).

Special approvals presently in effect remain valid.

Important

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Note:

- Propylene glycol-based antifreezes are stipulated for use in some types of applications. These products have a lower thermal conductivity than the usual ethylene glycol products. This brings about a higher temperature level in the engine.
- The product BASF G206 is available for use at extremely low temperatures (< -40 °C).
- Flushing with water is required at every change to a different coolant product. For flushing and cleaning specifications for engine coolant circuits, see (→ Page 117).

3.7 Coolant without antifreeze

The preceding MTU Fluids and Lubricants Specifications used the designation "water-soluble corrosion inhibiting antifreeze". This designation will be replaced with immediate effect with "coolant without antifreeze".

Engine coolant without antifreeze is required in the case of higher coolant temperatures or larger temperature gradients in heat exchangers, e.g. in TB systems (with plate-core heat exchanger) and TE systems.

Provided that they are used in adequate concentration, coolants without antifreeze approved by MTU provide effective corrosion protection. The relevant concentration range for use is listed in the section on operational monitoring.

Important

For approved coolant additives for the individual engine series, refer to section "Approved coolants" (→ Page 24).

Special arrangements presently in effect remain valid.

Important

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Flushing with water is required at every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant if the engines were preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the section "Flushing and cleaning specifications for engine coolant circuits" (→ Page 117).

3.8 Emulsifiable corrosion-inhibiting oils

Emulsifiable corrosion-inhibiting oils must not be used with the following Series:

- Series 2000
- Series 4000

Special approval presently in effect remain valid.

3.9 Limit values for coolants

pH value when using:		
- Emulsifiable corrosion inhibiting oil	Min. 7.5	Max. 9.5
- Antifreeze	Min. 7.5	Max. 9.0
- Coolant without antifreeze for engines containing light metal	Min. 7.5	Max. 9.0
- Coolant without antifreeze for engines free of light metal	Min. 7.5	Max. 11.0
Silicon (valid for coolants containing Si)	Min. 25 mg/l	

Table 7:

The coolant must be changed in case of non-compliance with the above specifications.

Note:

For a holistic appraisal of a coolant function, apart from the above-mentioned limit values the respective coolant-specific characteristic data and the fresh water quality used must be taken into consideration.

3.10 Storage capability of coolant concentrates

The storage capability specifications refer to coolant concentrates in original, hermetically sealed packing with storage temperatures up to max. 30 °C.

The instructions of the manufacturer must also be observed.

Coolant concentrate	Limit value	Brand name / Comments
Emulsifiable corrosion-inhibiting oil	6 months	
Antifreeze	Approx. 3 years	Observe manufacturer's specifications
Products containing propylene glycol	3 years	BASF G206
Coolant without antifreeze	6 months	Nalco Trac 102
	1 year	Detroit Diesel Corp. Power Cool 3000 Penray Pencool 3000
	2 years	Arteco Freecor NBI Chevron Texcool A-200 – Nalco Alfloc 2000 Nalco Nalcool 2000 Nalco Nalco 2000 Detroit Diesel Corp. Power Cool 2000 Penray Pencool 2000 PrixMax RCP
	3 years	BASF Glyscorr G93 green Drew Marine Drewgard XTA Ginouves York 719 MTU Friedrichshafen Coolant C150 MTU America Power Cool® Plus 6000 Nalco Alfloc (Maxitreat) 3477 Valvoline ZEREX G-93
	5 years	Arteco Havoline Extended Life Corrosion Inhibitor XLI [EU 032765] BP Castrol Extended Life Corrosion Inhibitor CCI Corporation A216 CCI Manufacturing IL A216 Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free [US 236514] Detroit Diesel Corp. Power Cool Plus 6000 ExxonMobil Mobil Delvac Extended Life Corrosion Inhibitor Fleetguard DCA-4L Old World Industries Final Charge Extended Life Corrosion Inhibitor (A216) Total WT Supra

Table 8:

Note:

For reasons of corrosion protection, do not store in galvanized bins. Take this requirement into account when coolant must be transferred.

Containers must be hermetically sealed and stored in a cool, dry place. Frost protection must be provided in winter.

Further information can be obtained from the product and safety data sheets for the individual coolants.

3.11 Color additives for detection of leaks in the coolant circuit

The following listed fluorescent dyes are approved as additives for coolant without antifreeze for the detection of leaks.

Manufacturer	Product name	Part No.	Container size	Storage stability ¹⁾
Chromatech Inc. Chromatech Europe B.V.	D11014 Chromatint Uranine Conc	X00066947	20 kg	2 years

Table 9: Approved dye additives

¹⁾ = based on original and hermetically sealed containers in frost-free storage (> 5 °C)

Application:

Approx. 40 g dye must be added to 180 l coolant.

This dye quantity is already very generous and must not be exceeded.

The fluorescence (yellow color tone) is easily recognizable in daylight. In dark rooms, UV light can be used with a wave length of 365 nm.

3.12 MTU Advanced Fluid Management System for coolant – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following:

- Optimization of the coolant change intervals
- Evaluation of metal migration
- Evaluation of the coolant's corrosive properties
- Detection of the causes of problems in the cooling system in connection with blown cylinder-head gaskets, electrical ground problems, localized overheating and contaminants within and outside the system

For full information on the MTU Advanced Fluid Management System available in North America, please contact an authorized MTU Onsite Energy service partner.

The following test packages from MTU advanced Fluid Management System can be ordered from authorized MTU Onsite Energy service partners in North America:

- C-P92
Basic test – For monitoring the corrosivity of the coolant and for detecting metal migration
- C-P94
Extended test – Identification of the causes of leaks in the combustion system, grounding problems and contamination in the plant
- C-P93
Extended Test Plus – Monitoring of corrosivity and metal migration plus HPLC analysis and IC analysis for confirmation of the determined contamination of the corrosion inhibitor

The following coolant parameters can be determined:

Coolant parameters	C-P92	C-P94	C-P93
15 elementary metals	✓	✓	✓
Glycol percentage	✓	✓	✓
Freezing point	✓	✓	✓
Boiling point	✓	✓	✓
pH value	✓	✓	✓
Total hardness	✓	✓	✓
SCA number	✓	✓	✓
Nitrite	✓	✓	✓
Specific conductivity	✓	✓	✓
Carboxylic acid	✓	✓	✓
Sensory parameters (color, oil, fuel, magnetic precipitation, amagnetic precipitation, odor and foam)	✓	✓	✓
Contamination and corrosion inhibitor through IC (chloride, sulfate, nitrite, nitrate, phosphate and glycolate)	-	✓	✓
HPLC	-	-	✓

The MTU Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Samples must be taken:

- While the engine is operating under normal conditions or immediately after stopping the engine while the engine is still at operating temperature
- Every 250 hours at the same point

Note: The software offered by MTU for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The MTU Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

4 Liquid Fuels

4.1 Diesel fuels – General information

Important
 Dispose of used fluids and lubricants in accordance with local regulations.
 Used oil must never be disposed of via the combustion engine!

Selection of a suitable diesel fuel

The quality of the fuel is very important for satisfactory engine performance, long engine service life and acceptable exhaust emission levels.

Important
 Diesel fuels are not available worldwide in the quality required according to (→ Table 10).
 The fuel properties depend on many factors, in particular, region, time of year and storage.

Unsuitable fuel usually leads to a reduced service life of engine components and can also cause engine damage.

Further details on fuel qualities, tank care and filtration are available in the publication "Useful information on fuels, tank systems and filtration" (publication number A060631/..).

Characteristics of the fuel		Test method		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorine compounds.
Total contamination (= elements insoluble in fuel)	max.	D6217	EN 12662	24 mg/kg
Density at 15 °C	min.	D1298	EN ISO 3675	0.820 g/ml
	max.	D4052	EN ISO 12185	0.860 g/ml
API gravity at 60 °F	min.	D287		41
	max.			33
Viscosity at 40 °C	min.	D445	EN ISO 3104	1.5 mm ² /s
	max.			4.5 mm ² /s
Flashpoint (closed crucible)	min.	D93	EN ISO 2719	55 °C
Boiling curve:		D86	EN ISO 3405	
- Initial boiling point				160 to 220 °C
- Volume share at 250 °C	max.			65% by volume
Recovery at 350 °C	min.			85% by volume
- Residue and loss	max.			3% by volume

¹⁾ Filter plugging point or Cold Filter Plugging Point (CFPP) denotes the temperature at which a test filter is blocked under defined conditions by precipitated paraffins. This characteristic is used for diesel fuels as per DIN EN 590 to describe the climatic requirements (e.g. summer and winter diesel).
²⁾ The cloud point is the temperature at which a liquid product becomes turbid in the test glass due to precipitation of paraffin. This must not be higher than the ambient temperature.
 Note: 1% by weight = 10000 mg/kg = 10000 ppm

Characteristics of the fuel		Test method		Limit values
		ASTM		
Fatty acid methyl ester content (FAME) ("Biodiesel")	max.		EN 14078 Internal MTU procedure	7.0% by volume
Proportion of water: (absolute, no free water)	max.	D6304	EN ISO 12937	200 mg/kg
Carbon residue from 10% distillation residue	max.	D189	EN ISO 10370	0.30% by weight
Oxide ash:	max.	D482	EN ISO 6245	0.01% by weight (100 mg/kg)
Sulfur content: 2000Gx5, 4000Gx3, 4000Gx4	max.	D5453, D2622	EN ISO 20846, EN ISO 20884	0.5% by weight (5000 mg/kg)
Sulfur content: 2000Gx6				0.05% by weight (500 mg/kg)
Cetane number	min.	D613	EN ISO 5165, EN ISO 15195	45
Cetane index	min.	D976	EN ISO 4264	42
Copper corrosion 3 hrs at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1 a
Oxidation stability(Rancimat)	min.		EN 15751	20 hours
Oxidation stability	max.	D2274	EN ISO 12205	25 g/m ³
Lubricity at 60 °C (HFRR value)	max.	D6079	EN ISO 12156-1	520 µm
Filter plugging point (CFPP)		D6371	DIN EN 116	See ¹
Cloud Point		D2500	DIN EN 23015	See ²
Neutralization number	max.	D974		0.2 mg KOH/g

¹⁾ Filter plugging point or Cold Filter Plugging Point (CFPP) denotes the temperature at which a test filter is blocked under defined conditions by precipitated paraffins. This characteristic is used for diesel fuels as per DIN EN 590 to describe the climatic requirements (e.g. summer and winter diesel).

²⁾ The cloud point is the temperature at which a liquid product becomes turbid in the test glass due to precipitation of paraffin. This must not be higher than the ambient temperature.

Note: 1% by weight = 10000 mg/kg = 10000 ppm

Table 10:

The fuel supplier must ensure that the fuel can still be used at extremely low temperatures and correct engine operation can be guaranteed. Extremely low temperatures must be noted, which can be expected under the given geographical and other local conditions.

The operator must ensure that fuel necessary for the corresponding climatic requirements is used.

Note:

The engines are certified for operation with the fuels approved in the MTU Fluids and Lubricants Specifications.

The component TBO specified in the maintenance schedule relates to operation of the engine with diesel fuel as per DIN EN 590.

For operation with a high sulfur content in the fuel, the following must be observed:

Series 4000

When a fuel with sulfur content > 1500 mg/kg is used, the times specified in the maintenance schedule for component TBO of the cylinder head may be reduced, see following table (→ Page 38)

TBO cylinder head as a function of sulfur content in the fuel

Sulfur content in fuel (mg/kg)	TBO cylinder head (h)
<1500	According to maintenance schedule
1500 to 3000	12000 ¹⁾
3000 to 4000	7000 ¹⁾
4000 to 5000	5000 ¹⁾

Table 11:

¹⁾= If the TBO cylinder head specified in the maintenance schedule is shorter, the shorter TBO shall always apply.

Important

If the sulfur content in the fuel is > 0.5% by weight (> 5000 ppm), please consult with the MTU-Friedrichshafen (application engineering).

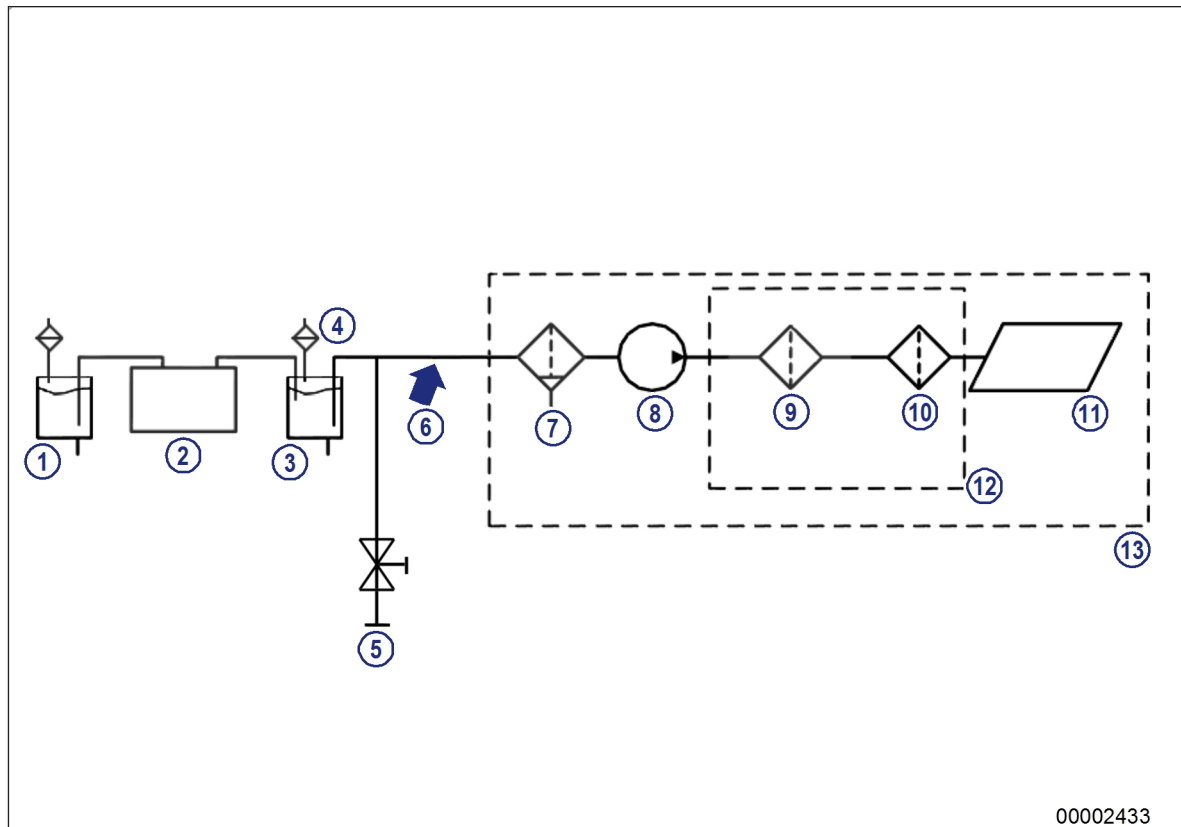


Figure 3: Fuel system

- | | | |
|------------------------------|--|---------------------|
| 1 Fuel tank | 6 Interface for fuel specification | 11 Injection system |
| 2 Fuel conditioning (option) | 7 Fuel prefilter with water separator (option) | 12 Engine filter |
| 3 Last tank before engine | 8 Fuel low-pressure pump | 13 Engine scope |
| 4 Tank ventilation filter | 9 Intermediate filter (option) | |
| 5 Sample extraction | 10 Main filter | |

Note:

The limit values named in the table (→ Table 10) must be observed at the interface [(→ Figure 3), item 6] at the latest to guarantee safe and efficient engine operation. This applies in particular to water and total contamination.

Important
In addition to the limit values listed in the table (→ Table 10), a particle distribution in the fuel in acc. with ISO 4406 must be observed, see (→ Table 12).

Particle distribution for fuels

Particle distribution	Test method ASTM		Limit values	
			Series 2000 Gx6, Series 4000 Gx3, Series 4000 Gx4	Series 2000 Gx5
Particle distribution for fuel between last tank before engine and prefilter [(→ Figure 3), item 6]	D7619 D7647	Coding of number of particles as per ISO 4406	max. ISO Code 18/17/14 for 4/6/14 µm particle size	max. ISO Code 21/20/17 for 4/6/14 µm particle size

Table 12:

Important
The limit values named in the table (→ Table 12) must already be observed in the feed between the last tank before the engine and the prefilter (if necessary, with water separator).

For plants without a prefilter, this refers to the feed between the last tank and the MTU equipment. For the analysis of the fuel quality, an interface (sample extraction cock) must be provided for sample extraction during operation.

For existing plants without an accessible feed, a sample extraction point in the last tank before the MTU equipment is permissible.

Note:

With poorer particle distribution, it is necessary to integrate further / more-optimized filter stages in the fuel system to achieve the operational life of fuel filters and components of the injection system.

For the limit values named for the interface, it has been validated that MTU-approved prefilters provide sufficient filtration.

MTU Friedrichshafen GmbH shall not provide warranty cover for damage and impairment to engine caused by the following usage:

- Fuel grades not approved by MTU (see (→ Table 10), (→ Table 12), (→ Page 41))
- Prefilters not approved by MTU

Laboratory analysis

An order for fuel analysis can be placed with MTU.

The following data is required:

- Fuel specifications
- Sampling point
- Serial number of engine from which fuel sample was taken

Submit the following:

- 0.5 liters of fuel
- 1.5 liters of fuel (with additional determination of cetane number)

Test Package for North America

The MTU Advanced Fluid Management System is available in North America, which contributes to preventive maintenance through innovative diagnostics.

MTU Advanced Fluid Management System for fuels, see (→ Page 65).

4.2 Series-dependent approval of fuel grades for MTU engines

4.2.1 Distillate fuels according to DIN EN 590 and ASTM D975

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
DIN EN 590: 2014-4 <ul style="list-style-type: none"> • Summer and winter quality • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Approved
ASTM D975-16 <ul style="list-style-type: none"> • Grade 1-D • S 15, S 500, S 5000 • Density: 0.820 to 0.860 g/ml • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity min. 1.5 mm²/s • Cetane number min. 45 or centane index min. 42 • Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> • Viscosity min. 1.5 mm²/s • Cetane number min. 45 or centane index min. 42 • Sulfur content max. 500 mg/kg
ASTM D975-16 <ul style="list-style-type: none"> • Grade 2-D • S 15, S 500, S 5000 • Density: 0.820 to 0.860 g/ml • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Sulfur content max. 500 mg/kg

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
DIN EN 590: 2014-4 <ul style="list-style-type: none"> • Summer and winter quality • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Approved
ASTM D975-16 <ul style="list-style-type: none"> • Grade 1-D • S 15, S 500, S 5000 • Density: 0.820 to 0.860 g/ml • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity min. 1.5 mm²/s • Cetane number min. 45 or centane index min. 42 	Approval issued if: <ul style="list-style-type: none"> • Viscosity min. 1.5 mm²/s • Cetane number min. 45 or centane index min. 42
ASTM D975-16 <ul style="list-style-type: none"> • Grade 2-D • S 15, S 500, S 5000 • Density: 0.820 to 0.860 g/ml • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 	Approval issued if: <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42

4.2.2 British Standard 2869

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
BS 2869:2010 <ul style="list-style-type: none"> Part 1 Class A2 Density: max. 860 kg/m³ Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
BS 2869:2010 <ul style="list-style-type: none"> Part 2 Class D Density: max. 860 kg/m³ Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
BS 2869:2010 <ul style="list-style-type: none"> Part 1 Class A2 Density: max. 860 kg/m³ Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
BS 2869:2010 <ul style="list-style-type: none"> Part 2 Class D Density: max. 860 kg/m³ Viscosity: max. 4.5 mm²/s. If viscosity min. 4.5 mm²/s: Preheating required Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved

4.2.3 Chinese distillate fuels as per GB 19147-2013

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
GB 19147-2013 <ul style="list-style-type: none"> • Grade 0 • III: S max. 350 mg/kg • IV: S max. 50 mg/kg • V: S max. 10 mg/kg • Density: 0.820 to 0.860 g/ml* * deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power re-adjustment, it is possible that the engine operational values change • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) • Neutralization number: Max 0.2 mgKOH/g • Viscosity at 40 °C: 1.5 to 4.5 mm²/s 	Approved	Approved
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
GB 19147-2013 <ul style="list-style-type: none"> • Grade 0 • III: S max. 350 mg/kg • IV: S max. 50 mg/kg • V: S max. 10 mg/kg • Density: 0.820 to 0.860 g/ml* * deviating values: Approval possible project-specifically. If the density is too low, this can result in a power reduction. In the framework of power re-adjustment, it is possible that the engine operational values change • Proportion of water: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) • Neutralization number: Max 0.2 mgKOH/g • Viscosity at 40 °C: 1.5 to 4.5 mm²/s 	Approved	Not approved

4.2.4 Heating oil

Commercially available diesel fuels meeting the following specifications are approved for use:

Heating oil

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
DIN 51603-1:2011-09, heating oil EL Standard <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Lubricity max. 520 μm • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (\rightarrow Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Density at 15 °C min. 0.820 g/ml • Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> • Sulfur content max. 500 mg/kg
DIN 51603-1:2011-09, heating oil EL low-sulfur <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Lubricity max. 520 μm • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (\rightarrow Page 36) 	Approved	Approved
DIN 51603-6:2011-09, heating oil EL alternative	Not approved	Not approved
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
DIN 51603-1:2011-09, heating oil EL Standard <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Lubricity max. 520 μm • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (\rightarrow Page 36) 	Approved	Not approved
DIN 51603-1:2011-09, heating oil EL low-sulfur <ul style="list-style-type: none"> • Cetane number min. 45 or centane index min. 42 • Lubricity max. 520 μm • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (\rightarrow Page 36) 	Approved	Not approved
DIN 51603-6:2011-09, heating oil EL alternative	Not approved	Not approved

4.2.5 Marine distillate fuels in accordance with ISO 8217:2013-12

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
DMX <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
DMZ <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
DMA <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
DMB	Not approved	Not approved
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
DMX <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity > 4.5 mm²/s: Preheating required 	Not approved
DMZ <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity 1.5 to 4.5 mm²/s • Outside the limit range between 1.5 and 4.5 mm²/s: Approval following co-ordination with MTU possible • Density 0.820 to 0.870 g/ml • Cetane number min. 45 or cetane index min. 42 	Not approved

TIM-ID: 0000080026 - 001

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
DMA <ul style="list-style-type: none"> • Proportion of water: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> • Viscosity 1.5 to 4.5 mm²/s • Outside the limit range between 1.5 and 4.5 mm²/s: Approval following co-ordination with MTU possible • Density 0.820 to 0.870 g/ml • Cetane number min. 45 or centane index min. 42 	Not approved
DMB	Not approved	Not approved

4.2.6 Aviation turbine fuels

Commercially available diesel fuels meeting the following specifications are approved for use:

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
F-34 / F-35 • JP-8	Generally not approved, approval upon request	Generally not approved, approval upon request
F-44 • JP-5	Generally not approved, approval upon request	Generally not approved, approval upon request
F-63 • In accordance with DCSEA 108/A	Generally not approved, approval upon request	Generally not approved, approval upon request

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
F-34 / F-35 • JP-8	Generally not approved, approval upon request	Generally not approved, approval upon request
F-44 • JP-5	Generally not approved, approval upon request	Generally not approved, approval upon request
F-63 • In accordance with DCSEA 108/A	Approved	Generally not approved, approval upon request

4.2.7 NATO diesel fuels

Commercially available diesel fuels meeting the following specifications are approved for use:

Diesel fuel NATO Code F-54

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
NATO Code F-54 in accordance with TL 9140-0001 Edition 8 <ul style="list-style-type: none"> Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 Total contamination: Max. 24 mg/kg Lubricity: Max. 520 µm Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> Sulfur content max. 500 mg/kg
NATO Code F-54 in accordance with STANAG 7090 Edition 4 <ul style="list-style-type: none"> Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 Density: min. 0.820 g/ml Total contamination: Max. 24 mg/kg Lubricity: Max. 520 µm Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> Sulfur content max. 500 mg/kg 	Approval issued if: <ul style="list-style-type: none"> Sulfur content max. 500 mg/kg

Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
NATO Code F-54 in accordance with TL 9140-0001 Edition 8 <ul style="list-style-type: none"> Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 Total contamination: Max. 24 mg/kg Lubricity: Max. 520 µm Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
NATO Code F-54 in accordance with STANAG 7090 Edition 4 <ul style="list-style-type: none"> Approval if fuel corresponds to diesel fuel DIN EN 590:2014-04 Density: min. 0.820 g/ml Total contamination: Max. 24 mg/kg Lubricity: Max. 520 µm Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved

Diesel fuel NATO Code F-75

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
NATO-Code F-75 in accordance with TL 9140-0003 <ul style="list-style-type: none"> Reduced power possible due to min. density of 0.815 g/ml Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
NATO-Code F-75 in accordance with STANAG 1385 <ul style="list-style-type: none"> Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml max. sulfur content 1.0 % Adapt oil and oil change interval Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Not approved	Not approved
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
NATO-Code F-75 in accordance with TL 9140-0003 <ul style="list-style-type: none"> Reduced power possible due to min. density of 0.815 g/ml Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
NATO-Code F-75 in accordance with STANAG 1385 <ul style="list-style-type: none"> Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml max. sulfur content 1.0 % Adapt oil and oil change interval Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> Cetane number min. 45 or cetane index min. 42 	Not approved

Diesel fuel NATO Code F-76

Approved fuels Fuel specifications	Series 2000	
	2000Gx5	2000Gx6
NATO Code F-76 in accordance with STANAG 1385 Edition 6 <ul style="list-style-type: none"> Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Generally not approved, approval upon request	Generally not approved, approval upon request
NATO-Code F-76 in accordance with DEF-STAN 91-4 Issue 8 <ul style="list-style-type: none"> Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Generally not approved, approval upon request	Generally not approved, approval upon request
NATO-Code F-76 in accordance with MIL-DTL-16884N <ul style="list-style-type: none"> Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Generally not approved, approval upon request	Generally not approved, approval upon request
Approved fuels Fuel specifications	Series 4000	
	4000Gx3	4000Gx4
NATO Code F-76 in accordance with STANAG 1385 Edition 6 <ul style="list-style-type: none"> Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> Cetane number min. 45 or centane index min. 42 	Not approved
NATO-Code F-76 in accordance with DEF-STAN 91-4 Issue 8 <ul style="list-style-type: none"> Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approved	Not approved
NATO-Code F-76 in accordance with MIL-DTL-16884N <ul style="list-style-type: none"> Proportion of water: Max. 200 mg/kg Total contamination: Max. 24 mg/kg Particle distribution in accordance with table "Particle distribution for fuel", see chapter (→ Page 36) 	Approval issued if: <ul style="list-style-type: none"> Cetane number min. 45 or centane index min. 42 	Not approved

4.2.8 Paraffinic diesel fuel according to DIN EN 15940

Selected paraffinic diesel fuels according to DIN EN 15940 are currently in the qualification phase.

Important information

Project-specific approval from MTU-Friedrichshafen GmbH is possible upon request.

4.2.9 B20 diesel fuel

B20 diesel fuel is a diesel fuel with a biodiesel share of 20%.

Important information

Project-specific approval from MTU-Friedrichshafen GmbH is possible upon request.

The following section provides additional information on B20 diesel fuel.

Use of B20 diesel fuels

Biodiesel mixtures consist of fuels which are obtained from biological raw materials and mixed with conventional diesel fuel. For instance, B20 denotes a mixture comprising 20% biodiesel and 80% fuel based on crude oil/mineral oil. MTU engines were not specially designed to be operated with biodiesel mixtures. For this reason, the use of biodiesel mixtures may have negative effects in terms of engine power, service and maintenance requirements, emissions and service life.

Operators of MTU engines therefore need to be clear about the effects that biodiesel may have on their engines, and must take all of the necessary measures to ensure the reliability and safety of their engines. This letter provides MTU customers with important information on the use of biodiesel mixtures in MTU engines, and explains the potential impact these fuels may have on the MTU warranty. Please read this information carefully before using biodiesel mixtures in MTU engines.

1. Regarding the use of approved biodiesel mixtures

At present, only biodiesel mixtures with up to 7% biodiesel (in accordance with DIN EN 590) or 5% biodiesel (in accordance with ASTM D 975) are approved for use in the MTU Fluids and Lubricants Specifications.

Although biodiesel mixtures with up to 20% biodiesel (B20) are not yet approved in the MTU Fluids and Lubricants Specifications at present, they can be used in the engines listed below in section 6, AS LONG AS the following requirements are met:

- The biodiesel complies with DIN EN 14214 or ASTM D 6751.
- The B20 fuel grade corresponds with DIN EN 16709.
- The distilled diesel fuel added to the biodiesel is approved in the latest version of the MTU Fluids and Lubricants Specifications.
- The operator complies with the operating requirements given in section 2 and the additional maintenance recommendations from section 5.

Important information

The provisions with regard to requirements placed on fuel may differ depending on legislation and application of the engine. The operator is responsible for ensuring that only fuels which comply with the applicable provisions are used in the engines.

2. Operating requirements for the use of B20

The following operating requirements must be met when biodiesel mixtures are used in MTU engines:

- a For engines used in emergency generators, an additive must be used to improve the oxidation stability of the biodiesel.
- b All engines used in fire pumps, fire-extinguishing equipment or police equipment must be thoroughly rinsed with pure, high-quality distilled diesel fuel which complies with the MTU Fluids and Lubricants Specifications each time they are operated with a biodiesel mixture. Furthermore, an additive must be used in these engines to improve the oxidation stability of the biodiesel.
- c All engines which are only used seasonally or which are not operated for extended periods between uses must be thoroughly rinsed with pure, high-quality distilled diesel fuel which complies with the MTU Fluids and Lubricants Specifications before they are decommissioned.
- d Biodiesel mixtures cannot be used in engines equipped with an exhaust gas after-treatment system (e.g. catalytic converters, particle filters (DPF) and/or systems for reducing NO_x emissions, e.g. SCR systems).

3. Impact on the MTU warranty

The manufacturer shall not be responsible for breakdowns which can be attributed to the use of fuels not approved in the MTU Fluids and Lubricants Specifications and such breakdowns shall therefore not be covered by the MTU warranty. MTU shall reject all warranty claims connected to the use of biodiesel mixtures with a biodiesel content of more than 7% (in accordance with DIN EN 590) or 5% (in accordance with ASTM D 975) if the operator is unable to prove that the operating requirements and recommendations contained in this letter were met and strictly followed. Regardless of this, MTU shall on no account be liable for providing compensation for costs arising from the effects described below in section 4.

Important information

All properties guaranteed by MTU in terms of engine power and/or availability in operation only apply to the cases in which fuels approved by MTU are used and the engine demonstrates no defects or damage arising from operation with fuels not approved in the MTU Fluids and Lubricants Specifications.

4. Effects of biodiesel on engines/exclusion of liability

The biodiesel contained in biodiesel mixtures is a natural product and therefore undergoes natural aging processes. These may have a negative effect on the engines in which the biodiesel mixtures are used. The effects that biodiesel may have on engines are explained below.

Important: THESE EFFECTS ARE NOT FAULTS CAUSED BY THE ENGINE MANUFACTURER. THEY ARE THEREFORE EXCLUDED FROM THE MTU WARRANTY. MTU SHALL NOT ASSUME ANY LIABILITY FOR COSTS ARISING FROM THE EFFECTS DESCRIBED BELOW.

- The formation of deposits may cause components to become "sticky", which potentially restricts their movement. On engines with long downtimes, this can result in a situation where the engine can no longer be started. This is why additives for improving the oxidation stability of the biodiesel must be employed when biodiesel mixtures are used in emergency generators. MTU SHALL ACCEPT NO LIABILITY IN THE EVENT THAT THE ENGINE IN AN EMERGENCY GENERATOR CAN NOT BE STARTED AS A RESULT OF THE FORMATION OF DEPOSITS.
- The formation of deposits may have an adverse effect on the interaction of components inside the unit. This results in an increased risk of components failing, and even the breakdown of entire cylinders. The high operating temperatures in the surroundings encourage the formation of mineral deposits, other deposits and encrustations which may render the valve unable to correctly regulate the fuel supply. This means that it is no longer possible for the quantity of fuel required at full load to be injected into the engine, thereby reducing the maximum engine power.
- The viscosity properties of biodiesel are less favorable at low temperatures. The use of biodiesel at low temperatures may therefore cause the fuel filter to become blocked.
- On all engines, lubricating the piston skirts with oil leads to a small amount of fuel entering the engine oil. This is generally of little importance with conventional diesel fuels in accordance with the MTU Fluids and Lubricants Specifications since the fuel evaporates quickly upon reaching the operating temperature. On the other hand, biodiesel evaporates much less effectively, with the result that more biodiesel accumulates in the oil. Aging of the biodiesel can therefore cause residues to form, filters to become clogged and ultimately cause the engine to come to a stop, resulting in significantly shorter oil change intervals.
- Compared to conventional diesel fuels according to the MTU Fluids and Lubricants Specifications, biodiesel has a lower energy density. Operating the engine with B20 results in a power reduction of approximately 2% and an increase in fuel consumption of around 3%.
- Biodiesel contains chemical components which can interact with the sensors in the exhaust gas recirculation system in such a way that incorrect data is reported to the engine control system. This can have consequences such as engine operation being adapted to the wrong values and emissions therefore no longer complying with the applicable provisions. This is why biodiesel must not be used in engines which feature exhaust gas recirculation (EGR) and/or exhaust gas after-treatment systems.
- Compared to conventional diesel fuels according to the MTU Fluids and Lubricants Specifications, biodiesel has a higher water solubility, meaning that a higher proportion of water should be expected depending on the fuel temperature. This can lead to increased corrosion and faster microbe growth in the fuel system. Due to the higher proportion of water in biodiesel, reduced water separator performance must be expected.
- Biodiesel is a solvent. After switching over to a biodiesel mixture, impurities and certain deposits may become loose in the tank and lines, causing the fuel filter to be subjected to an increased accumulation of these. Biodiesel mixtures may also strip paint when they come into contact with painted surfaces.
- On engines with exhaust gas aftertreatment systems, the functioning of the catalytic converter may be impaired as biodiesel mixtures can contain a higher proportion of trace elements (e.g. calcium, magnesium, sodium, potassium and phosphorus) than conventional diesel fuels according to the MTU Fluids and Lubricants Specifications. This means that the legally prescribed emission limits are not complied with and the operating license becomes invalid. Furthermore, legally prescribed technologies for checking emissions on these engines (e.g. NOx monitoring diagnostics) lead to a significant decrease in engine power. The aforementioned trace elements may also result in excess ash formation and accumulations in the soot filters and catalytic converters. Excess ash formation results in a constantly rising exhaust back pressure and can therefore cause a slow reduction in engine power.

The aforementioned points do not constitute a complete risk assessment. MTU is unable to assess all biodiesel variants and their long-term effects on MTU products.

5. Additional maintenance recommendations

The following requirements must be met to ensure the quality and availability of your engine:

- Select the highest possible content of distilled fuel. Only use fuels approved in the MTU Fluids and Lubricants Specifications.
- After switching over to a biodiesel mixture, replace the fuel filters after 50 operating hours at the latest (in order to remove the impurities which become loose from the tank and lines).
- The fuel filters and fuel prefilters must be renewed every 250.
- Install a fuel preheating system if the engine is operated at temperatures below 0 °C (32 °F). This can reduce the negative effect on the fuel supply.
- Follow the recommendations below with regard to engine oil and maintenance:
 - If biodiesel mixtures are used, the change intervals for engine oil and filters must be halved in comparison to the intervals stated in the MTU Fluids and Lubricants Specifications.
 - The TO for the LP fuel pump, the O-rings in the LP fuel system as well as the valves in the fuel filter head is shortened to TBO/3.
 - In addition to changing the oil and filters on time, the engine oil and filters must be analyzed regularly in order to ensure that the oil quality is correct. Interval: Every 100 operating hours or every three months, depending on which comes first. A decision must be made to either further reduce or extend the change intervals on the basis of the results.
 - The oil and oil filter must be replaced before biodiesel is used.
 - High-quality engine oil must be used. Operating the engine without high-quality category 2 oil leads to a deterioration in oil quality. The MTU Fluids and Lubricants Specifications contain a list of approved oil types.
- Use a suitable tank and line system:
 - Do not use any components which contain zinc, copper or NBR seals.
 - Ensure that the system can be filled up to the fill line.
 - Minimize the entry of atmospheric oxygen through the tank vent in the event of temperature fluctuations, etc. (e.g. by installing a pressure relief valve and filter; contact your tank supplier to do this).
 - It is recommended to use a tank vent with humidity separator.
- For systems without a water separator: Retrofit a water separator to reduce the risk of microbe growth and corrosion in the fuel system.
- Regular maintenance of the water separator is mandatory. Separated water must be drained off daily, depending on the water quantity.
- Avoid relatively long engine downtimes and temporary decommissioning (more than one week). If downtimes cannot be avoided, you must use a suitable additive to improve oxidation stability. In Q4/2013, MTU approved an additive specially certified for MTU diesel engines. When this additive is used, B20 can be stored for up to four months, depending on the storage conditions and quality of the biodiesel. Prior to this point, we provided an additive on request.
- For engines used seasonally, we strongly recommend rinsing the fuel system, including the fuel tank, with pure, high-quality distilled diesel fuel in accordance with the MTU Fluids and Lubricants Specifications before the engine is decommissioned for a relatively long period (more than one week).
- Prevent biodiesel from coming into contact with painted surfaces to avoid damaging and stripping the paint.
- You must also always comply with the latest version of the MTU Fluids and Lubricants Specifications.

More extensive preventative measures are additionally required for some applications. Our Customer Service department is available to answer any questions you may have on this topic.

6. Affected engines

This customer information applies to the following engine series:

Series	Remarks
S1600Gx0	All years of manufacture
S2000Gx2	All years of manufacture
S2000Gx3	With metal low-pressure fuel lines
S2000Gx4	All years of manufacture
S2000Gx5	All years of manufacture
S2000Gx6	All years of manufacture
S4000Cx0	All years of manufacture
S4000Cx1	All years of manufacture
S4000Gx1	With metal low-pressure fuel lines
S4000Gx2	All years of manufacture
S4000Gx3	All years of manufacture

Table 13:

Should you have any questions about this customer information, please contact your on-site MTU representative.

4.3 Biodiesel – Biodiesel admixture

The standardized general term "FAME", (Fatty Acid Methyl Esters) is used here to designate biodiesel fuels.

General information

- We can make no comment with regard to the level of FAME resistance of the fuel system, which is not part of our scope of supply.
- FAME is an extremely effective solvent. Any contact with paint, for example, must therefore be avoided.
- The characteristic smell of FAME exhaust, especially during long periods of idling, may be perceived as unpleasant. The nuisance caused by smell can be reduced by an oxidation catalyst which may be installed by the vehicle / equipment manufacturers at their own risk.

Important information

Our company accepts no responsibility for and provides no warranty in respect of any fault or damage connected in any way with the use of FAME of a lower quality or resulting from noncompliance with our specifications on operation using FAME. All resultant irregularities and consequential damage lie outside our responsibility.

Use of B20 fuels

Important information

Information on the use of B20 fuels can be obtained from the chapter (→ Page 53).

The following engines are approved/not approved for operation with 100% FAME in compliance with DIN EN 14214:2014-06.

Approved/non-approved engines for operation with 100% FAME

Series	Approved / Not approved	Conversion necessary
SUN	No approval	
700	No approval	
750	No approval	
OM 457 LA	From series introduction	no
460	From series introduction	no
900	From series introduction	no
500	From series introduction	no
S40	No approval	
S50	No approval	
S60	No approval	
183	No approval	
2000	No approval	
396	No approval	
4000	No approval	
538	No approval	
595	No approval	
956	No approval	

Series	Approved / Not approved	Conversion necessary
1163		No approval
8000		No approval

Table 14:

Important information
Diesel fuel with a FAME content of max. 7% in compliance with DIN EN 590:2014-04 may be used. Such fuel may also be used in engines which have not been approved for operation with FAME, without affecting oil drain intervals.

Fuel

- The fuel must comply with DIN EN 14214:2014-06. Operation with fuels of lower quality can lead to damage and malfunctions.
- Either FAME or diesel fuel may be used. The various mixtures of FAME and normal diesel fuel, which may occur in the fuel tank as a result, present no problems.

Engine oil and servicing

- For operation using 100% FAME, engine oils are to be preferred which comply with MB Fluids and Lubricants Specifications, Sheet 228.5 or Oil Category 3 in accordance with MTU Fluids and Lubricants Specifications. Engine oils in accordance with Sheet 228.3 or Oil Category 2 as per MTU Fluids and Lubricants Specifications may also be used provided that oil drain intervals are reduced.
- A certain amount of fuel always finds its way into the engine oil via the pistons and cylinders. Its high boiling point means that FAME does not evaporate but remains in the engine oil in its entirety. Under certain conditions chemical reactions may take place between FAME and the engine oil. This can lead to engine damage.
- For this reason, engine oil and filter change intervals must be shortened for operation both with pure FAME and with FAME-diesel mixtures.
- For Series 457, 460, 900 and 500 engines, special equipment is available which facilitates an increase in the engine oil change intervals for operation with 100% FAME (→ Table 15). This involves fitting the engines with special equipment Code MK21 (special unit pump) and Code MK04 (fuel prefilter with heated water separator).

Effects on the engine oil change interval with operation with 100% FAME

Engine version	Engine oil change interval
Engines not fitted with special equipment for operation with FAME	Reduction of engine oil change interval to 30% of the standard interval required for operation with fossil diesel fuels
Engines fitted with special equipment Code MK21 and Code MK04	Reduction of engine oil change interval to 50% of the standard interval required for operation with fossil diesel fuels

Table 15:

Important information
The relevant engine oil change intervals must be complied with without fail! Exceeding the engine oil change intervals can cause engine damage!

- Operation with 100% FAME requires shortened fuel filter change intervals. A new fuel filter must be fitted each time the engine oil is changed.
- FAME has a high cleaning effect, which results in a risk of clogging by loosened deposits. If a switch has been made to FAME, a fuel filter and engine oil change should therefore be carried out after approx. 25 operating hours.
- Over longer periods, fuel filter service life may be reduced as a result of old residues being carried into the filter from the fuel system. A special, approved fuel prefilter can be installed as an improvement. This fuel prefilter with heated water separator is already installed on engines fitted with special equipment Code MK04.

Engine power and engine standstill

- Due to its calorific value, operation with 100% FAME involves a reduction of approx.8% to 10% in engine power. This leads to a corresponding increase in fuel consumption as compared to operation with diesel fuel. Engine power corrections are not permissible.
- Prior to any extended period out of operation, the fuel system must be flushed out in order to prevent congestion. For flushing, the engine must be operated for at least 30 minutes on FAME-free diesel fuel.

Vegetable oils as an alternative to diesel fuel

Important information

The use of pure vegetable oils as an alternative to diesel fuel or FAME is strictly prohibited due to the absence of standardization and to negative experience (engine damage caused by coking, deposits in the combustion chambers and oil sludge)!

Diesel fuels in winter operation

At low outdoor temperatures, the diesel fuel's fluidity can be inadequate on account of paraffin precipitation.

In order to prevent operational problems (e.g. clogged filters) during the winter months, diesel fuel with suitable cold-flow characteristics is available on the market. Deviations are possible during transitional periods and in individual countries.

4.4 Heating oil EL

Heating oil differs from diesel fuel mainly because of the following non-specified characteristics:

- Cetane number
- Sulfur content
- Oxidation stability
- Corrosion effect on copper
- Lubricity
- Low temperature behavior

If the heating requirements comply with the specifications of the diesel fuel DIN EN 590:2014-04 (summer and winter quality), there are no technical reasons why it can not be used in the diesel engine

4.5 Supplementary fuel additives

Supplementary fuel additives

The engines are designed such that satisfactory operation with normal, commercially available fuels is ensured. Many of these fuels already contain performance-enhancing additives.

The additives are added by the supplier as the agent responsible for product quality.

The anti-wear additives and biocides represent an exception(→ Page 62).

Important information

Attention is drawn to the fact that the use of diesel fuels or additives other than those stipulated in the MTU Fluids and Lubricants Specifications is always the responsibility of the operator.

Diesel fuels with sulfur content < 500 mg/kg

On Series 362, 396, 538, 652, 595, 956, 1163-02 and -03 engines with cylinder heads not fitted with valve seat inserts, the use of low-sulfur fuel (< 500 mg/kg) can lead to increased valve seat wear. If anti-wear additives are mixed in, this wear can be reduced. The approved supplementary additives must be mixed with the fuel in the predefined concentration. The additive must be filled before every refueling.

Microorganisms in fuel

Bacterial attack and sludge formation may occur in the fuel under unfavorable conditions. In such cases, the fuel must be treated with biocides in accordance with the manufacturer's specifications. Overconcentration must always be avoided.

The biocides approved at MTU are listed in table (→ Table 17).

Approved anti-wear additives

Manufacturer	Brand name	Concentration for use
The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092 USA Tel. 01 440-943-4200	ADX 766 M	250 to 350 mg/kg
Tunap Industrie GmbH Bürgermeister-Seidl-Str. 2 82515 Wolfratshausen Tel. +49 (0) 8171 1600-0 Fax. +49 (0) 8171 1600-91	Tunadd PS	250 to 350 mg/kg

Table 16:

Important information

The use of anti-wear additives is not permitted on engines/plants with exhaust aftertreatment!

Approved biocides

Biocides should have a pure hydrocarbon structure, i.e. should only consist of the following components:

- Carbon
- Hydrogen
- Oxygen
- Nitrogen

They must not contain inorganic substances because they can cause damage to the engine. The use of halogenated biocides is prohibited due to their effects on the engine system and the environment.

A release for biocides that meet the above requirements is possible upon request.

Manufacturer	Brand name	Concentration for use
ISP Biochema Schwaben GmbH Ashland Specialty Ingredients Luitpoldstrasse 32 87700 Memmingen Tel. +49 (0)8331 9580 0 Fax. +49 (0)8331 9580 51	Bakzid	100 ml / 100 l
Maintenance Technologies Paddy's Pad 1056 CC t/a Maintenance Technologies Tel. +27 21 786 4980 Cell +27 82 598 6830	Diesecure Fuel Decontainment	1 : 1200 (833 mg/kg)
Adolf Würth GmbH & Co. KG Reinhold Würth-Straße 12-17 74653 Künzelsau Tel. +49 (0) 7940 15-2248	Diesecure Fuel Decontainment	1 : 1200 (833 mg/kg)
Schülke und Mayr 22840 Norderstedt Tel. +49 (0) 40 52100-00 Fax. +49 (0) 40 52100-244	grotamar 71 grotamar 82 StabiCor 71	0.5 l / ton 1.0 l / 1000 l 0.5 l / ton
Supafuel Marketing CC PO Box 1167 Allens Nek 1737 Johannesburg South Africa Tel. +27 83 6010 846 Fax. +27 86 6357 577	Dieselfix / Supafuel	1:1200 (833 mg/kg)
Wilhelmsen Ships Service AS Willem Barentszstraat 50 3165 AB Rotterdam-Albrtand-swaard Tel. +31 10 487 7777 Fax. +31 10 487 7888 Netherlands	DieselPower MAR 71 (Biocontrol MAR 71)	333 ml / ton

Table 17:

Flow improvers

Flow improvers can not prevent paraffin precipitation but they do influence the size of the crystals and thus allow the diesel fuel to pass through the filter.

The effectiveness of the flow improvers is not guaranteed for every fuel.

Certainty is only assured after laboratory testing of the filtering capability.

Required quantities and mixing procedures must be carried out according to the manufacturer's instructions.

4.6 Unsuitable materials in the diesel fuel circuit

Components made of copper and zinc materials

The use of components made of copper and zinc materials in the fuel circuit is prohibited. They can cause chemical reactions in the fuel and thus lead to formation of a coating in the fuel system.

Requirements

Based on current knowledge, the following materials and coatings must not be used in a diesel fuel circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- Zinc, also as surface protection
- Zinc-based alloys
- Copper
- Copper-based alloys with the exception of CuNi10 and CuNi30 (e.g. seawater cooler)
- Tin, also as surface protection
- Magnesium-based alloys

Non-metallic materials

- Elastomers: Nitrile rubber, natural rubber, chloroprene rubber, butyl rubber, EPDM
- Silicone elastomer
- Fluorosilicone elastomer
- Polyurethane
- Polyvinyl

Information:

In case of doubt about the use of materials on the engine and add-on components / components in coolant circuit, consultation with the respective MTU specialist department must be held.

4.7 MTU Advanced Fluid Management System for fuels – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following:

For full information on the MTU Advanced Fluid Management System available in North America, please contact an authorized MTU Onsite Energy service partner.

The following test packages from MTU Advanced Fluid Management System can be ordered from authorized MTU Onsite Energy service partners in North America:

- F-PDFM1
Basic test – For checking the degree of contamination of the diesel fuel.
The test determines existing metallic elements and examines the proportion of water and contamination with bacteria and particles.
- F-PDFM2
Extended test – Includes the basic test plus an examination for determination of the degree of contamination, any possible filter contamination and ignition behavior of the engine.
- F-PDFM3
Extended Test Plus – Includes the extended text plus a lubricity analysis.
Maintenance of the correct lubricity has a positive effect on the service life of the components of the engine fuel system.

The following fuel parameters can be determined:

Fuel parameter	F-PDFM1	F-PDFM2	F-PDFM3
24 elementary metals	✓	✓	✓
Viscosity at 40 °C	-	✓	✓
Percent sulfur	-	✓	✓
Water and sediment	✓	✓	✓
Pour point	✓	✓	✓
Thermal stability	✓	✓	✓
Bacteria, fungi and mildew	✓	✓	✓
Flashpoint according to Pensky-Marten	-	✓	✓
Calculated centane index	-	✓	✓
Distillation	-	✓	✓
Cloud point	-	✓	✓
Percentage of water according to Karl Fischer	✓	✓	✓
Particle content	✓	✓	✓
Density according to API	-	✓	✓
Lubricity	-	-	✓

The MTU Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Samples must be taken:

- While the engine is operating under normal conditions or immediately after stopping the engine while the engine is still at operating temperature
- Every 250 hours at the same point

Note: The software offered by MTU for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The MTU Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

5 Approved Engine Oils and Lubricating Greases

5.1 Single-grade oils – Category 1, SAE grades 30 and 40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Single-grade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Marine MS4011	40	X			
	Addinol Turbo Diesel MD305	30		X		
	Addinol Turbo Diesel MD405	40		X		
Aegean Oil SA	Vigor Super D	40	X			
Avia	Avia Special HDC	30, 40	X			
Castrol Ltd.	Castrol MLC	30, 40		X		
Cepsa Lubricantes	Cepsa Rodaje Y Proteccion	30	X			Increased corrosion protection
Cyclon Hellas	Cyclon D Prime	30, 40	X			
Gulf Oil International	Gulf Superfleet	40	X			
Motor Oil (Hellas)	EMO Turbo Champion Plus	30, 40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310	30		X		
	Marbrax CCD-410	40		X		
PT. Pertamina Lubricants	Meditiran SMX	40	X			
PTT Public Comp.	PTT Navita MTU Type 1	40	X			
Repsol Lubricantes y Especialidades, S.A.	Repsol Serie 3	30, 40		X		
	Repsol Marino 3	30		X		
	Repsol Marino 3 SAE 40	40			X	
SRS Schmierstoff Vertrieb GmbH	SRS Rekord	30, 40		X		
Shell International Petroleum Company	Shell Gadinia S	30, 40		X		
	Shell Rimula R3	30, 40	X			
	Shell Rimula R3+	30	X			
	Sirius	30	X			
	Shell Sirius Monograde	30, 40	X			
SK Lubricants	SD 5000	40	X			
Total	Total Caprano TD 30	30		X		
	Total Caprano TD 40	40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
United Oil	XD 7000 Extra Duty-3U		X			
	XD 7000 Extra Duty-4U		X			

Table 18:

5.2 Multigrade oils - Category 1, SAE grades 15W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Important information

¹⁾ = These multigrade oils can only be used if crankcase ventilation is routed to atmosphere.

²⁾ = Engine oils marked ²⁾ are also permitted for the "Series 60"

Multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Super Star MX 1547	15W-40		X		
Advanced Lubrication Specialties	Translub 15W40 CI-4	15W-40		X		
BP p.l.c.	BP Vanellus Multi	15W-40	X			
ENI S.p.A	eni i-Sigma universal DL	15W-40	X			
Exxon Mobil Corporation	Mobil Delvac Super 1400E	15W-40	X			
Exxon Mobil Corporation	Mobil Delvac XHP	15W-40	X			
Gulf Oil International	Gulf Superfleet	15W-40	X			
Manufacture Zavod imeni Shau-myana	M5z/14D ₂ CE	15W-40			X	
Petróleos de Portugal, Petrogal S.A.	Galp Galaxia Super 15W-40	15W-40	X			
Singapore Petroleum Company Limited	SPC SDM 801	15W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Primalub	15W-40	X			
Total	Total Caprano TD	15W-40	X			
Unil Opal	Intercooler 400	15W-40	X			
United Oil	XD 9000 Ultra Diesel-U	15W-40	X			

Table 19:

5.3 Single-grade oils – Category 2, SAE-grades 30 and 40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

MTU single-grade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MTU Friedrichshafen GmbH	Power Guard® DEO SAE 40	40	X			20 l container: X00062816 210 l container X00062817 IBC: X00064829
MTU America	Power Guard® SAE 40 Off-Highway Heavy Duty	40		X		5 gallons: 23532941 55 gallons: 23532942 Approved for Series 8000 [(→ Table 20), note] available through MTU America Not approved for Series 2000 M72
MTU India Pvt Ltd.	Diesel Engine Oil DEO SAE 40	40		X		20 l container: 73333/P 205 l container: 75151/D Sale of Indian oil only intended in Indian market

Table 20:

Important information
For Series 8000 engines, the approved SAE class 40 engine oils may only be used in combination with pre-heating and oil priming ($T_{oil} > 30 \text{ }^{\circ}\text{C}$).

Further single-grade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil GmbH	Addinol Turbo Diesel MD 407	40	X			
Adnoc Distribution	ADNOC Voyager Plus 40 CF/SL	40	X			
Atak Madeni Yag Lubricants	Protector MX 30	30			X	
	Protector MX 40	40			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
BayWa AG	Tectrol HD 30	30		X		
	Tectrol HD 40	40		X		
Belgin Madeni Yaglar	Lubex Marine M	30		X		
	Lubex Marine M	40		X		
	Lubex Marine LTM-30	30		X		
	Lubex Marine LTM-40	40		X		
Bucher AG Langenthal	Motorex Monolube	30		X		
Castrol Ltd.	Castrol HLX	30, 40		X		Approved for fast commercial vessels up to 1500 h, Series 595, 1163
Cepsa Lubricants	Cepsa Petrel HDL 40	40			X	
Chevron Lubricants (Texaco)	Ursa Premium TDX	40		X		
	Delo 400	30, 40		X		
	Delo Gold	40		X		
Chevron – Lyteca – (Texaco)	Ursa Premium TDX	40		X		
Cyclon Hellas	Cyclon D Super	40		X		
Delek	Delkol Super Diesel	40		X		
	Delkol Super Diesel MT Mono	40	X			
ENI S.p.A.	Agip Sigma GDF	40		X		
ENOC Marketing L.L.C.	ENOC Strata Super Duty	40		X		
Exxon Mobil Corporation	Mobil Delvac 1630	30		X		Not approved for Series 2000 M72
	Mobil Delvac 1640	40		X		Not approved for Series 2000 M72
Fuchs Europe Schmierstoffe GmbH	Titan Universal HD	30, 40	X			
	Titan Universal HD 30 MTU	30	X			Increased corrosion protection
Gulf Oil International	Gulf Superfleet Plus	40	X			
Gulf Western Oil, Australia	Turboil	40			X	
GS Caltex Corporation	Kixx D1 40	40	X			
Hyrax Oil Sdn Bhd	Hyrax Top Deo	40	X			
Koçak Petrol Ürünleri San. ve TIC. Ltd.	Speedol Ultra HDX 30 TBN 12	30		X		
	Speedol Ultra HDX 40 TBN 12	40		X		
	Speedol Deniz Dizel Motor Yağı	30, 40		X		
	Speedol Ultra HDX	30, 40	X			
Kuwait Petroleum	Q8 T 750	30, 40	X			

TİM-İD: 0000018996 - 006

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Manufacture Zavod imeni Shau-myana Ltd.	M-14D2CE	40			X	
Motor Oil, Hellas	EMO SHPD Plus	30, 40		X		
OOO Lukoil International	Lukoil Avantgarde M 40	40	X			
Oryx Energies	Supreme RR	40			X	
Panolin AG	Panolin Extra Diesel	40	X			
Paz Lubricants & Chemicals	Pazl Marine S 40	40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310-AP	30		X		
	Marbrax CCD-410-AP	40		X		
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia 40	40		X		
Prista Oil Holding EAD	Prista SHPD 40	40			X	
PTT Public Comp.	PTT Navita MTU Type 2	40		X		
	Navita Plus, SAE 40	40		X		
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Serie 3 MT	40			X	
Shell International Petroleum Company	Shell Sirius X	30			X	
	Shell Sirius X	40			X	
Singapore Petroleum Company Limited	SPC SDM 900, SAE30	30		X		
	SPC SDM 900, SAE40	40		X		
Sonol	Seamaster 40	40	X			
SRS Schmierstoff Vertriebs GmbH	SRS Rekord plus 30	30		X		
	SRS Rekord plus 40	40		X		
	SRS Antikorrol M plus	30		X		Increased corrosion protection Only permitted for run-in and series acceptance
	SRS Motorenöl O-278	40		X		
Total	Total Caprano MT 30	30			X	
	Total Caprano MT 40	40			X	
	Total Disola MT 30	30	X			
	Total Disola MT 40	40	X			
	Total Rubia MT 30	30			X	
	Total Rubia MT 40	40			X	
Viva Energy Australia	Penske Power Systems Premium	40			X	

Table 21:

5.4 Multigrade oils – Category 2 of SAE grades 10W-40, 15W-40 and 20W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Important information

²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

MTU multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MTU Friedrichshafen GmbH	Diesel Engine Oil DEO SAE 15W-40	15W-40		X		20 l container: X00070830 210 l container: X00070832 IBC: X00070833 Loose items: X00070835 (only on request)
MTU Asia	Diesel Engine Oil - DEO 15W-40	15W-40		X		20 l container: 64247/P 200 l container: 65151/D
MTU Asia China	Diesel Engine Oil - DEO SAE 15W-40	15W-40		X		20 l canister: X00064242/P 205 l barrel: 65151/D
	Diesel Engine Oil - DEO SAE 10W-40	10W-40		X		20 l canister: 60606/P
MTU India Pvt. Ltd.	Diesel Engine Oil - DEO 15W-40	15W-40		X		20 l canister: 63333/P ²⁾ 205 l barrel: 65151/D Sale only intended in Indian market

Table 22:

Further multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 mgKOH/g	
Adnoc Distribution	Adnoc Voyager Plus	15W-40		X		²⁾
Aegean Oil S.A.	Vigor Turbo SD 15W-40	15W-40	X			²⁾
Addinol Lube Oil	Addinol Super Longlife MD1047	10W-40		X		²⁾
	Addinol Diesel Longlife MD1548	15W-40		X		²⁾

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Anomina Petroli Italiana	IP Tarus	15W-40	X			
	IP Tarus Turbo	15W-40	X			
	IP Tarus Turbo Plus	15W-40	X			2)
Arabi Eneritech KSC	Burgan Ultra Diesel CH-4	15W-40		X		2)
Aral AG	Aral Turboral 10W-40	10W-40		X		
	Aral Turboral 15W-40	15W-40		X		2)
Atak Madeni Yag Lubricants	Alpet Turbot Fleetmax 1540	15W-40		X		2)
Auto-Teile-Ring GmbH	Cartechnic Motorenöl SAE 15W-40	15W-40	X			
Avista Oil Refining & Trading Deutschland GmbH	Avista Advantage SHPD	15W-40	X			
	Avista Advantage UHPD	15W-40	X			
	Pennasol Turbo Super	15W-40		X		2)
	MOTOR GOLD Turbotec	15W-40		X		2)
Bahrain Petroleum Company B.S.C.	Frontier Megatek	10W-40	X			
	Frontier Super Plus	15W-40		X		2)
	Frontier Turbo	15W-40		X		
	Frontier Turbo LD	10W-40		X		
BayWa AG	Tectrol Turbo 4000	10W-40		X		
Belgin Madeni Yaglar	Lubex Marine M	15W-40		X		
BP p.l.c.	BP Vanellus C6 Global Plus	10W-40		X		
	BP Vanellus Multi-Fleet	15W-40			X	2)
	BP Multi Mine	15W-40	X			2)
	BP Mine Multi 15W-40	15W-40		X		2)
	BP Vanellus Longdrain	15W-40		X		2)
	BP Vanellus Multi A	10W-40		X		2)
	BP Vanellus Agri	10W-40		X		2)
	BP Vanellus Multi A	15W-40	X			2)
	BP Vanellus Agri	15W-40	X			2)
	BP Vanellus Max Extra	15W-40			X	2)
Bucher AG Langenthal	Motorex Universal	10W-40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Castrol Ltd.	Castrol CRB Multi 10W-40 CI-4/E7	10W-40		X		
	Castrol CRB Multi 15W-40 CI-4/E7	15W-40		X		2)
	Castrol CRB Turbo 15W-40 CH-4/E7	15W-40	X			2)
	Castrol Rivermax CRB 15W-40 CI-4/E7	15W-40		X		2)
	Castrol Rivermax RX+ 15W-40	15W-40	X			2)
	Castrol Vecton 15W-40 DH-1	15W-40			X	2)
	Castrol RX Diesel	15W-40	X			
	Castrol RX Diesel 15W-40 CI-4/E7	15W-40		X		2)
	Castrol Vecton	10W-40		X		
	Castrol Vecton 15W-40 CI-4/E7	15W-40		X		2)
	Castrol Vecton 15W-40 CI-4/E7	15W-40			X	2)
Cepsa	Cepsa Euromax SHPD	15W-40		X		2)
Champion Chemicals N.V.	Champion New Energy	15W-40		X		2)
Chevron Lubricants (Caltex)	Delo SHP Multigrade	15W-40		X		
	Delo Gold Multigrade	15W-40	X			
	Delo Gold Ultra	15W-40		X		
	Delo Gold Ultra E	10W-40		X		
	Delo Gold Ultra E	15W-40	X			2)
	Delo 400 Multigrade	15W-40			X	2)
	OEC SAE 15W-40	15W-40		X		
Chevron Lubricants (Texaco)	Ursa Super TD	15W-40		X		2)
	Ursa Premium TDX	15W-40		X		2)
	Ursa Premium TDX Plus	15W-40		X		2)
	Ursa Heavy Duty	15W-40	X			
CPC Corporation, Taiwan	CPC Superfleet CG4 Motor Oil	15W-40	X			
Cubalub	Cubalub Extra Diesel MX	15W-40			X	2)
	Cubalub Extra Diesel	15W-40	X			
Cyclon Hellas	Cyclon D Super	15W-40	X			2)
Delek	Delkol Super Diesel	15W-40	X			
Delek Industries Ltd.	Super Diesel	15W-40		X		
Dunwell Petro-Chemical Co., Ltd.	Apex Super Motor Oil SL/CI-4, 15W-40	15W-40		X		2)
EKO A.B.E.E.	Eko Forza plus	15W-40	X			
Engen Petroleum Ltd.	Engen Dieselube 600 Super	15W-40	X			2)
	Engen Dieselube 700 Super	15W-40		X		2)

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Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
eni S.p.A.	Agip Blitum T	15W-40	X			
	eni i-Sigma super fleet	15W-40		X		
	eni i-Sigma performance E3	15W-40	X			
	eni i-Sigma performance E7	15W-40		X		2)
	eni i-Sigma performance E7	15W-40	X			2)
Exol Lubricants Ltd.	Taurus Extreme M	15W-40	X			2)
	Taurus Extreme HST	15W-40		X		2)
Exxon Mobil Corporation	Mobilgard 1 SHC	20W-40			X	Approved for fast commercial vessels up to 1500 h, 396, 1163
	Mobil Delvac Super 1400	15W-40	X			
	Mobil Delvac MX	15W-40		X		
	Mobil Delvac MX Extra	15W-40		X		
	Mobil Delvac Advanced City Logistics	15W-40	X			
Finke Mineralölwerk GmbH	AVIATICON Turbo Super Plus	15W-40	X			2)
Fuchs Europe Schmierstoffe GmbH	Fuchs Titan Truck Plus	15W-40		X		2)
	Titan Unimax Ultra MC	10W-40		X		
	Titan Formel Plus	15W-40		X		
	Fuchs Titan Truck	15W-40	X			2)
	Titan Unimax Plus MC	10W-40		X		
	Fuchs Titan Universal HD	15W-40	X			
Fuchs Lubrifiants France	Cofran Plura Super	15W-40		X		2)
Fuchs Petrolub SE	Fuchs Max Way	15W-40		X		2)
	Fuchs Titan Truck Plus	10W-30		X		
	Fuchs Titan Truck Plus	15W-40		X		
Gazpromneft Lubricants Ltd.	Belaz G-Profi Mining	15W-40		X		2)
	Belaz G-Profi Mining FF	15W-40		X		2)
	G-Profi MSI 10W-40	10W-40		X		
	G-Profi MSI 15W-40	15W-40		X		
	G-Profi MSH 15W-40	15W-40		X		
	G-Profi MSI Plus	15W-40		X		2)
	Gazpromneft Diesel Premium	15W-40	X			2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
German Mirror Lubricants and Greases Co. FZE	Mirr Turbo Plus Diesel Engine Oil API CI-4 SAE 10W-40	10W-40		X		
	Mirr Turbo Plus Diesel Engine Oil API CI-4 SAE 15W-40	15W-40	X			2)
	Mirr Turbo Diesel Engine Oil API CH-4 SAE 15W-40	15W-40	X			2)
Ginouves Georges SAS	York 849	15W-40		X		2)
GS Caltex India Private Limited	Kixx Dynamic Gold	15W-40		X		2)
GS Caltex Corporation	Kixx HD 1	10W-40		X		
	Kixx HD 1	15W-40		X		2)
Gulf Oil International	Gulf Super Duty VLE	15W-40	X			
	Gulf Superfleet LE	10W-40		X		
	Gulf Superfleet LE	15W-40	X			2)
	Gulf Superfleet Supreme	10W-40		X		
	Gulf Superfleet Supreme	15W-40		X		2)
	Gulf Superfleet Plus	15W-40	X			
Gulf Western Oil, Australia	TOP DOG XDO	15W-40	X			2)
Hafa France	Stradex 1800	10W-40		X		
Hessol Lubrication GmbH	Hessol Turbo Diesel	15W-40		X		2)
	Hessol Super Longlife	10W-40		X		
High Industrial Lubricants & Liquids Corporation (HILL)	Fastroil Force F300 Diesel	15W-40		X		2)
	Fastroil Force F500 Diesel	15W-40		X		2)
	Fastroil Force F700 Diesel Pro	10W-40		X		
Hitachi Construction Machinery CO., Ltd.	Hitachi Premium Orange	15-W40	X			
Huiles Berliet S.A.	RTO Maxima RD	15W-40	X			2)
	RTO Maxima RLD	15W-40		X		2)
Hyrax Oil Sdn Bhd	Hyrax Admiral 15W-40	15W-40	X			2)
INA Maziva Ltd.	INA Super Max	15W-40		X		2)
Indian Oil Corporation	Servo Premium (N)	15W-40		X		
Ipiranga Produtos des Petróleo S.A.	Ipiranga Brutus Alta Performance	15W-40		X		2)
Kuwait National Lube Oil MfgCo (KNLOC)	Burgan Ultra Diesel CH-4	15W-40		X		2)
Kuwait Petroleum	Q8 T 750	15W-40	X			2)
	Q8 T 800	10W-40	X			2)
Kocak Petrol Ürünleri San	Speedol SHPD Tirot 15W-40	15W-40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Liqui Moly	Liqui Moly Marine 4T Motor Oil	15W-40		X		2)
	Liqui Moly Touring High Tech SHPD	15W-40	X			
Lotos Oil	Turdus Powertec CI-4 15W-40	15W-40		X		2)
	Turdus Powertec 1000	15W-40		X		2)
LPC S.A.	Cyclon Granit Maximum	15W-40		X		2)
Lubricantes de América	Generac Aceite	15W-40		X		
	Lubral Nano Diesel	15W-40		X		
Lubricating Specialties Company (LSC)	Top 1 Transport	15W-40		X		2)
Lubrisa	Gulf Superfleet Supreme	15W-40		X		2)
Lukoil Lubricants Europe Oy	Teboil Power Plus	15W-40	X			
	Tepoil Super HPD	15W-40		X		
	Tepoil Super HPD C	10W-40		X		
Mega Lube Marketers cc.	Megalube Diesel Engine Oil	15W-40		X		
Meguín GmbH	megol Motorenoel SHPD	15W-40	X			
Modriča Oil Refinery	Maxima Turbo	15W-40		X		
MOL-LUB Kft..	MOL Dynamic MK9	15W-40		X		
	MOL Mk-9	15W-40		X		
	Mol Dynamic Super Diesel	15W-40	X			
	Mol Dynamic Transit	10W-40		X		2)
	Mol Dynamic Transit	15W-40		X		2)
	MOL Super Diesel	15W-40	X			
Motor Oil, Hellas	EMO SHPD Plus	15W-40		X		
MPM International Oil Company B.V.	Motor Oil 15W-40 Super High Performance	15W-40		X		2)
NetLube Iran	Max Turbo	15W-40		X		2)
NSL OilChem Trading Pte Ltd	Liquid Gold D-Flo X4	15W-40		X		2)
Oman Oil Marketing Company SAOG	Omanoil Maximo Super 15W40 CH-4	15W-40	X			2)
Orlen Oil	Mogul Diesel DTT Extra	15W-40			X	2)
	Platinum Ultor	15W-40	X			2)
	Platinum Ultor Plus	15W-40			X	2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
OOO "LLK-International"	BELAZ CI-4	15W-40	X			2)
	Lukoil Avantgarde Extra	15W-40	X			
	Lukoil Avantgarde Ultra	15W-40		X		
	Lukoil Avantgarde NP	15W-40		X		
	Lukoil Avantgarde Ultra Plus	10W-40		X		
Oryx Energies	Enduro 600	15W-40		X		
Panolin AG	Panolin Universal SFE	10W-40		X		
	Panolin Diesel Synth	10W-40		X		
PDVSA CA	PDV Ultradiesel	15W-40		X		2)
Pertamina	Meditran SX Plus	15W-40		X		2)
Petrobras Colombia Combustibles	Petrobras Top Turbo T2	15W-40	X			
Petrobras Distribuidora S.A.	Lubrax Nautica Diesel	15W-40		X		2)
Petro-Canada Lubricants	Duron	15W-40		X		2)
	Duron XL	15W-40		X		2)
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia LD star	15W-40		X		
Petron Corporation	Petron Rev-x Premium Multi Grade	15W-40		X		2)
Petronas Lubricants International	Petronas Urania 3000	15W-40		X		2)
	Petronas Urania LD7	15W-40		X		
	Petronas Urania LD 7	10W-40	X			
	Petronas Urania Supremo CI-4	10W-40	X			2)
	Petronas Urania Supremo CI-4	15W-40	X			2)
Petromin Corporation	Petromin Turbomaster XD	15W-40		X		2)
Phillips 66 Lubricants	Conoco Hydroclear Power D	15W-40			X	
Prista Oil AD	Prista Turbo Diesel	15W-40	X			
PTT Public Limited	Navita Plus SAE 15W-40	15W-40	X			
Qatar Lubricants Company Ltd.	QALCO Topaz HMF	15W-40	X			
Qingdao Copton Technology Co., LTD.	Copton CH-4 Diesel Engine Oil	15W-40	X			
Raloy Lubricantes, S.S. de C.V.	Raloy Diesel Power	15W-40		X		2)
Raj Petro Specialities P Ltd.	Zoomol Rforce 3100 RF1	15W-40	X			2)
	Zoomol Rforce 3100 RF4	15W-40		X		2)
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Expert SHPD	10W-40		X		
	RAVENOL Mineralöl Turbo Plus SHPD	15W-40	X			2)

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Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Super Turbo SHPD	15W-40	X			2)
	Repsol Neptuno S-Turbomar	15W-40	X			2)
RN-Lubricants, LLC	Rosneft Revolut D2	15W-40	X			
	Rosneft Revolut D3	15W-40		X		2)
	Rosneft Revolut D5	15W-40		X		
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40		X		2)
S.A.E.L.	Gulf Gulfleet Long Road	15W-40	X			
Shell International Petroleum Company	Shell Rimula MV	15W-40	X			
	Shell Rimula R3 MV	15W-40	X			2)
	Shell Rimula R3 X	15W-40		X		2)
	Shell Rimula R4	15W-40		X		2)
	Shell Rimula R4 X	15W-40		X		2)
	Shell Rimula RT4	15W-40		X		2)
	Shell Rimula RT4 X	15W-40		X		2)
	Shell Rimula T3	15W-40		X		2)
	Shell Rimula T4	15W-40		X		2)
	Shell Rimula X	15W-40		X		
	Shell Rotella T2	15W-40		X		
	Shell Rotella T Multigrade	15W-40		X		2)
	Shell Sirius	15W-40		X		2)
	Eicher Premium Plus Diesel Engine Oil	15W-40		X		2)
Shanghai HIRI Lubricants R & D Centre	HIRI	15W-40	X			
Singapore Petroleum Company Limited	SDM 900 SAE 15W40	15W-40		X		
Sinopec Lubricant Co., Ltd.	Sinopec Tulux T500	15W-40		X		2)
SK Lubricants Co. Ltd.	ZIC X5000 10W-40	10W-40		X		
	ZIC X5000	15W-40	X			2)
	ZIC X7000 CI-4 10W-40	10W-40		X		
	ZIC X7000 CI-4	15W-40	X			2)

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 gKOH/g	
SRS Schmierstoff Vertrieb GmbH	SRS Motorenöl O-236	15W-40	X			2) enhanced corrosion protection
	SRS Multi-Rekord top	15W-40		X		2)
	SRS Multi Rekord plus	15W-40	X			
	SRS Turbo Rekord	15W-40	X			2)
	SRS Cargolub TFX	10W-40		X		
Tesla Technoproducts FZE	Denebola Saheli Ultra XS 1120	15W-40		X		2)
Total Lubrificants	Antar Milantar PH	15W-40	X			2)
	Antar Milantar PX	15W-40	X			2)
	Fina Kappa Optima	15W-40		X		2)
	Fina Kappa Extra Plus	15W-40	X			2)
	Total Caprano Energy FE	15W-30		X		
	Total Caprano TDH	15W-40		X		2)
	Total Caprano TDI	15W-40		X		2)
	Total Disola W	15W-40		X		
	Total Genlub TDX	15W-40	X			
	Total Rubia TIR 6400	15W-40	X			
	Total Rubia Works 1000	15W-40		X		2)
	Hitachi Genuine Engine Oil 15W40 DH-1	15W-40		X		2)
Unil Opal	Medos 700	15W-40	X			2)
Valvoline EMEA	All-Fleet Extra SAE 15W-40	15W-40	X			2)
	All-Fleet Plus	15W-40	X			2)
	NextGen All-Fleet extra	15W-40		X		2)
	Premium Blue Classic	15W-40		X		2)
	Valvoline Premium Blue 7800	15W-40		X		
Viscolube	Revivoil - Re Refined High-Tech HD Motoroil	15W-40	X			2)
Viva Energy Australia	Penske Power Systems Premium	15W-40	X			2)
Wolf Oil Corporation NV.	Wolf Vitaltech 15W40	15W-40		X		2)
Wunsch Öle GmbH	Wunsch Rekord TLM-TU 10W-40	10W-40		X		

Table 23:

5.5 Multigrade oils – Category 2.1 (Low SAPS oils) of SAE grades 0W-30, 10W-30, 5W-40, 10W-40 and 15W-40

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Important information
²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

MTU multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MTU America	Power Guard® SAE 15W-40 Off-Highway Heavy Duty	15W-40	X			5 gallons: 800133 55 gallons: 800134 IBC: 800135 available through MTU America ²⁾

Table 24:

Further multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Bucher AG Langenthal	Motorex Focus CF	15W-40	X			²⁾
BP p.l.c.	BP Vanellus Eco	15W-40	X			²⁾
Castrol Ltd.	Castrol CRB Mining 15W-40	15W-40	X			²⁾
	Castrol CRB Mining 15W-40 CK-4		X			²⁾
	Castrol CRB Turbo G4 15W-40	15W-40	X			²⁾
	Castrol Hypuron	10W-30		X		
Champion Chemicals N.V.	Champion OEM Specific 15W40 MS	15W-40	X			
Chevron Lubricants (Caltex)	Delo 400 LE	15W-40	X			²⁾

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Chevron Lubricants (Chevron)	Delo 400 LE	15W-40	X			2) also approved for Series 4000-04 T
	Delo 400 MGX	15W-40	X			2)
	Delo 400 SDE	15W-40	X			2)
	Delo 400 XLE	10W-30		X		
	Delo 400 XLE	15W-40		X		2)
Chevron Lubricants (Texaco)	Ursa Ultra LE	15W-40	X			2)
ExxonMobil Corporation	Mobil Delvac 1 ESP	0W-30	X			
	Mobil Delvac 1 ESP	5W-40		X		
	Mobil Delvac 1300 Super F2	15W-40	X			
	Mobil Fleet	15W-40	X			2)
eni S.P.A.	eni i-Sigma top MS	15W-40	X			2)
Fuchs Europe	Fuchs Titan Cargo	15W-40	X			2)
Fuchs Petrolub SE	Fuchs Titan Cargo	10W-30	X			
	Fuchs Titan Cargo	15W-40	X			2)
Gulf Oil International	Gulf Supreme Duty XLE	15W-40	X			2)
	Gulf Supreme Duty XLE	10W-30	X			
Hitachi	Hitachi Genuine Engine Oil 10W-40 DH-2	10W-40	X			
Kuwait Petroleum	Q8 T 760	10W-30	X			
Lotos Oil	Turdus Powertec 1100	15W-40	X			2)
Morris Lubricants	Versimax HD6	15W-40	X			2)
MPM International Oil Company B.V.	Motor Oil 15W-40 Extra High Performance	15W-40	X			2)
OOO "LLK-International"	Lukoil Avantgarde Professional LA	10W-30	X			
	Lukoil Avantgarde Professional LA	10W-40	X			
	Lukoil Avantgarde Professional LA	15W-40	X			2)
Panolin AG	Panolin Universal LA-X	15W-40	X			2)
Pennzoil Products	Pennzoil Long-Life Gold	15W-40		X		2)
Petro-Canada	Duron -E	15W-40	X			2)
Phillips 66 Lubricants	Fleet Supreme EC	15W-40	X			2) also approved for Series 4000-04 C
	Guardol ECT	15W-40	X			2)
	Kenndall Super-D XA	15W-40	X			2)

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Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Prolube Lubricants	Prolube Ultraplus	15W-40	X			2)
Repsol Lubricantes Y Especialidades, S.A.	Repsol Diesel Turbo THPD Mid Saps	15W-40	X			2)
Shell International Petroleum Company	Shell Rimula Super	15W-40		X		2)
	Shell Rimula RT4L	15W-40		X		2)
	Shell Rotella T	15W-40		X		2)
	Shell Rotella T3	15W-40		X		2)
	Shell Rotella T5	10W-30	X			
	Shell Rotella T5	10W-40	X			
	Shell Rotella T6	5W-40		X		
	Shell Rimula R5 LE	10W-30	X			
	Shell Rimula R5 LE	10W-40	X			
	Shell Rotella T Triple Protection	15W-40		X		
	Shell Rimula R4 MV	15W-40	X			2)
	Shell Rimula R4 L	15W-40	X			2)
	SK energy	ZIC XQ 5000	15W-40	X		
SRS Schmierstoff Vertrieb GmbH	SRS Turbo Rekord plus	15W-40	X			2)
	SRS Turbo Rekord plus FE	10W-40	X			
Total Lubrifiants	Total Rubia TIR 7900	15W-40	X			
	Total Rubia Works 2000	10W-40	X			
	Total Max Star FE	10W-30	X			
	Total Rubia Works 2000 FE 10W-30	10W-30	X			
Trinidad & Tobago National Petroleum Marketing Company Ltd. (NPMC)	Ultra Duty 15W-40 Engine Oil	15W-40	X			2)
Valvoline EMEA	Valvoline All Fleet Extra LE SAE 15W-40	15W-40	X			2)
	All-Fleet Extra LE NTI	15W-40	X			2)
	Premium Blue 8100 15W-40	15W-40	X			2)
Valvoline USA	All Fleet Plus	15W-40	X			2)
Verco International	April Superpro RXL 1 Gold Plus	15W-40	X			2)

Table 25:

5.6 Multigrade oils – Category 3 of SAE grades 5W-30, 5W-40 and 10W-40 for diesel engines

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

MTU multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 mgKOH/g	
MTU Asia China	Diesel Engine Oil - DEO 5W-30	5W-30			X	20 l canister: 60808/P available through MTU Suzhou

Table 26:

Further multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	> 12 mgKOH/g	
Addinol Lube Oil GmbH	Addinol Commercial 1040 E4	10W-40		X		
	Addinol Ultra Truck MD 0538	5W-30			X	
	Addinol Super Truck MD 1049	10W-40			X	
Aral AG	Aral Mega Turboral	10W-40			X	
	Aral Mega Turboral 10W-40	10W-40			X	
	Aral Super Turboral	5W-30			X	
Avia Mineralöl AG	Avia Turbosynth HT-E	10W-40			X	
	Avia Turbosynth HT-U	5W-30			X	
BayWa AG	Tectrol Super Truck 530	5W-30			X	
	Tectrol Super Truck 1040	10W-40		X		
Bucher AG Langenthal - Motorex Schmiertechnik	MC Power Plus SAE 10W/40	10W-40			X	
BP p.l.c.	BP Energol IC-MT 10W-40	10W-40			X	
	BP Vanellus Max	5W-30			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Castrol Ltd.	Castrol CRB Turbomax 10W-40 E4/E7	10W-40			X	
	Castrol Enduron MT	10W-40			X	
	Castrol Enduron Plus	5W-30			X	
	Castrol Elixion HD	5W-30			X	
	Castrol Vectron 10W-40 E4/E7	10W-40			X	
	Castrol Vectron Long Drain	10W-40			X	
	Castrol Vectron Long Drain 10W-40 E4/E7	10W-40			X	
	Castrol Vectron 5W-30 Arctic	5W-30			X	
	Castrol Vectron Fuel Saver 5W-30	5W-30			X	
	Castrol Vectron Fuel Saver E7	5W-30			X	
Cepsa	Cepsa Eurotrans SHPD	5W-30			X	
	Cepsa Eurotrans SHPD	10W-40		X		
Champion Chemicals N.V.	Champion New Energy 10W40 Ultra	10W-40			X	
Chemicis Khavremianeh Kohan	Chemicis Excel Plus	10W-40			X	
Chevron Lubricants (Caltex)	Delo Gold Ultra T	10W-40			X	
	Delo XLD Multigrade	10W-40			X	
Chevron Lubricants (Texaco)	Ursa HD	10W-40			X	
	Ursa Premium FE	5W-30			X	
	Ursa Super	10W-40		X		
	Ursa Super TDX	10W-40			X	
	Ursa TDX	10W-40			X	
Deutsche Ölwerke Lubmin GmbH	AVENO HC PT Diesel	10W-40			X	
eni S.P.A.	Agip Sigma Trucksint TFE	5W-40			X	
	Agip Sigma Super TFE	10W-40			X	
	eni i-Sigma top	10W-40			X	
Enoc Marketing LLC	Enoc Vulcan 770 SLD	10W-40		X		
	Enoc Vulcan SLD	10W-40			X	
Exxon Mobil Corporation	Mobil Delvac XHP Extra	10W-40			X	
	Mobil Delvac XHP Ultra 5W-30	5W-30			X	
	Mobil Delvac 1 SHC 5W-40	5W-40			X	
Exol Lubricants Ltd.	Taurus Extreme M3	10W-40			X	
Fabrika Maziva, FAM AD	Fenix Ultra Sint	10W-40			X	
Finke Mineralölwerk GmbH	AVIATICON Finko Truck LD	10W-40			X	
Fuchs Europe Schmierstoffe GmbH	Titan Cargo SL	5W-30			X	
	Titan Cargo MC	10W-40			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Fuchs Lubricants France	Cofran Marathon	10W-40			X	
	Fuchs Max Way E4	10W-40				
	Fuchs Max Way Ultra	5W-30				
Gulf Oil International	Gulf Fleet Force synth.	5W-30			X	
	Gulf Superfleet ELD	10W-40			X	
	Gulf Superfleet XLD	10W-40			X	
	Gulf Superfleet Synth ELD	10W-40			X	
High Industrial Lubricants & Liquids Corporation	Fastroil Force Ultra High Performance Diesel (UHPD)	10W-40			X	
Huiles Berliet S.A.	RTO Extensia RXD ECO	5W-30			X	
Iranol Oil Co.	Iranol D40000-EIII	10W-40			X	
Kuwait Petroleum	Q8 T 860	10W-40		X		
	Q8 T 860 D	10W-40			X	
	Q8 T 860 S	10W-40			X	
	Q8 T 905	10W-40	X			
Lotos Oil	Turdus Powertec 3000	10W-40			X	
	Turdus Powertec Synthetic	5W-30			X	
Lukoil Lubricants Europe Oy	Teboil Super XLD-2	5W-30			X	
Meguin	Megol Motorenöl Super LL Dimo Premium	10W-40			X	
MOL-LUB Kft	MOL Synt Diesel	10W-40		X		
	MOL Dynamic Synt Diesel E4	10W-40			X	
Orlen Oil Sp.o.o.	Platinum Ultor Max	5W-30			X	
OOO LLK International	Lukoil Avantgarde Professional	5W-30			X	
	Lukoil Avantgarde Professional	10W-40			X	
	Lukoil Avantgarde Professional M5	10W-40			X	
	Lukoil Avantgarde Professional M6	10W-40			X	
	Lukoil Avantgarde Ultra M3	15W-40			X	
Panolin	Panolin Diesel HTE	10W-40			X	
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia Extreme	5W-30		X		
	Galp Galaxia Ultra XHP	10W-40			X	
Petromin Corporation	Petromin Turbo Master LD	10W-40			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Petronas Lubricants International	Petronas Akros Synt Gold	10W-40			X	
	Arexons HD-Truck E7	10W-40			X	
	Urania Maximo	10W-40			X	
	Petronas Urania Optimo	10W-40			X	
	Urania 100 K	10W-40			X	
	Urania 5000 F	5W-30			X	
	Urania 5000 LD	10W-40			X	
	Urania FE	5W-30			X	
	Petronas Urania Maximo	5W-30			X	
PHI OIL GmbH	Motordor Silver 10W40	10W-40			X	
Raj Petro Specialities P Ltd.	Zoomol Rforce 8200 RF1	10W-40			X	
Ramoil S.p.A.	Duglas Oil Ultra HC 10W-40 UHPDO	10W-40			X	
Ravensberger Schmierstoff Vertrieb GmbH	RAVENOL Super Performance Truck	5W-30			X	
	RAVENOL Performance Truck	10W-40			X	
Repsol Lubricantes y Especialidades S.A.	Repsol Turbo UHPD	10W-40			X	
	Repsol Diesel Turbo VHPD	5W-30			X	
	Repsol Diesel Turbo UHPD Urban	10W-40			X	
RN-Lubricants, LLC	Rosneft Revolut D4	10W-40			X	
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40			X	
SCT Vertriebs GmbH	Fanfaro TRD E4 UHPD	10W-40		X		
	Mannol TS-6 UHPD Eco	10W-40		X		
	Pemco Diesel G-6 Eco UHPD	10W-40		X		
Shell International Petroleum Company	Shell Rimula R5 M	10W-40			X	
	Shell Rimula R6 M	10W-40			X	
	Shell Rimula R6 ME	5W-30			X	
	Shell Rimula R6 MS	10W-40			X	
SK Lubricants Co.	ZIC X7000	5W-30			X	
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TFF	10W-40			X	
	SRS Cargolub TFL	5W-30			X	
	SRS Cargolub TFG	10W-40			X	
	SRS Cargolub TFG plus	10W-40			X	
Tedex SA	Tedex Diesel Truck UHPD (S) Motor Oil	10W-40			X	
Total Lubrifiants	Gulf Gulfleet Highway 10W-40	10W-40			X	
	RTO Extensia ECO	5W-30			X	
	Total Rubia TIR 9200 FE	5W-30			X	

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Transnational Blenders B. V.	Engine Oil Super EHPD	10W-40			X	
Unil Opal	Unil Opal LCM 800	10W-40			X	
Valvoline EMEA	All Fleet Superior	10W-40			X	
	Profleet	10W-40			X	
	Valvoline All-Fleet Extreme NTI	10W-40		X		
Wolf Oil Corporation N.V.	Wolf Vitaltech 10W40 Ultra	10W-40			X	
	Champion New Energy 10W40 Ultra	10W-40			X	

Table 27:

5.7 Multigrade oils – Category 3.1 (Low SAPS oils) of SAE grades 5W-30, 10W-30 and 10W-40

For details and special features, see chapter "Lubricants for four-cycle engines" (→ Page 7)

Important information

²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

Multigrade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Extra Truck MD 1049 LE	10W-40	X			
Aral AG	Aral Mega Turboral LA	10W-40	X			
	Aral Super Turboral LA	5W-30	X			
BayWa AG	Tectrol Super Truck Plus XL 1040	10W-40	X			
Bucher AG Langenthal	Motorex Focus QTM	10W-40	X			
	Motorex Nexus FE SAE 5W-30	5W-30	X			
BP p.l.c.	BP Vanellus Max Drain Eco	10W-40		X		
	BP Vanellus Max Eco 10W-40	10W-40		X		
BVG Vertriebsgesellschaft AG	Alpha Advanced Eco-Efficiency low SAPS	10W-40	X			
Castrol Ltd.	Castrol Vecton Long Drain 10W-30 E6/E9	10W-30	X			
	Castrol Vecton Long Drain 10W-40 E6/E9	10W-40	X			
	Castrol Vecton Fuel Saver 5W-30 E6/E9	5W-30	X			
Cepsa Comercial Petroleo, SA	Cepsa Eurotech LS 10W40 Plus	10W-40		X		
Champion Chemicals N.V.	Champion OEM Specific 10W40 Ultra MS	10W-40		X		
Chevron Lubricants (Caltex)	Delo XLE Multigrade	10W-40	X			
Chevron Lubricants (Chevron)	Delo 400 RDE	10W-30		X		
	Delo 400 RDS	10W-40		X		
	Delo 400 XLE	15W-40	X			
	Delo 400 XLE HD	5W-30		X		
	Delo 400 XLE HD	10W-40		X		
	Delo 400 XLE SYN-HD	10W-40		X		
	Delo 400 XLE Synthetic	5W-30	X			
	Delo 400 LE Synthetic	5W-30	X			
Chevron Lubricants (Texaco)	Ursa Ultra X	10W-30		X		

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Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
CONDAT Lubrifiants	Vicam Planet 10W40	10W-40			X	
Deutsche Ölwerke Lubmin GmbH	AVENO Universal UHPD	10W-40				
De Oliebron B.V.	Tor Turbosynth LSP Plus	10W-40			X	
eni S.p.a.	eni i-Sigma top MS	10W-40	X			
Enoc Marketing L.L.C.	Enoc Vulkan Green	10W-40			X	
Exxon Mobil Corporation	Mobil Delvac 1 ESP	5W-30		X		
	Mobil Delvac 1 LE	5W-30	X			
	Mobil Delvac HD	10W-40		X		
	Mobil Delvac XHP ESP M	10W-40			X	
	Mobil Delvac XHP LE	10W-40			X	55 gallons: 800141
	Mobil Delvac XHP Ultra LE	5W-30		X		
Finke Mineralölwerk GmbH	AVIATICON Finko Super Truck LA Plus	10W-40		X		
Fuchs Petrolub SE	Titan Cargo Maxx	5W-30			X	
	Titan Cargo Maxx	10W-40			X	
	Fuchs Titan Cargo EU6	5W-30	X			
Fuchs Schmierstoffe GmbH	Fuchs Titan Cargo LA	5W-30	X			
Gulf Oil International	Gulf Superfleet Synth ULE	5W-30	X			
	Gulf Superfleet XLE	10W-40	X			
	Gulf Superfleet Synth XLE	10W-30		X		
	Gulf Superfleet Synth XLE	10W-40	X			
	Gulf Superfleet Universal	10W-40			X	
Helios Lubeoil	Helios Premium KMXX 10W-40	10W-40	X			
Huiles Berliet S.A.	RTO Extensia FP	10W-40	X			
Igol	PRO 200 X	10W-40	X			
INA Maziva d.o.o.	INA Super 2009 5W-30	5W-30	X			
	INA Super 2009	10W-40			X	
Kuwait Petroleum R&T	Q8 905	10W-40	X			
	Q8 T 904	10W-40		X		
	Q8 T 904 FE	10W-30	X			
	Q8 T 905	10W-40	X			
	Q8 T 910	5W-30	X			
	Q8 Formula Truck 8500 FE	10W-30	X			
	Q8 Formula Truck 8700 FE	5W-30	X			
LLK finland Oy	Teboil Super XLD-2	5W-30			X	
Meguin GmbH & Co. KG	megol Motorenoel Low Saps	10W-40		X		

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Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Morris Lubricants	Ring Free Ultra	10W-40		X		
	Fendt Power Grade 10W-40	10W-40		X		
MPM International Oil Company B.V.	Motor Oil 10w-40 Premium Synthetic Ultra High Performance Diesel	10W-40		X		
Oel-Brack AG	Midland maxtra	10W-40		X		
OMV Petrol Ofisi A.Ş	Maximus HD-E	5W-30	X			
OOO LLK International	Lukoil Avantgarde CNG	10W-40	X			
	Lukoil Avantgarde Professional LE	5W-30			X	
	Lukoil Avantgarde Professional LS	5W-30	X			
	Lukoil Avantgarde Professional LS	10W-40			X	
	Lukoil Avantgarde Professional LS5	5W-30	X			
	Lukoil Avantgarde Professional LS5	10W-40	X			
Orlen Oil	Platinum Ultor Complete	10W-40	X			
	Platinum Ultor Optimo	10W-30	X			
	Platinum Ultor Progress	10W-40		X		
	Mogul Diesel L-SAPS	10W-40		X		
Panolin	Panolin Diesel Synth EU-4	10W-40	X			
	Panolin Ecomot	5W-30		X		
	Panolin Ecomot	10W-30	X			
	Panolin Ecomot	10W-40	X			
Petro-Canada Lubricants Inc.	Duron UHP 5W30	5W-30	X			
	Duron UHP E6 10W40	10W-40	X			
Petróleos de Portugal	Galp Galaxia Ultra LS	10W-40	X			
Petronas Lubricants International	Petronas Urania 5000 E	5W-30			X	
	Petronas Urania 5000 E	10W-40			X	
	Petronas Urania FE LS	5W-30			X	
	Petronas Urania Ecotech	10W-40			X	
PHI OIL GmbH	Motodor LSP Gold 5W30	5W-30			X	
	Motodor LSP Silver	10W-40		X		
Prista Oil Ad	Prista UHPD	10W-40	X			
Ravensberger Schmierölvertrieb GmbH	Ravenol Euro VI Truck	10W-40	X			
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Turbo UHPD MID SAPS	10W-40	X			
	Repsol DieselTurbo VHPD Mid Saps	5W-30		X		
Rowe Mineralölwerk GmbH	Rowe Hightec Truckstar SAE 10W-40 HC-LA	10W-40		X		

Manufacturer	Brand name	SAE viscosity class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Shell International Petroleum Company	Shell Rimula R6 LM	10W-40	X			Increased corrosion protection
	Shell Rimula R6 LME	5W-30		X		
	Shell Rimula Ultra	5W-30			X	
SK energy	ZIC XQ 5000	10W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Antikorrol MLA	10W-40		X		Increased corrosion protection
	SRS Cargolub TLA	10W-40	X			
	SRS Cargolub TLS	5W-30			X	
	SRS Cargolub TLS plus	5W-30		X		
	SRS Turbo Diesel LA	10W-40	X			
	SRS Cargolub low-friction engine oil LA	10W-40		X		
	SRS Turbo-Rekord top FE	10W-40		X		
	SRS Turbo-Rekord ultra FE	10W-40	X			
Statoil Lubricants	MaxWay Ultra E6 10W-40	10W-40			X	
Total Lubrificants	Total Rubia TIR 8900	10W-40	X			
	Total Rubia Works 2500	10W-40	X			
Transnational Blenders B. V.	Engine Oil Synthetic UHPD E6	10W-30		X		
	Engine Oil Synthetic UHPD E6	10W-40		X		
	Motor oil SCR	10W-40	X			
Valvoline EMEA	Valvoline ProFleet LS	5W-30			X	
	Valvoline ProFleet LS	10W-40	X			
	ProFleet LS NTI	10W-40	X			
Wibo Schmierstoffe GmbH	Wibokraft Ultra AF 10W40	10W-40		X		
Wolf Oil Corporation N.V.	Wolf Officialtech 10W40 Ultra MS	10W-40		X		
	Champion OEM Specific 10W40 Ultra MS	10W-40		X		
Yacco SAS	Yacco Transpo 65	10W-40			X	

Table 28:

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5.8 Lubricating Greases

5.8.1 Lubricating greases for general applications

For details and special features, see chapter "Lubricating greases" (→ Page 15)

Manufacturer	Brand name	Notes
Aral AG	Mehrzweckfett Arallub HL2	
BP p.l.c.	Energrease LS2	
Castrol Ltd.	Spheerol AP2	
Chevron	Multifak EP2	
SRS Schmierstoff Vertrieb GmbH	SRS Wiolub LFK2	
Shell Deutschland GmbH	Shell Gadus S2 V220 2	
Total	Total Multis EP2	
Veedol International	Multipurpose	

Table 29:

5.8.2 Lubricating greases for diesel engine-generator set components

Important		
Mixtures of different greases are not permitted!		
Manufacturer	Brand name	Notes
Exxon Mobil Corporation	Mobil Polyrex EM	High-temperature grease: Lubricity in the range from -30 to 250 °C (-22 to 482 °F) For: <ul style="list-style-type: none"> • Generator bearings of Marathon generators • Generator bearings of Leroy-Somer generators^{*)} • Fan wheel and belt pulley bearing on electrically driven coolant cooler, Series 4000
Shell	GADUS S3 V220C	For generator bearings of Leroy-Somer generators ^{*)}
SKF	Mehrzweckfett LGMT2	For generator bearings of HM generators
ROCOL Limited	Rocol RTD-Compound	For belt tensioner on electrically driven coolant cooler, Series 4000
ASCO Power Technologies	Lubrication Kit 75-100	For automatic transfer switch (ATS) ASCO

^{*)} NOTE: For information about the applicable lubricating greases for Leroy-Somer generators, refer to the nameplate on the generator.

For information about lubricating greases for generators made by other manufacturers, please contact MTU Onsite Energy service partners.

6 Approved Coolants

6.1 Coolants without antifreeze for cooling systems containing light metal

6.1.1 Coolant without antifreeze – Concentrates for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Important information

For the marine engine Series 1163-03 and 1163-04, only coolants marked with an asterisk * in the brand name can be used!

Coolants without antifreeze – concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate*		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool® Plus 6000 Concentrate*		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
Arteco NV	Freecor NBI		X				6000 / 2	
BASF SE	Glyscorr G93 green*		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	6000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 6000	X				X	6000 / 2	colored red
Drew Marine	Drewgard XTA*		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Valvoline	ZEREX G-93*		X				6000 / 2	
YORK SAS	York 719*		X				6000 / 2	

Table 30:

6.1.2 Coolant without antifreeze – Ready mixtures for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Important information

For the marine engine Series 1163-03 and 1163-04, only coolants marked with an asterisk * in the brand name can be used

Coolant without antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS10/90 Corrosion Inhibitor Premix*		X				6000 / 2	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)

Table 31:

6.2 Coolants without antifreeze for cooling systems free of light metal

6.2.1 Coolants without antifreeze – Concentrates for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Coolants without antifreeze – concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X				6000 / 2	X00057233 (20 l) X00057232 (210 l) X00070455 (1000 l) also available through MTU Asia
MTU America Inc.	Power Cool®Plus 6000 Concentrate		X				6000 / 2	colored green 23533526 (1 gallon) 23533527 (5 gallons) available through MTU America
Arteco NV	Freecor NBI		X				6000 / 2	
	Havoline Extended Life Corrosion Inhibitor [EU Code 32765] (XLI)	X					6000 / 2	
BASF SE	Glysacorr G93 green		X				6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	X				X	6000 / 2	
CCI Corporation	A 216	X				X	6000 / 2	
CCI Manufacturing IL Corporation	A 216	X				X	6000 / 2	X00051509 (208 l)
Chevron Corp.	Texcool A – 200		X				6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 2000		X	X			6000 / 2	
	Power Cool Plus 6000	X				X	6000 / 2	colored red
Drew Marine	Drewgard XTA		X				6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X	6000 / 2	
Fleetguard	DCA-4L		X	X	X		2000 / 1	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Nalco	Alfloc (Maxitreat) 3477	X					6000 / 2	
	Alfloc 2000		X	X			6000 / 2	
	Nalco 2000		X	X			6000 / 2	
	Nalcool 2000		X	X			6000 / 2	
	Trac 102		X	X			6000 / 2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X	6000 / 2	
Penray	Pencool 2000		X	X			6000 / 2	
PrixMax Australia Pty. Ltd.	PrixMax RCP	X					6000 / 2	
Total	Total WT Supra	X					6000 / 2	
Valvoline	Zerex G-93		X				6000 / 2	
YORK SAS	York 719		X				6000 / 2	

Table 32:

6.2.2 Coolant without antifreeze – Ready mixtures for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Coolant without antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X				6000 / 2	X00069385 (20 l) X00069386 (210 l) X00069387 (1000 l) (sales region: Italy)
Nalco	Alfloc (Maxitreat) 3443 (7 %)	X					6000 / 2	

Table 33:

6.3 Antifreezes for cooling systems containing light metal

6.3.1 Antifreeze – Concentrates for cooling systems containing light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100 Antifreeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l) also available through MTU Asia
Avia Mineralöl AG	Antifreeze APN	X	X				9000 / 5	
	Antifreeze APN - S	X					9000 / 3	
BASF SE	Glystantin G05		X	X			9000 / 5	
	Glystantin G48 blue green	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glystantin G30 pink	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48	X	X				9000 / 5	
Castrol	Castrol Radicool NF	X	X				9000 / 5	
CCI Corporation	L 415	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521	X				X	9000 / 3	
Clariant	Genantin Super		X	X			9000 / 5	
Classic Schmierstoff GmbH + Co KG	Classic Kolda UE G48	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream® G30® Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48® Antifreeze Coolant Concentrate	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant	X				X	9000 / 3	
	Power Cool Diesel Engine Coolant		X	X			9000 / 3	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Mobil Heavy Duty Coolant		X	X			9000 / 3	
	Mobil Mining Coolant		X	X			9000 / 3	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F30	X					9000 / 3	
	AVIATICON Finkofreeze F48	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
Gazpromneft Lubricants Ltd.	Belaz G-Profi Antifreeze Red	X					9000 / 3	
Krafft S.L.U.	Refrigerante ACU 2300		X	X			9000 / 3	X00058075 (barrel)
Kuttenkeuler GmbH	Kuttenkeuler Antifreeze ANF KK48	X	X				9000 / 5	
	Glycostar®ST48	X	X				9000 / 5	
INA Maziva Ltd.	INA Antifriz AI Super	X	X				9000 / 5	
Mitan Mineralöl GmbH	Alpine C48	X	X				9000 / 5	
Nalco	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48 C	X	X				9000 / 5	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X	9000 / 3	
	Fleet Charge SCA Pre-charged Coolant / Antifreeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze	X				X	9000 / 3	
OMV	OMV Coolant Plus	X	X				9000 / 5	
	OMV Coolant SF	X					9000 / 3	
Panolin AG	Panolin Anti-Frost MT-325	X	X				9000 / 5	
Penske Power Systems	Power Cool - HB500 Coolant Concentrate	X	X				9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Concentrate	X	X				9000 / 5	
Recochem Inc.	R542	X	X				9000 / 3	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
SMB - Sotagal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total	Glacelf MDX	X	X				9000 / 5	
Valvoline	Zerex G-05		X	X			9000 / 5	
	Zerex G-48	X	X				9000 / 5	
	Zerex G-30	X					9000 / 3	
YORK SAS	York 716	X	X				9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 K	X					9000 / 3	

Table 34:

6.3.2 Antifreeze – Concentrates for special applications

For details and special features, see chapter on “Coolants” (→ Page 17)

Concentrates for special applications

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
BASF SE	G206	X	X				9000 / 3	For use in arctic regions (< -40 °C)

Table 35:

6.3.3 Antifreeze – Ready mixtures for cooling systems containing light metals

For details and special features, see chapter on “Coolants” (→ Page 17)

Ready mixtures for cooling systems containing light metals

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Antifreeze Premix	X	X				9000 / 5	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant AH 40/60 Antifreeze Premix	X	X				9000 / 5	X00070533 (20 l) X00070531 (210 l) X00070532 (1000 l) (sales region: England, Spain)
	Coolant AH 50/50 Antifreeze Premix	X	X				9000 / 5	X00070528 (20 l) X00070530 (210 l) X00070527 (1000 l) (sales region: England)
	Coolant RM30 (40 %)	X					9000 / 3	X00073922 (20 l) X00073916 (205 l) X00073923 (1000 l)
MTU America Inc.	Power Cool® Universal 35/65 mix	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix	X	X				9000 / 5	800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			9000 / 5	23533531 (5 gallons) 23533532 (55 gallons)
Bantleon	Avilub Antifreeze Mix (50 %)	X	X				9000 / 5	X00049213 (210 l)
BayWa AG	Tectrol Coolprotect Mix 3000	X					9000 / 3	Antifreeze protection up to -24 °C
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
Castrol	Castrol Radicool NF Pre-mix (45%)	X	X				9000 / 5	
CCI Corporation	L 415 (50%)	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	X				X	9000 / 3	
Cepsa Comercial Petróleo S.A.U.	XTAR Super Coolant Hybrid NF 50%	X	X				9000 / 5	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X	9000 / 3	
	Power Cool Prediluted 50/50 Diesel Engine Coolant		X	X			9000 / 3	
Exxon Mobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F48 RM 50/50	X	X				9000 / 5	
	AVIATICON Finkofreeze F30 RM 40:60 +	X					9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/ Antifreeze (50/50)	X				X	9000 / 3	
	Fleet Charge SCA Pre-charged 50/50 Prediluted Coolant		X	X			9000 / 3	
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
Raloy Lubricantes	Antifreez Long Life NF-300 Ready-to-Use (50:50)	X	X				9000 / 5	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	
Tosol-Sintez	Glystantin Alu Protect G30 Ready Mix	X					9000 / 3	
	Glystantin Alu Protect Plus G48 Ready Mix	X	X				9000 / 5	
Total	Coolelf MDX (-26 °C)	X	X				9000 / 5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready	X					9000 / 3	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 (50%)	X					9000 / 3	

Table 36:

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6.4 Antifreezes for cooling systems free of light metal

6.4.1 Antifreeze – Concentrates for cooling systems free of light metal

For details and special features, see chapter on “Coolants” (→ Page 17)

Important information

For the Series 4000-04 and 4000-05, only coolants marked with an asterisk * in the brand name can be used!

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH100* Antifreeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) X00068202 (1000 l) also available through MTU Asia
Artego NV	Havoline Extended Life Coolant XLC [EU Code 30379]	X					9000 / 3	
Avia Mineralöl AG	Antifreeze APN*	X	X				9000 / 5	
	Antifreeze APN - S*	X					9000 / 3	
BASF SE	Glysantin G05		X	X			9000 / 5	
	Glysantin G48 blue green*	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30 pink*	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
BayWa AG	Tectrol Coolprotect*	X	X				9000 / 5	
BP Lubricants	ARAL Antifreeze Extra*	X	X				9000 / 5	
	Castrol Heavy Duty Extended Life Coolant*	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48*	X	X				9000 / 5	
Caltex	Caltex Extended Life Coolant [AP Code 510614] (XLC)	X					9000 / 3	
Castrol	Castrol Radicool NF*	X	X				9000 / 5	
CCI Corporation	L415*	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C521*	X				X	9000 / 3	
Chevron Corp.	Havoline Dexcool Extended Life Antifreeze [US Code 227994]	X					9000 / 3	
Clariant	Genantin Super		X	X			9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Classic Schmierstoff GmbH + Co. KG	Classic Kolda UE G48*	X	X				9000 / 5	
Comma Oil & Chemicals Ltd.	Comma Xstream® G30®* Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48®* Antifreeze Coolant Concentrate	X	X				9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze		X	X			9000 / 3	
	Power Cool Plus Coolant*	X				X	9000 / 3	
	Power Cool Diesel Engine Coolant		X	X			9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant*	X				X	9000 / 3	
	Mobil Antifreeze Advanced*	X					9000 / 3	
	Mobil Antifreeze Extra*	X	X				9000 / 5	
	Mobil Antifreeze Special		X	X			9000 / 5	
	Mobil Heavy Duty Coolant		X	X			9000 / 3	
	Mobil Mining Coolant		X	X			9000 / 3	
	Esso Antifreeze Advanced*	X					9000 / 3	
	Esso Antifreeze Extra*	X	X				9000 / 5	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F30*	X					9000 / 3	
	AVIATICON Finkofreeze F48*	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin*	X	X				9000 / 5	
	Maintain Fricofin G12 Plus*	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
	Maintain Fricofin HDD [Oil-code T-AF3-1]		X	X		X	9000 / 3	
Gazpromneft Lubricants Ltd.	Belaz G-Profi Antifreeze Red*	X					9000 / 3	
	G - Energy Antifreeze SNF	X					9000 / 3	
Krafft S.L.U	Refrigerante ACU 2300		X	X			9000 / 3	X00058075 (barrel)
Kuttenkeuler GmbH	Kuttenkeuler Antifreeze ANF KK48*	X	X				9000 / 5	
	Glycostar® ST48*	X	X				9000 / 5	
INA Maziva Ltd.	INA Antifriz AI Super*	X	X				9000 / 5	
Mitan Mineralöl GmbH	Alpine C48*	X	X				9000 / 5	
MOL-Lub Kft.	EVOX Premium concentrate	X					9000 / 3	

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Nalco	Nalcool 4070	X	X	X			9000 / 3	
	Nalcool 5990	X	X				9000 / 3	
Nalco Australia	Nalcool NF 48 C*	X	X				9000 / 5	
OAo Technoform	Cool Stream Premium C	X					9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant*	X				X	9000 / 3	
	Fleetcharge SCA Pre-charged Coolant / Anti-freeze		X	X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze*	X				X	9000 / 3	
OMV	OMV Coolant Plus*	X	X				9000 / 5	
	OMV Coolant SF*	X					9000 / 3	
Panolin AG	Panolin Anti-Frost MT-325*	X	X				9000 / 5	
Penske Power Systems	Power Cool - HB500	X	X				9000 / 3	
	Power Cool - HB800	X	X	X			9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Concentrate*	X	X				9000 / 5	
Recochem Inc.	R542	X	X				9000 / 3	
	R824M	X	X	X			9000 / 3	
Shell	Shell HD Premium N		X	X			9000 / 3	
SMB - Sotragal / Mont Blanc	Antigel Power Cooling Concentrate*	X	X				9000 / 5	
Total	Glacelf Auto Supra	X					9000 / 3	
	Glacelf MDX*	X	X				9000 / 5	
	Glacelf Supra	X					9000 / 3	
Valvoline	Zerex G-05		X	X			9000 / 5	
	Zerex G-48*	X	X				9000 / 3	
	Zerex G-30*	X					9000 / 5	
YORK SAS	York 716*	X	X				9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 K*	X					9000 / 3	

Table 37:

6.4.2 Antifreeze – Concentrates for special applications

For details and special features, see chapter on “Coolants” (→ Page 17)

Concentrates for special applications

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
BASF SE	G206	X	X				9000 / 3	For use in arctic regions (< -40 °C) No approval for Ser- ies 4000-04

Table 38:

6.4.3 Antifreeze – Ready mixtures for cooling systems free of light metals

For details and special features, see chapter on “Coolants” (→ Page 17)

Important information

For the Series 4000-04 and 4000-05, only coolants marked with an asterisk * in the brand name can be used!

Antifreeze, ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
MTU Friedrichshafen GmbH	Coolant AH 35/65 Antifreeze Premix*	X	X				9000 / 5	X00069382 (20 l) X00069383 (210 l) X00069384 (1000 l) (sales region: Italy)
	Coolant AH 40/60 Antifreeze Premix*	X	X				9000 / 5	X00070533 (20 l) X00070531 (210 l) X00070532 (1000 l) (sales region: England, Spain)
	Coolant AH 50/50 Antifreeze Premix*	X	X				9000 / 5	X00070528 (20 l) X00070530 (210 l) X00070527 (1000 l) (sales region: England)
	Coolant RM 30 (40%)*	X					9000 / 3	X00073922 (20 l) X00073916 (205 l) X00073923 (1000 l)
MTU America Inc.	Power Cool® Universal 35/65 mix*	X	X				9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix*	X	X				9000 / 5	800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			9000 / 5	23533531 (5 gallons) 23533532 (55 gallons)
Arteco NV	Havoline Extended Life Coolant + B2 50/50 OF01 [EU Code 33073] (50%)	X					9000 / 3	
	Havoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40%)	X					9000 / 3	
	Havoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35%)	X					9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)*	X	X				9000 / 5	X00049213 (210 l)
BayWa AG	Tectrol Coolprotect Mix 3000*	X					9000 / 3	Antifreeze protection up to -24 °C

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
Bucher AG Langenthal	Motorex Coolant G48 ready to use (50/50)*	X	X				9000 / 5	
Caltex	Caltex Extended Life Coolant Pre-Mixed 50/50 [AP Code 510609] (50 %)	X					9000 / 3	
Castrol	Castrol Radicool NF Premix (45 %)*	X	X				9000 / 5	
CCI Corporation	L 415 (50 %)*	X				X	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50 %)*	X				X	9000 / 3	
Cepsa Comercial Petróleo S.A.U.	Xtar Super Coolant Hybrid NF 50%*	X	X				9000 / 5	
Chevron Corp.	Havoline Dexcool Extended Life Prediluted 50/50 Antifreeze Coolant [US Code 227995]	X					9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)*	X				X	9000 / 3	
	Power Cool Prediluted 50/50 Diesel Engine Coolant		X	X			9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F48 RM 50/50*	X	X				9000 / 5	
	AVIATICON Finkofreeze F30 RM 40:60 +	X					9000 / 3	
Fuchs Petrolub SE	Maintain Fricofin HDD Premix 50/50 [Oilcode T-AF3-2]		X	X		X	9000 / 3	
Nalco	Nalcool 4100 (50 %)	X	X	X			9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)*	X				X	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant / Antifreeze (50/50)*	X				X	9000 / 3	
	Fleet Charge SCA Pre-charged 50/50 Prediluted Coolant		X	X			9000 / 3	

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Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
	Power Cool - HB800 Premix 50/50	X	X	X			9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Ready-to-Use (50:50)*	X	X				9000 / 5	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44 %)*	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)*	X	X				9000 / 5	
Total	Coolelf MDX (-26 °C)*	X	X				9000 / 5	
	Coolelf Supra (40%)	X					9000 / 3	
	Coolelf GF NP (50%)	X					9000 / 3	
Tosol-Sinzez	Glystantin Alu Protect/G30 Ready Mix*	X					9000 / 3	
	Glystantin Protect Plus/G48 Ready Mix*	X	X				9000 / 5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready*	X					9000 / 3	
Valvoline	Zerex G-05 50/50 Mix		X	X			9000 / 5	
ZAO Obninskorgsintez	Lukoil Antifreeze HD G12 (50%)*	X					9000 / 3	

Table 39:

6.5 Coolant Additives with Limited Series Approval

6.5.1 Antifreeze - Concentrates and ready mixtures on ethylene-glycol basis for series with and without light metal

Antifreeze, concentrates

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
BASF SE	Glysantin®G40 pink (concentrate)	X	X				9000 / 3	X00066724 (20 l) X00066725 (210 l) Concentration for use: 40 to 50% by volume
Bucher AG Langenthal	Motorex Coolant M 4,0 Concentrate	X	X				9000 / 3	Antifreeze protection up to -38 °C
Valvoline	ZEREX G40 (concentrate)	X	X				9000 / 3	Concentration for use: 40 to 50% by volume Material number (USA): 800180 (Drum)

Table 40:

Antifreezes - ready mixtures

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Bucher AG Langenthal	Motorex Coolant M 4,0 Ready to use	X	X				9000 / 3	Antifreeze protection up to -38 °C

Table 41:

6.5.2 Antifreeze – Ready mixtures based on propylene glycol for series free of light metal

Antifreeze, ready mixture

Manufacturer	Brand name	Inhibitors					Operating time Hour / Year	Comments / Material number
		Organic	Silicon	Nitrite	Phosphatized	Molybdate		
Fleetguard	PG XL (40%) ready mixture		X	X	X		9000 / 3	

Table 42:

7 Flushing and Cleaning Specifications for Engine Coolant Circuits

7.1 General information

In the course of time, sludge deposits from aging coolant additives can accumulate in the coolant circuits. Reduced cooling capacity, clogged vent lines and drain points and dirty coolant level sight-glasses can result.

Below-standard water quality or incorrect coolant preparation can also heavily contaminate the system.

If such conditions occur, the coolant circuit is to be flushed out with fresh water, repeatedly if necessary.

If these flushing sequences are insufficient or if the system is too heavily contaminated, the coolant circuit and all affected parts must be cleaned.

Only clean, fresh water (no river or sea water) must be used for flushing.

Only products approved by MTU or corresponding products at the specified concentrations may be used for cleaning, see (→ Page 118). The specified cleaning procedure is to be complied with.

Immediately after flushing or cleaning, fill the coolant circuits with treated engine coolant as stipulated in the current MTU Fluids and Lubricants Specifications. Otherwise there is a danger of corrosion!

Important

Fluids and lubricants (e.g. treated engine coolant), used flushing water, cleaning agents and cleaning solutions can be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturer's instructions, legal requirements and technical guidelines valid in the individual countries. Considerable differences can apply from country to country so that no generally valid statement on the applicable regulations for fluids and lubricants etc. can be made in this publication.

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants / cleaning agents which it has approved.

Important

Scrap oil heat exchangers from engines with bearing or piston seizures or friction damage!

Test equipment, auxiliary materials and fluids and lubricants

MTU test kit or electric pH-value measuring instrument

Required auxiliary materials:

- Compressed air
- Superheated steam

Required fluids and lubricants:

- Fresh water
- Prepared engine coolant

7.2 Approved cleaning agents

Manufacturer	Product name	Concentration for use		Order No.
For coolant systems:				
Kluthe	Hakutex 111 ^{1, 5)}	2% by volume	Liquid	X00065751
	Hakupur 50-706-3 ¹⁰⁾	2% by volume	Liquid	X00055629
For subassemblies:				
Henkel	Bonderite C-AK FD ²⁾	1 to 10% by weight	Powder	⁷⁾
	Bonderite C-MC 11120 ³⁾	2 to 10% by weight	Powder	⁷⁾
Kluthe	Hakutex 60 MTU	100% by volume	Liquid	X00070585 (25 kg)
For coolant systems contaminated with bacteria, fungi or yeast (so-called system cleaners):				
Schülke & Mayr GmbH	Grotan WS Plus ⁵⁾	0.15% by volume	Liquid	X00065326 (10 kg)
	Grotanol SR2 ⁶⁾	0.5% by volume	Liquid	X00069827 (10 kg)
For external cooler on air side:				
Kluthe	Hakupur 50 K ⁹⁾	0.5 to 5% by volume	Liquid	X00070940 ⁷⁾
For painted, contaminated surfaces:				
Kluthe	Hakupur 449 ⁹⁾	1% by volume	Liquid	X00071179 ⁷⁾

Table 43:

¹⁾ For light lime deposits, light corrosion

²⁾ For greasy lime deposits

³⁾ Preferred for heavy lime deposits

⁴⁾ For heavy lime deposits

⁵⁾ Bacteria contamination up to 10^4

⁶⁾ Bacteria contamination up to $> 10^4$, contamination with fungi and yeast

⁷⁾ Not stocked by MTU

⁸⁾ With serious corrosion; not permitted for aluminum materials

⁹⁾ Cleaning agent for cleaning with high-pressure cleaning device (parameter: Pressure: 15 bar, gentle spray jet, cleaning agent temperature: 80 °C)

¹⁰⁾ Not suitable for galvanized surfaces

Important information

The technical data sheets and safety data sheets of the product must be observed!

7.3 Engine coolant circuits - Flushing

1. Drain engine coolant.
2. Measure pH-value of the fresh water using the MTU test kit or electric pH-value measuring device.
3. Fill coolant circuit with fresh water.

Important information

Never pour cold water into a hot engine!

4. Preheat, start and run engine until warm.
5. Run engine for approx. 30 minutes at increased speed.
6. Take flush-water sample at engine-coolant-sample extraction cock.
7. Shut down engine.
8. Drain flush water.
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
 - a) pH value difference < 1 : Fill system with treated coolant and start engine.
 - b) pH value difference > 1 : Fill system with fresh flush water and repeat flushing process.
 - c) If the pH value difference is still > 1 after 4 to 5 flushing operations: The coolant circuit must be cleaned, see (→ Page 120). The assemblies may also have to be cleaned, see (→ Page 121).

Important information

Refer to the engine operating instructions for additional information.

7.4 Engine coolant circuits – Cleaning

1. Cleaning agents for coolant circuits are prepared in warm, fresh water as a concentrated solution, see (→ Page 118).
2. In the case of powdered products, stir until the cleaning agent is completely dissolved and without sediment.
3. Pour solution together with fresh water into coolant circuit.
4. Start engine and run until warm.
5. Select temperature and duration of residence time according to the specifications of the technical data sheets of the manufacturer.
6. Shut down engine.
7. Drain off cleaning agents and flush the engine coolant circuit with fresh water.
8. Take flush-water sample at engine-coolant-sample extraction cock.
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
 - a) pH value difference < 1: Fill system with treated coolant and start engine.
 - b) pH value difference > 1: Clean assemblies, see (→ Page 121).

Important information

Refer to the engine operating instructions for additional information.

7.5 Assemblies – Cleaning

1. Remove, disassemble and clean assemblies that are exposed to heavy sludge deposits e.g. expansion tanks, preheating units, heat exchangers (coolant cooler, oil heat-exchanger, charge-air cooler, charge-air preheater, fuel preheater etc.) and lower sections of pipework.
2. Before cleaning, examine degree of contamination on water sides.
3. If greasy lime deposits are found, first degrease the water side.
4. Deposits in charge-air coolers caused by oil mist can be removed using Kluthe Hakutex 60.
5. Remove hard lime deposits with a decalcifying product. In the event of stubborn lime deposits, if necessary a 10% inhibited hydrochloric acid solution may have to be used.
6. Dissolve deposits on and in heat-exchanger elements in a heated cleaning bath. Observe the manufacturer's specifications and use only approved detergents in the permissible concentration, see (→ Page 118)

Important information

Deposits on the oil side can also be dissolved in a kerosene bath.
The dwell time in the cleaning bath depends on the type and degree of contamination, as well as the temperature and activity of the bath.

7. Clean individual components such as housings, covers, pipes, sight glasses, heat-exchanger elements with superheated steam, a nylon brush (soft) and a powerful water jet.

Important information

In order to avoid damage:
Do not use hard or sharp-edged tools (steel brushes, scrapers, etc.) (oxide protective layer).
Do not set the pressure of the water jet too high (may damage cooler fins, for example).

8. After cleaning, blow through the heat exchanger elements with low-pressure steam in the direction opposite to operational flow, rinse with clear water (until pH-value difference is < 1) and blow dry with compressed or hot air.
9. Check that all components are in perfect condition, repair or replace as necessary.
10. Flush oil and engine coolant sides of heat-exchanger elements with corrosion-inhibiting oil. This step may be omitted if the heat exchanger is installed and taken into service immediately after cleaning.
11. After installing all assemblies, flush engine coolant circuit once, see (→ Page 119).
12. Check coolant system for leaks during initial operation of engine.

Important information

For further information, see the Maintenance Manual for the engine in question.

7.6 Coolant circuits contaminated with bacteria, fungi or yeast

System cleaning

The system cleaner must flow a sufficiently long time through the complete cooling system to ensure effective cleaning and disinfection.

Therefore, the predefined amount of the approved system cleaner must be added to the contaminated coolant in the system, see (→ Page 118). Use a circulating pump to provide continuous mixture flow through the coolant system for at least 24 hours or max. 48 hours.

Flushing

When the coolant and system cleaner have been drained, the cooling circuit must be flushed with fresh water. Flushing must be carried out until no more contaminants are visible and the flushing liquid has the same pH-value as the fresh water used (max. pH-value difference < 1).

Refill

Before refilling the circuit, make sure the system is free of contaminants.

Refill must be performed directly after flushing to avoid the risk of corrosion!

8 Revision Overview

8.1 Revision overview from version A001064/08 to version A001064/09

Seq. No.	Section	Subject	Page	Action
1	2.1	Engine oils – General information	(→ Page 7)	Revised
2	3.2	Operational monitoring	(→ Page 20)	Revised
3	3.5	Fresh water requirements	(→ Page 26)	Revised
4	3.9	Limit values for coolants	(→ Page 30)	Revised
5	3.10	Coolant concentrates – Storage capability	(→ Page 31)	Revised
6	4.1	Diesel fuels – General information	(→ Page 36)	Revised
7	4.2.1	Distillate fuels according to DIN EN 590 and ASTM D975	(→ Page 41)	Revised
8	4.2.3	Chinese distillate fuels according to GB 19147-2013 and 252-2011	(→ Page 44)	Revised
9	4.2.4	Heating oil	(→ Page 45)	Revised
10	4.2.6	Aviation turbine fuel	(→ Page 48)	Revised
11	4.2.7	NATO diesel fuels	(→ Page 49)	Revised
12	4.2.9	B20 diesel fuel	(→ Page 53)	Revised
13	4.5	Unsuitable materials in diesel fuel circuit	(→ Page 64)	Revised
14	5.1	Single-grade oils – Category 1, SAE grades 30 and 40 for diesel engines	(→ Page 67)	Revised
15	5.2	Multigrade oils – Category 1, SAE grades 15W-40 for diesel engines	(→ Page 69)	Revised
16	5.3	Single-grade oils – Category 2, SAE-grades 30 and 40 for diesel engines	(→ Page 70)	Revised
17	5.4	Multigrade oils – Category 2 of SAE grades 10W-40, 15W-40 and 20W-40 for diesel engines	(→ Page 70)	Revised
18	5.5	Multigrade oils – Category 2.1 (Low SAPS oils) of SAE grades 0W-30, 10W-30, 5W-40, 10W-40 and 15W-40	(→ Page 82)	Revised
19	5.6	Multigrade oils – Category 3 of SAE grades 5W-30, 5W-40 and 10W-40 for diesel engines	(→ Page 85)	Revised

Seq. No.	Section	Subject	Page	Action
20	5.7	Multigrade oils – Category 3.1 (Low SAPS oils) of SAE grades 5W-30, 10W-30 and 10W-40	(→ Page 90)	Revised
21	6.1.1	Coolant without antifreeze – Concentrates for cooling systems containing light metal	(→ Page 96)	Revised
22	6.2.1	Coolants without antifreeze – Concentrates for cooling systems free of light metal	(→ Page 99)	Revised
23	6.3.1	Antifreeze – Concentrates for cooling systems containing light metal	(→ Page 102)	Revised
24	6.3.3	Antifreeze – Ready mixtures for cooling systems containing light metals	(→ Page 106)	Revised
25	6.4.1	Antifreeze – Concentrates for cooling systems free of light metal	(→ Page 108)	Revised
26	6.4.3	Antifreeze – Ready mixtures for cooling systems free of light metals	(→ Page 112)	Revised
27	6.5.1	Antifreeze – Concentrates and ready mixtures on ethylene-glycol basis for series with and without light metal	(→ Page 115)	Revised
28	7.2	Approved cleaning agents	(→ Page 118)	Revised

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Appendix B Electricity Line Drawing

LON1 Phase B Environmental Permit Variation Application

Best Available Techniques and Operating Techniques Assessment, LON1 Phase B

NTT Global Data Centers EMEA Limited

SLR Project No.: 410.V61547.00001

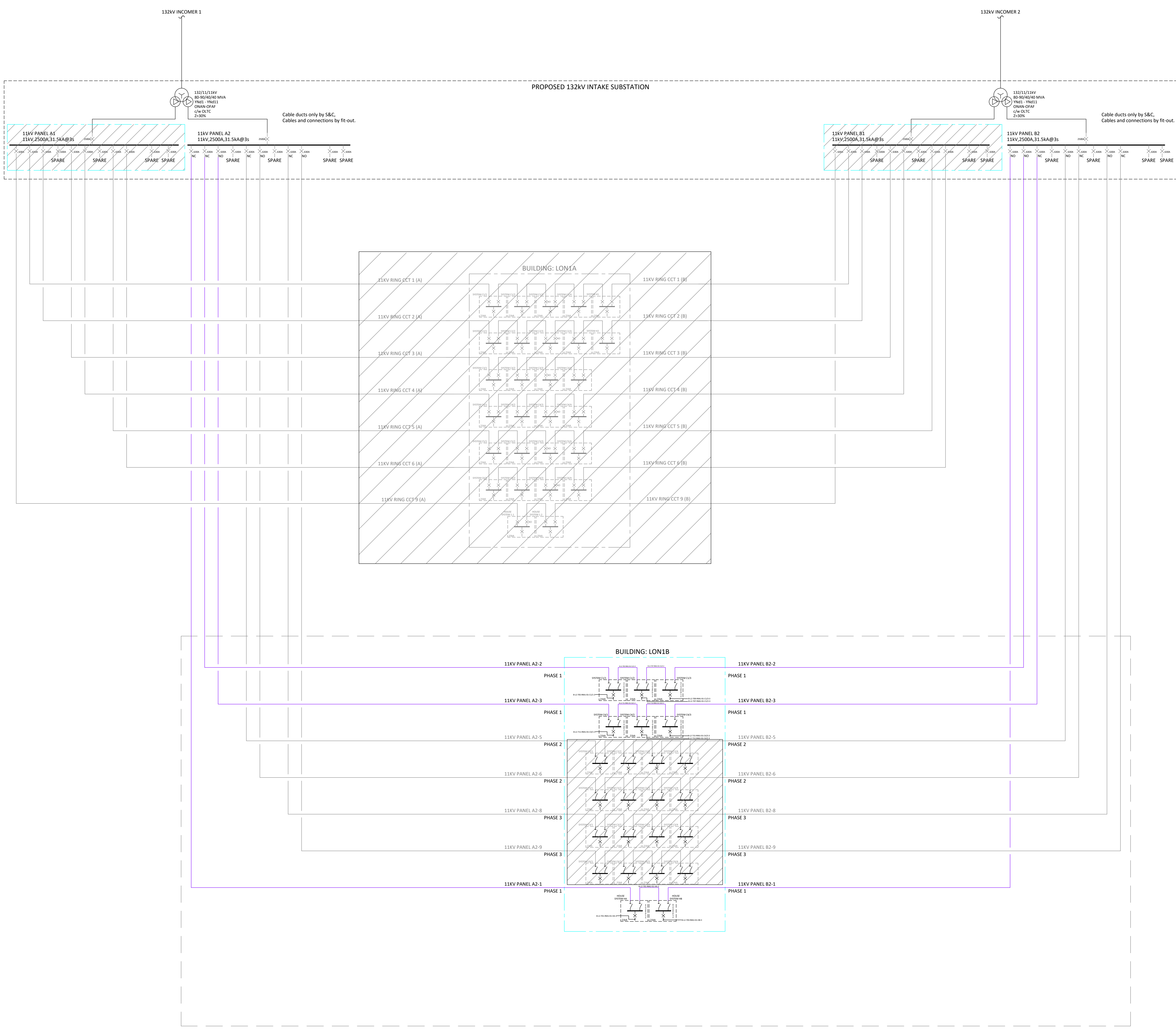
26 July 2024

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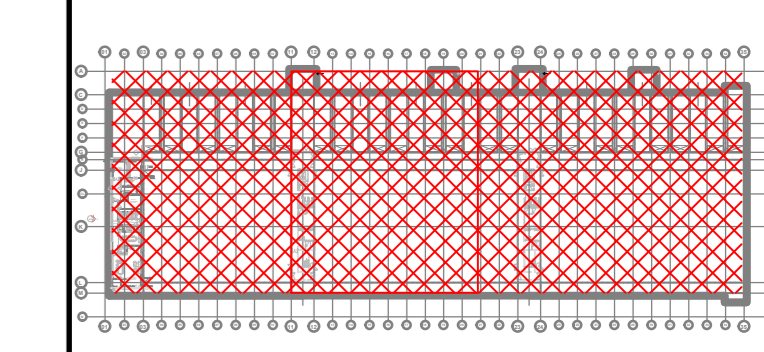
- NOTES:**
- The installation and design shall comply with the Occupational Health and Safety Act, and all Regulations.
 - All dimensions shown in millimetres.
 - This drawing shall be read in conjunction with all associated equipment schedules and mechanical, electrical, structural and architectural drawings.
 - All service routes, equipment locations & service/maintenance space shall be checked against fully detailed architectural, structural & services drawings.
 - All dimensions shall be checked on site.
 - The contractor shall fully comply with all relevant standards, regulations, standard codes of practice, methods of working, and good practice.
 - Coordination working drawings, installation drawings and submittals drawing shall be prepared by the contractor.
 - Dimensions shall not be scaled from the drawing. The contractor shall be responsible for obtaining all dimensions and levels on site for actual setting out of works.

PARTICULAR NOTES

- For MV cable details refer to the MV & HV Cable Schedule: ON18-B2-XX-SH-E-8103.
- Installed into ducts and manholes between Freedom's substation and Pods. The contractor to terminate both ends of the MV cable unless otherwise instructed.
- The contractor shall perform MV duct survey to validate the existing sleeves conditions and installation details like clear, size of duct, depth of the duct, bending radius as built information to validate the MV Cable size. The MV cable size noted in the schematic to be validated with MV duct survey information.
- Protection settings within the Freedom Substation to be done by specialist Delta Hv.
- The change over system shall be designed for closed transition with Mains after mains restoration. Only one LV Generator will be in closed transition with mains supply to limit MV fault current to 21kA. The detailed sequence of operation to be developed during next stages.
- Grid storage excluded. Grid export excluded.



REV	DATE	CHDR	DESCRIPTION
PO2	2022/07/28	DCW	Revised Stage 3 50% Issue - For Review
PO1	2022/02/04	AAL	Revised Stage 3 100% Issue
PO0	2022/10/28	AAL	RIBA STAGE 3 - 50% ISSUE



REVIEW

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Client: **NTT**

Project: **NTT COMMUNICATIONS DATACENTRE LON1B PHASE 1 & 2 & 3**

The **ELECTRICAL SERVICES**
ELECTRICAL DISTRIBUTION SCHEMATIC
11KV DISTRIBUTION AND 132KV INTAKE PHASE 1 & 2 & 3

Designed AAL	Checked AAL	Drawn AA	Rev PO2
Scale NTS@A0	Date Created OCT 2022	Dwg No. LON1B-RED-B2-XX-SC-E-01030	

Properties: Company Version: 2022 Date: 2022 User: NTS



Appendix C Drainage Plan

LON1 Phase B Environmental Permit Variation Application

Best Available Techniques and Operating Techniques Assessment, LON1 Phase B

NTT Global Data Centers EMEA Limited

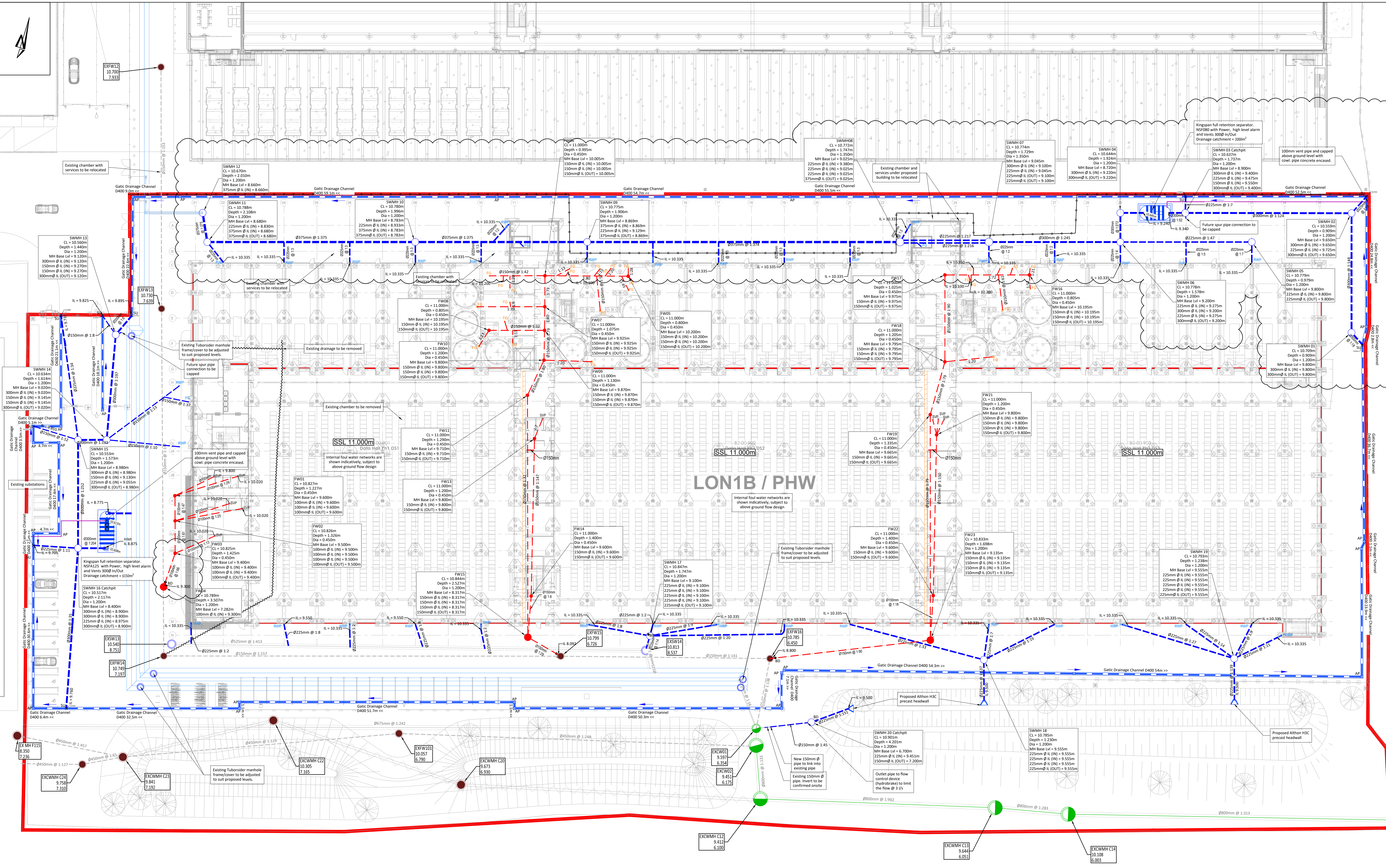
SLR Project No.: 410.V61547.00001

26 July 2024

GENERAL NOTES:

- This drawing shall be read in conjunction with all the relevant architects, engineers' and service engineers drawings specifications.
- Do Not Scale off the drawing.

- KEY:**
- Site Boundary
 - Proposed Building Level
 - Proposed Surface Water Pipe & Chamber
 - Proposed Foul Water Pipe & Chamber
 - Proposed Slot Drain & Sump Unit
 - Proposed Vent Pipe
 - Indicative 500mm Services Trench
 - Foul Water Pops
 - Rain Water Downspout (10.335mm u.n.o)
 - Proposed Backdrop
 - Rodding Eye
 - Existing Surface Water Pipe & Chamber
 - Existing Foul Water Pipe & Chamber
 - Existing Combined Water Pipe & Chamber
 - Existing Drainage to be Removed
 - Existing Temporary Fence Line



REV	DATE	BY	DESCRIPTION	CHKD
C05	20.07.23	SMB	SWMH10 to SWMH12 pipes invert amended Backdrops @ FW03 removed	SN
C04	14.07.23	SMB	Generator floor gullies and pipes run removed SWMH05 to SWMH08 pipes run amended	SN
C03	06.07.23	SMB	Pipe runs amended Canopy rainwater downpipes added	SN
C02	29.06.23	SMB	Pipes and Chambers added	SN
C01	22.06.23	SMB	Construction Issue	SN
P03	25.05.23	SMB	Internal drainage revised	SN
P02	15.05.23	SMB	Channel drainage revised	SN
P01	18.04.23	SMB	First Issue	SN

Notes:

- This drawing is to be read in conjunction with all relevant drawings, specifications and documentation.
- The position, size and levels of all drains are to be confirmed on site prior to the commencement of the works and any discrepancies reported immediately to the Engineer.
- Do not scale from this drawing, work to dimensions or co-ordinates provided. All levels are in metres and all dimensions are in millimetres, unless otherwise noted.
- The Contractor shall allow for the protection, temporary and permanent support and diversion works as necessary, to all existing services to the satisfaction of the public utilities.
- The Contractor shall allow for dealing with surface water run-off into excavations and from groundwater by means of pumps, pumping and de-watering as appropriate, in order to keep the excavation as reasonably dry as possible during the duration of the works.
- All private drainage within the site is to comply with the requirements of the relevant British/European Standard and the Building Regulations Part H.
- Concrete protection to pipework is to be provided as follows:
 - All pipework within pedestrian/soft areas with less than 600mm cover.
 - All pipework subject to vehicular overrun with less than 1.2m cover.
 - All pipework within manholes are to be laid soffit to soffit (U.N.O). All chamber invert levels are for the outgoing pipe levels. Backdrop pipework shall be connected to soffit to soffit with the rodding access level specified.
- Any gradients of drains indicated are indicative only and the Contractor shall install the drains to the specified levels shown for each manhole (U.N.O). Catchpit invert levels are for the outgoing pipe with the sump level specified separately.
- Co-ordinate setting out information for manholes is to the intersection of the drains and not the centre of the manhole.
- Cover levels of the manholes are provisional and subject to adjustment on site to suit the finished ground levels. All external works construction areas to be as located by the architect.
- Manhole covers and frames are to be in accordance with the relevant British/European Standard and the following:
 - Vehicular Areas: Class E600, double triangular, 150mm deep ductile iron cover and frame with three point cover seating, badged FW or SW for Foul or Surface Water drainage.
 - Pedestrian Areas: Class B125, 100mm deep, badged FW or SW for Foul or Surface Water drainage.
 - Double seal manhole covers and frames are to be used on internal foul water drainage chambers. Finish to be confirmed by the Architect.
- Heavy duty cover slabs are to be used within vehicular traffic areas.
- Gully gratings and steel channel covers are to be in accordance with the relevant British/European Standard as follows:
 - Areas subject to vehicular overrun. Class D400 minimum.
 - Areas not subject to regular vehicle overrun (adjacent to kerbs etc.) Class C250.
 - Gully gratings adjacent to kerbs shall be hinged on the side of the traffic direction (left hand side).
- Positions and sizes of above ground foul and surface water drainage connections are to be confirmed prior to construction with the Architect and M&E Engineer.
- All oil/petrol separators to have oil alarm system in accordance with Client's requirements and vents in accordance with manufacturer's details/recommendations. Separator to have full concrete surround to manufacturer's recommendations.

- Diameter of PCC manholes varies with pipe size, and is to be in accordance with the tables shown on the accompanying Burrows Graham Standard Details drawings.
- Drainage channels are to be sized by the supplier and approved by the Engineer in writing prior to ordering. Drainage channels to be installed to manufacturers' requirements. Design of channels shall be based on a 1 in 30 year storm return period, 15 minute duration.
- All brickwork in connection with drainage is to be solid Class B Engineering Brick to the relevant British/European Standard.
- All precast concrete pipes, chamber products and road gullies shall be to the relevant British/European Standard and should be Kite-marked/CE marked accordingly.
- In situ concrete grades to be as stated on the drawings. Design chemical class for all precast concrete products shall be C4 unless agreed otherwise.
- All separators shall be in accordance with the Environment Agency document PPG3.
- All below ground plastic/gro tanks shall be installed in accordance with the manufacturers' instructions. They shall be provided with sufficient concrete surround to counter floatation and shall have a wall thickness adequate to resist the highest ground water level which could be encountered at their location.
- All existing drainage/structures to be abandoned shall be broken out and removed from site, the excavation shall be backfilled with a suitable granular material to the required level. Alternatively, deep drains may be cleaned and grouted with a 1:10 cementitious grout, with structures broken down 1m below finished ground level and backfilled with a suitable granular material.
- Where utility/land drainage trenches etc cross over drain trenches, the Contractor shall construct an impermeable barrier to prevent groundwater infiltrating into the drainage trench.
- Upon completion of the works the Contractor shall clean all drainage by jetting, removing all debris from site, no debris shall be permitted to enter the existing drainage system.
- All works are assumed to be within public highway or within land owners lands & no works are required on third party land owners property.
- All RWP, gully and channel connections shall be 150mm dia U.N.O. Wast/soil stack connections shall be 150mm dia U.N.O and shall have internal above ground rodding eyes or large access fittings in accordance with Building Regulations.
- Design assumes that no water authority sewers or other drainage systems require modification, diversion or abandonment.
- Backfill to all drainage trenches to be Class GFI material.
- All works within the public highway to be reinstated to highway authority requirements.
- Unless otherwise agreed all outfalls to ponds and watercourses to be proprietary PCC Units. Headwall details to be approved by local Internal Drainage Board where applicable.
- Peristocks where indicated shall be electronically operated complete with power supply and connection (refer to service engineers drawings for cable and ducting etc).
- No deep rooting trees/vegetation should be planted within 5.0m of any drainage works.
- All WPC's, SRWP's and RWP's are shown inductively. Locations shall be confirmed by others.
- All manholes less than 1.5m deep are considered as none man entry and shall be maintained from ground level.
- Below ground drainage connections to be provided to all canopy downpipes - 150mm dia with concrete bed and surround U.N.O.

Burrows Graham

North Office: 5 Ambassador Place, Stockport Road, Altrincham WA15 6ER
Tel: +44 (0)161 804 8046

South Office: Barkfield House, Dover Meads, High Street, Bournemouth BH2 2BL
Tel: +44 (0)1202 604 6066



PROJECT
**NTT LON 1B DATA CENTRE
DAGENHAM**

DRAWING TITLE
PROPOSED DRAINAGE PLAN

REV	DATE	BY	DESCRIPTION	CHKD
C05	20.07.23	SMB	SWMH10 to SWMH12 pipes invert amended Backdrops @ FW03 removed	SN
C04	14.07.23	SMB	Generator floor gullies and pipes run removed SWMH05 to SWMH08 pipes run amended	SN
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C01	22.06.23	SMB	Construction Issue	SN
P03	25.05.23	SMB	Internal drainage revised	SN
P02	15.05.23	SMB	Channel drainage revised	SN
P01	18.04.23	SMB	First Issue	SN

SCALE @ A0 1:250 DATE 18.04.2023 DRAWN BY SMB CHECKED BY SN

PROJECT NUMBER 22216 DRAWING STATUS CONSTRUCTION OFFICE SOUTH

DRAWING TITLE PROPOSED DRAINAGE PLAN

SCALE BAR 1:250



Appendix D Generator Room Design

LON1 Phase B Environmental Permit Variation Application

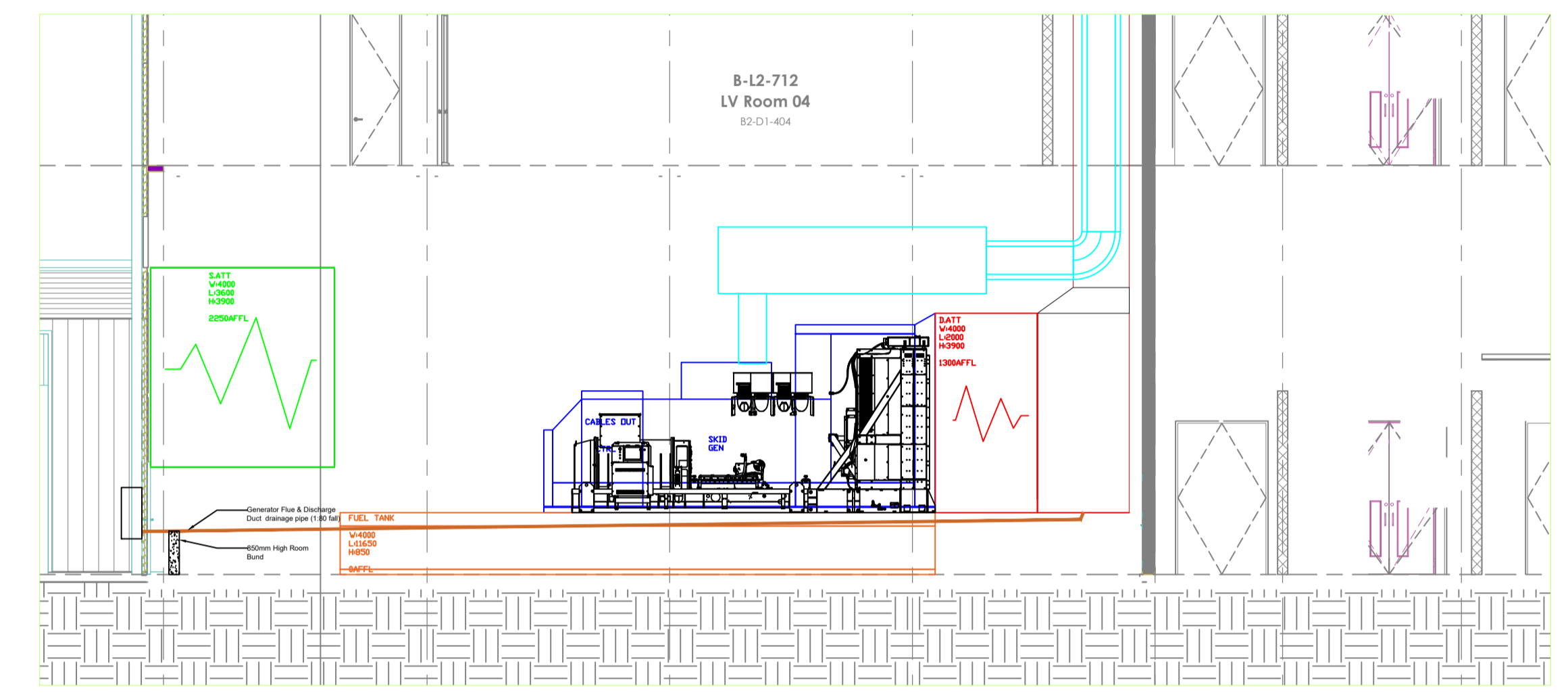
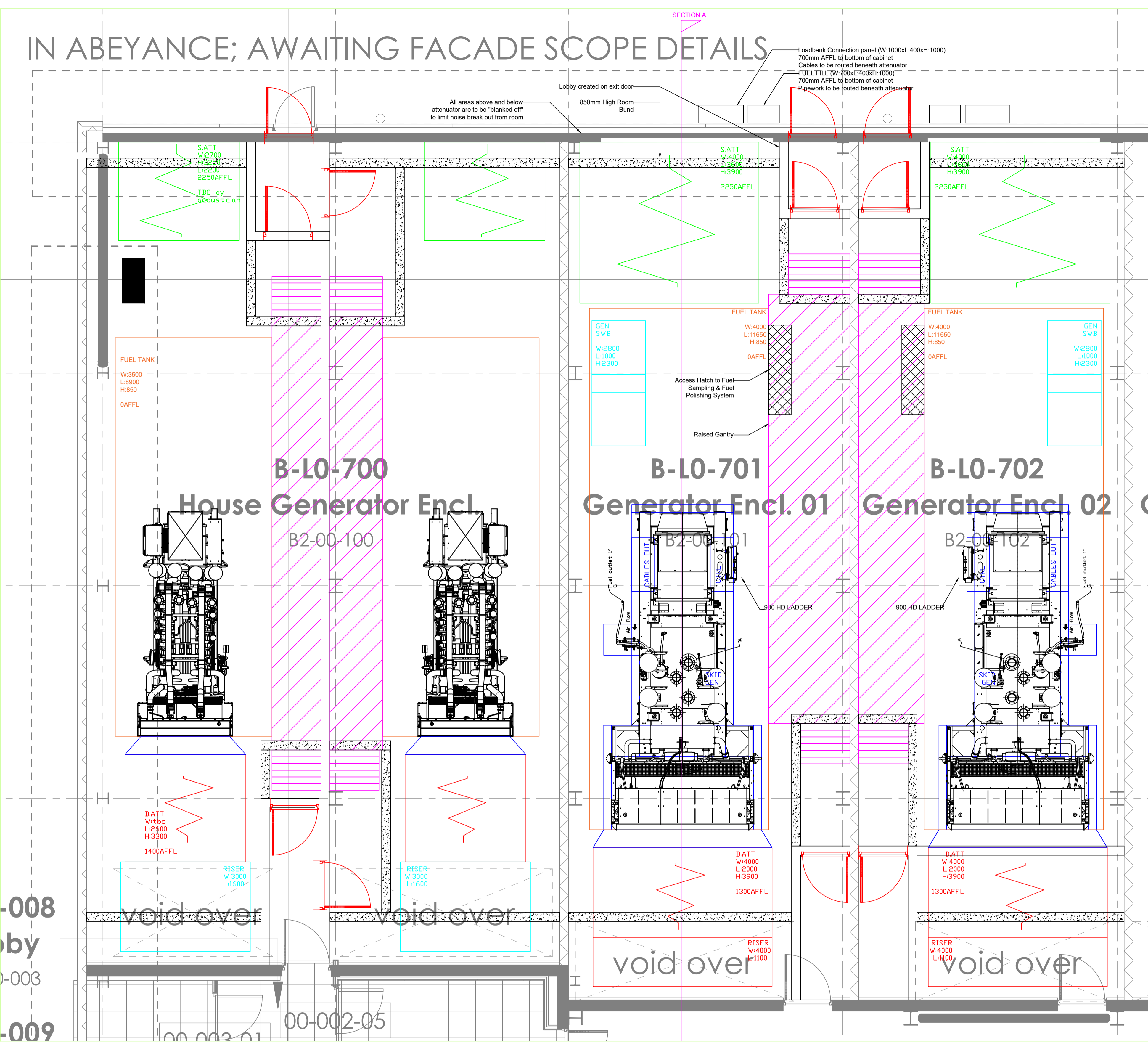
Best Available Techniques and Operating Techniques Assessment, LON1 Phase B

NTT Global Data Centers EMEA Limited

SLR Project No.: 410.V61547.00001

26 July 2024

IN ABEYANCE; AWAITING FACADE SCOPE DETAILS



NTT LON1B
 RED Generator Room Sketch
 Date: 24/08/2023
 By: DCW
 Rev: P01

