

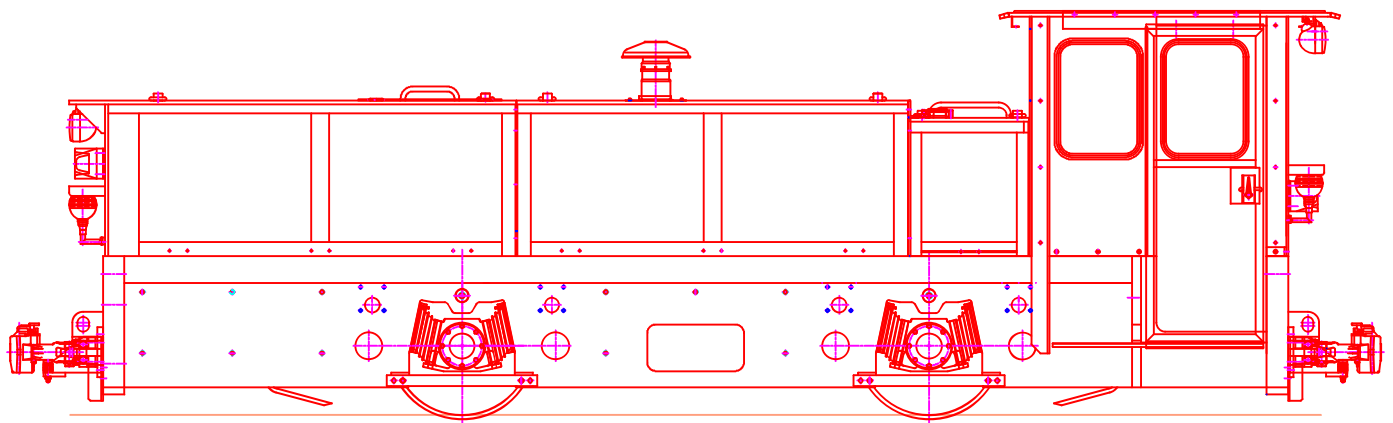
CFL-180 DCL



Loco-No.:
6257-6261
with mortar
mixer

Rev. B

Betriebsanleitung
Operation Manual



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TECHNICAL DESCRIPTION

Model: CFL – 180 DCL

Drive System: Diesel-Hydraulic

Usage: Tunnel/Underground Locomotive

1. Technical Data

Locomotive weight:	.....	25 t
Track gauge:	.....	750 mm (30") / 900 mm (36")
Axle arrangement::	.....	B (2-axled)
Engine output:	.....	184 KW
Max. speed:	.....	appr. 30-35 km/h
Outline dimensions:	.....	according to general arrangement drawings
Performance:	.....	according to tractive effort / haulage diagram
Min. curve radius:	.....	30 m (track clearance min 15 mm)

** Referring to Standard ambient conditions
Reduction might be necessary based on site ambient conditions

2. Structure

- Continuous main frame in box design
- Engine compartment with access flaps for maintenance purpose
- Fuel tank mounted on main frame and protected against collisions
- Rail guards adjustable in height
- Pneumatic components on support in engine compartment
- Electrical components in enclosed electric cubicle in driver's cabin

2.1 Locomotive Main Frame

- Main frame in box design with high torsion resistance
- MAG welded
- Side plates with cut-outs for inspection of axle gears, brake gears etc.
- 2 Lifting points at both sides

2.2 Operator's Cabin

General Design:

- Laterally open driver's cabin
- One operator's desk with ergonomic arrangement of controls and levers
- Rear window equipped with wipers

Equipment:

- Comfortable driver's seat, rotatable and adjustable in horizontal and vertical direction
- Hand fire extinguisher ABC powder
- Heating via hot water heat exchange from diesel engine water cooling circuit

2.3 Fuel System

- Filler caps at both sides of the locomotive
- Fuel gauge on the operator's panel
- Fuel tank capacity: appr. 310 ltrs.

3. Diesel Engine

- Diesel engine mounted on elastic rubber elements on the locomotive main frame.
- Exhaust emissions according European regulation EU-RL 97/68 Stage II and US-EPA Nonroad Tier II

3.1 Technical Data

Manufacturer:	.....	Deutz
Model:	.....	BF6M 1013 CP
Design:	.....	water-cooled with turbo charger
Cylinder arrangement:	.....	6 R
Nominal output:	.....	according to 1.
Engine speed:	.....	2300 rpm
Piston displacement:	.....	7,14 ltrs.
Fuel consumption:	.....	appr. 0,25 ltrs./KWh
(depending on operating conditions)		

3.2 Equipment

- Electric engine starter 24 V, 4 KW
- Engine brake in the exhaust pipe

3.3 Exhaust System

- Diesel particulate filter

4. Transmission System

- Electro-hydraulic powershift transmission
- Robust design for extreme operating conditions

4.1 Torque Converter

- Single stage, model Clark CL 13.7
- Directly connected to engine flywheel
- Direct gear (bypass of torque converter) for high speed and usage of engine brake

4.2 Powershift Transmission

- Model Clark 32384
- 3 Speeds for each driving direction
- Directly connected to torque converter
- Control via maintenance-free electro-hydraulic clutches

4.3 Cardan Shafts

- Heavy duty cardan shafts with length compensation
- Low maintenance
- Protection brackets on the underframe to avoid damages on the locomotive and the tracks in case of loose flange connection

5. Cooling System

- Integrated cooling system with water cooling
- Separate external radiator for cooling of the torque converter oil, driven hydrostatically and controlled thermostatically

6. Axle Drive

6.1 Axle Gears

- Designed and manufactured by SCHÖMA
- Single stage reduction gear with spiral-toothed bevel gear pair
- Total reduction ratio: $i = 4.1$
- Lubrication by splashing oil
- Supported on the main frame via torque arm, bolted in elastic silentblocks

6.2 Wheels and Axles

- Axles made of high tensile steel
- Monobloc driving wheels made of rolled steel
- Wheel profile according to DIN
- Max. wheel wear: appr. 35 mm
(Clearly visible grooves at the outside of the wheel)
- Wheels mounted and dismantled by cold pressing process

6.3 Axle Bearing

- Highly dimensioned roller bearings, protected against ingress of dust and splashing water
- Special permanent lubrication for low maintenance

6.4 Suspension

- Suspension via v-shaped metal rubber suspension elements (chevron springs)
- Comfortable suspension in vertical direction, high stiffness in transverse direction
- Wear-free and low maintenance requirements

7. Pneumatic / Brake Plant

7.1 Mechanical Brake Arrangement

- Block brakes acting on both sides of each wheel
- Brake blocks made of asbestos-free plastic material
- Brake cylinder partly designed as pressure activated brake cylinders, partly designed as combined pressure activated and spring loaded brake cylinders

7.2 Brake Control

- Electro-pneumatic brake control
- Air compressor performance appr. 700 ltrs. per minute at 8 bar
- Direct loco brake and indirect train brake

7.3 Sanding Device

- One sanding device located in front of each wheel
- Sanding in front of the driving axle, depending on the driving direction

8. Locomotive Control

- Microcontroller PLC control system
- Operation in multi traction
- Electronic anti-skid and anti-slip device provided

8.1 Monitoring and Safety Devices

<u>Operating Condition</u>	<u>Automatic Action</u>
Engine lubrication pressure < min. (engine speed-dependent)	<ul style="list-style-type: none"> - Warning light - Trouble notice on display - Engine stop - Brake applied
Transmission oil pressure < min.	<ul style="list-style-type: none"> - Warning light - Trouble notice on display - Engine stop - Brake applied
Cooling water temperature > max.	<ul style="list-style-type: none"> - Warning light - Trouble notice on display - Engine stop - Brake applied
Converter/transmission oil temperature > max.	<ul style="list-style-type: none"> - Warning light - Trouble notice on display - Engine to idling - No traction - Brake applied
Cooling water level < min.	<ul style="list-style-type: none"> - Warning light - Trouble notice on display - Max. remaining operating time = 60 min.
Main reservoir pressure < min.	<ul style="list-style-type: none"> - Warning light - Trouble notice on display - No traction - Brake applied

8.2 Electrical Plant

- Control voltage 24 V
- 3-Phase alternator 28 V / 55 A
- Lead-acid batteries 2 x 12 V at 125 Ah, with battery main switch

8.3 Data logger

- For record Data, a Datalogger is installed.

8.4 Deadman Device (Vigilance Control)

- Activated when all brakes released resp. locomotive starts moving

Functioning:

Within a time interval of 15 seconds (adjustable) the driver has to press or release one of the pushbuttons which are located on the driver's desk or on the levers. If he fails an acoustic warning is acticated. After activation of the acoustic warning signal (3 – 4 secs.) one of the deadman pushbuttons has to be pressed or released, otherwise the deadman control becomes life.

Effect:

Braking of locomotive to standstill, interruption of power transmission and reducing of engine speed to idling.

8.5 Audible Warning Devices

- Signal horn of 400 Hz
- One horn for each driving direction

8.6 Lighting

- Double headlights for each driving direction
- Single red light for each driving direction
- Yellow flash light for each driving direction
- Cabin lights
- Engine compartment lights
- Illumination of gauges and panel light

9. Noise Emissions

Inside the driver's cabin

- max. 85 d(B)A, open driver's cabin, loco stationary, engine high idle speed, locomotive stands outside

10. Coupler System

- WiKuMü coupler 350 mm over rail top

11. Video-System

- Wire-bound video plant with external Camera and Monitor in the operator's cab.

12. Painting

- Underframe edges in black (unless agreed otherwise)
- Locomotive colour white (unless otherwise agreed)

13. General Options

- Fire Suppression System for Engine Compartment, type "Fogmaker"
 - Activation manually (activators fitted at each locomotive end and inside the driver's cabin)

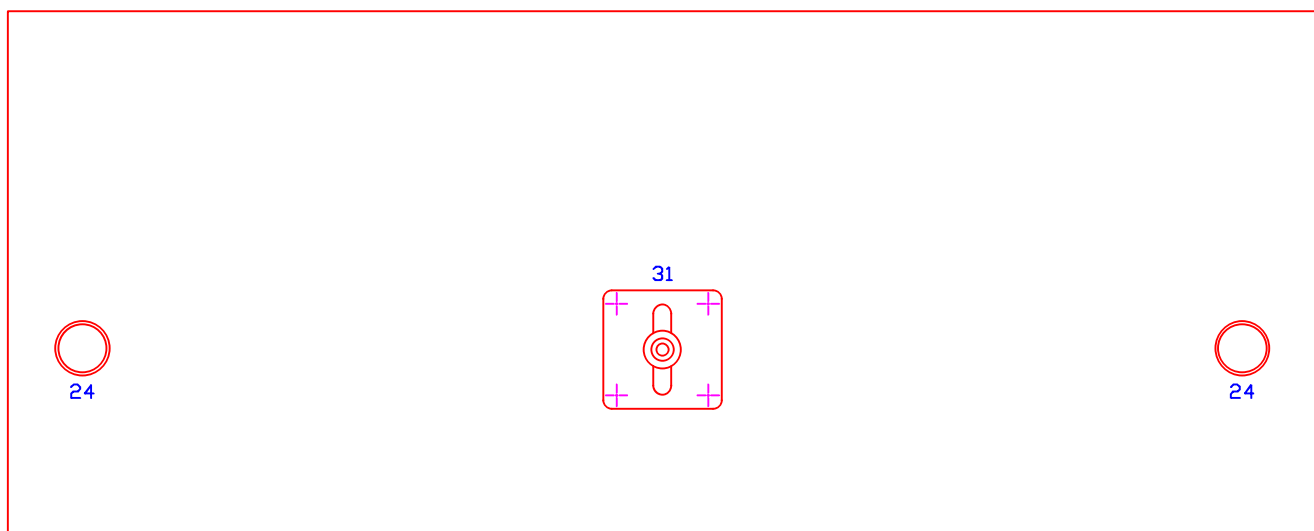
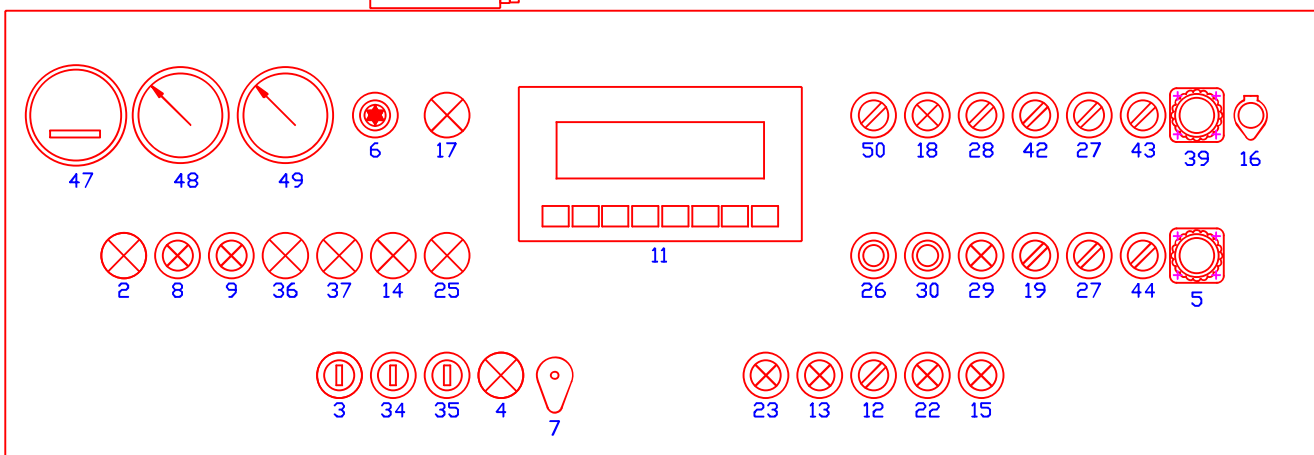
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Bedienungsanleitung Instruction Manual

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**Serial No.: 6257 – 6261
(with mortar mixer drive)
Project: Lee Tunnel**

Operation Manual

Rev.	Date	Description
-	06.01.14	First edition, M. Meyer, based on Locomotives 6257..61 Mortar mixer drive added, instruments at position 2, 3, 4.
A	14.11.14	M. Meyer, Mortar Mixer switch replaced by key switch, Pos. 3

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Arrangement and Function of Instruments and Controls

1. Actuator – fire suppression unit



Pull operating handle, red lamp lights (pos. 14) up when extinguishing plant is activated, diesel engine is automatically stopped and can only be started again after 20 seconds.

A special manual for the fire suppression system is attached.

2. Auxiliar hydraulics tank – Overtemperature, red indicator lamp

Lights up, if tank temperature exceeds 85°C. An alarm buzzer will be active simultaneously. Indicates a cooling problem in the auxiliary hydraulic drive (mortar mixer drive). Driver has to reduce engine revolutions immediately.

3. Mortar mixer operation, key switch

Left key switch position – Hydraulic switched off, no mixer operation.

Right key switch position - for automatic cascaded operation of connected mortar mixers. Mixing times adjustable with display password.



Middle key switch position - for manual operation – only hydraulic pressure will be provided by the locomotive. The mortar mixers are then not controlled by the PLC, but can be operated manually at the mixer car. If other loads shall be connected hydraulically, for example a crane or hydraulic lift, please contact SCHÖMA.

ATTENTION, Diesel engine will only start if mixer key switch is in OFF position!

4. Manual mortar mixer operation, yellow indicator lamp

Lights up, if manual mixer operation is selected.



Attention! Depending on the connected hydraulic load, the oil pump generates pressures up to 210bar. If no load is connected, the full pressure of 210bar is constantly available, which increases heat losses and unnecessary wear of the hydraulic components.

5. Microprocessor (PLC) – connection socket

To make a complete PLC testing and system diagnosis or to flash a new software.

6. Emergency stop button, red

Not-Aus

Press only in emergency situation, the brakes will be applied and the engine stops, transmission will be disengaged.

7. I-Button – driver's desk activated

Driver's desk activated which is tend by the driver. It's possible to remove the button temporary.



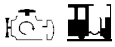
8. Push button with indicator lamp - engine start / stop, green



PLC controlled change over function – lights up with engine running. While preheating the lamp is blinking. All connected engines in a train consist will be started or stopped. The PLC avoids operation of the starter while the engine is running.

ATTENTION, Diesel engine will only start if mixer key switch is in OFF position!

9. Push button with indicator lamp - engine start Train / stop, green





All connected engines in a train consist will be started or stopped.

ATTENTION, Diesel engine will only start if mixer key switch is in OFF position!

10. not installed

11. Display

Shows the loco speed – adjusted and real - , engine speed, trouble notes and so on.

With the button  and  it is possible to select different service parameter.

The trouble notes are shown on a black background.



By pressing  and  it is possible to select the trouble notes.



By pressing "Help" an information for the trouble shooting is given.



When pressing "Esc" and "Enter" together all trouble notes will be deleted, only active when the loco is standing still.

Button "F1" will activate the parameter editor, only possible with a "password".

The LED „2nd Engine“ shows if any engine in a train consist is not running.

By pressing "Esc" and  or  it is possible to change the brightness.

By pressing "Esc" and  or  it is possible to change the contrast.

By pressing "Enter" and  or  on the page which is shown the language code it is possible to change the language

If the locomotive is equipped with a mortar mixer control unit, the "mixer" LEDs show which mixer (1, 2, 3) is currently active.

Pressure table for the pneum. Brake system:

Main air reservoir pressure (HB)	6 – 10 bar (below 6 bar it's impossible to drive)
Brake control line pressure (HL)	5,3-5,7bar brake released, 0 bar brake applied
Brake cylinder pressure (Cyl)	0 bar brake released, 4,8 bar brake full applied

12. Tumbler switch – driving mode analog / digital

Two options to drive the loco with the master switch (31).



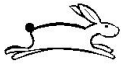
Digital driving mode = select the loco speed – the display shows the selected and real speed

Analog driving mode = select the loco acceleration – the display shows the real speed

It is possible to switch over while driving.

More information see (31)

13. Push button with indicator lamp – speed range, white



Lights up, if the normal speed range (up to max. speed - abt. 30 kph) is selected.
Select the shunting mode to have a sensitive operation up to abt. 10 kph. It is possible to switch over while driving.

14. Indicator lamp – fire suppression unit activated, red



Lights up, if the fire suppression unit was activated. The diesel engine is turned off and the locomotive is stopped. To leave the danger area it's able to start the engine again (after approximately 20 seconds). This information is indicated in the display. Before the engine can be started, the message "fire suppression unit activated" must be acknowledged. (Press "ESC+Enter"). The indicator lamp remains lighting until the fire suppression unit is refilled.

A special manual for the fire suppression system is attached.

15. Push button with indicator lamp – Loco shoved



The Locomotive can be shoved with a maximum speed of 3km/h. In this mode the dead-man is switched off, the brake is release and the push button lights up. This function is disabled, if the button is pressed again.

16. Socket

24V

Socket for a hand lamp or any other equipment up to max. 150 W - 24 Volt DC.

17. Indicator lamp – trouble function red, flashing



Flashing, if any trouble function is indicated and the reason is written on the display. Dependent on the reason the engine is stopped or the engine goes to idle, the transmission is disengaged, the brakes are applied and so on.

18. Push button with indicator lamp – particulate filter service, red

If the exhaust gas back pressure exceeds 150 mbar, the red indicator comes on. When driving with no load, it is possible that the automatic regeneration of the filter system will not start.

To start a special filter regeneration program:

- Loco is parked, engine's running, parking brake released
- Push the button and and push master switch to forward and deadman button together
- The red indicator is blinking, after abt. 2 minutes the regeneration is started
- The regeneration will be stopped, if the button is pressed once more



If the backpressure will not decrease, it is necessary to clean or change the filter cartridge . If the exhaust gas back pressure exceeds 200 mbar, the red indicator is blinking and max. loco speed will be reduced to 8 kph.

Attention: Running the engine with too high exhaust gas backpressure will damage the engine.

A special service manual for the particulate filter unit is attached.

19. Tumbler switch – head lights front and rear



Switch for head light front - red tail light rear
 And head light rear - red tail light front
 PLC controlled switch over depending on the driving direction.
 If a train is connected with a jumper cable the lights will be switched off on this direction automatically.

20. Reserve

To install an additional switch or indicator lamp.

21. Reserve

To install an additional switch or indicator lamp.

22. Push button with indicator lamp – slow speed control, yellow



Switch with change over function.
 Lights up, if the slow speed control is switched on.
 If the loco should run with constant slow speed below 5 kph, it is necessary to apply the loco service brake acc. to the adjusted speed.
 Switch on only if necessary for a short period, because the brake block wear will increase.

23. Push button with indicator lamp – spring loaded parking brake, red



PLC controlled change over function – lights up, when the parking brake is applied.
 The parking brake must be applied, before leaving the driver's cabin.
 It is possible to release the spring loaded parking brake by opening a special cock on the tool bar (sealed with wire), if no air pressure or battery voltage is available. Close this cock after solving the trouble.

24. Push button (mushroom head) – deadman device, black



Additional push button, description and function see (pos. 31) “Master switch“.

25. Indicator lamp – deadman device, yellow



Lights up, if the deadman device becomes active additionally an alarm buzzer sounds.
 3 - 4 secs. later the brakes will be applied and the transmission disengaged
 (see pos. 31).

26. Push button – signal horn, yellow



Depending on the driving direction operated electronic signal horns.

27. 3 - Position Tumbler switch – wind screen wiper and washer



Centre position to switch on the wiper, right hand position to activate the water pump.
 Fill up anti -freeze abt. 30 % in the reservoir while winter time.

28. Tumbler switch – cabin light



To switch on the cabin light

29. Push button with indicator lamp – high beam, blue



Lights up with high beam switched on

30. Push button – sanding, green



Depending on the driving direction the sander gears in front of the wheels are operating.

Attention: Never operate the sanding gears, when wheels are slipping!

The PLC will operate the sanding gears automatically if necessary.

31. Master switch with lateral arranged deadman button



Parking brake applied : engine speed adjustable

“Digital” driving mode (switch pos.12):

- Parking brake released
Select the driving direction and the loco speed
- press the side mounted deadman button and move the master switch into the desired driving direction to the first keystroke and release the deadman button, or move the master switch to the first keystroke and press then the deadman button. The min. speed will be noted on the display. Go back to centre and the loco will move with min. speed.
- increase the loco speed by moving the master switch to the selected driving direction, the adjusted speed will be noted on the display
- in the notched end position of the master switch the train brake will be applied



“Analog” driving mode (switch pos.12):

- Parking brake released
Select the driving direction and the loco acceleration
- press the side mounted deadman button and move the master switch into the desired driving direction to the first keystroke and release the deadman button, or move the master switch to the first keystroke and press then the deadman button. The min. speed will be noted on the display. Go back to centre and the loco will move with min. speed.
- the acceleration of the loco depends on, how much the operator moves the lever, low angel means slow, wide angel max. acceleration. In the centre position the speed is constant.
- in the notched end position of the master switch the train brake will be applied

Deadman - button:

Operate one of the deadman buttons in time

- the max. time to hold a deadman button pressed is 15 secs,
- the max. release time for the deadman button is 7 secs, when start driving, the yellow indicator lights up and the buzzer sounds additionally.
- the yellow indicator will light for 3 - 4 secs and the deadman buzzer comes on, if the deadman device is not operated in time, than the brakes will be applied and the transmission will be disengaged, the engine goes to idle speed.

After a “deadman operated” stopping, apply the parking brake and press a deadman button – buzzer is off -, then press “Esc” + “Enter” on the display.

32. Data Recorder – SCOM

The SCOM - memory records all driving data. Additional function are possible – please ask the SCHÖMA – service. The reading is done by a special cable.

33. Reserve

To install an additional switch or indicator lamp.

34. Main switch with key



Switch on to right side, the key must be removed to activate the operator's panel

35. Switch with key – towing position



Right side position: - Towing position - If an engine or transmission brake down happens, the PLC will release the service brakes. Only the towing disconnect at the Clark transmission has to be operated for the towing procedure. The maximum towing speed is 15 kph.

Attention: The brake of the locomotive is completely solved. Towing only in coupled condition.

36. Charging control lamp, red



The charge indicator must light up, when the engine is not running and main switch (pos. 34) is switched on.

During engine is running, the indicator should not light up. In case of control lamp lights up while driving, please check V-belt tension of alternator.

Otherwise: Alternator, rectifier or regulator are defect.

=> the batteries will be discharged !

37. Indicator lamp – engine trouble function, red



If any engine trouble function in the electronic control unit of the diesel engine (EMR) is indicated, the lamp lights up.

A special cable connection (to pos. 39) and software is necessary to indicate the trouble on a "Laptop". (Please contact DEUTZ Service)

38. Reserve

To install an additional switch or indicator lamp.

39. EMR – connection socket

To make a complete EMR testing, trouble shooting and system diagnosis.

40. Reserve

To install an additional switch or indicator lamp.

41. Reserve

To install an additional switch or indicator lamp.

42. Tumbler switch – engine compartment light



All bonnets are equipped with separate lamps.

43. Tumbler switch – flashing light front



In front of the engine bonnet mounted flashing light is switched on.

44. Tumbler switch – flashing light rear



In front of the driver's cabin mounted flashing light is switched on.

45. Reserve

To install an additional switch or indicator lamp.

46. Reserve

To install an additional switch or indicator lamp.

47. Service hour recorder



Is only counting when the alternator is charging.

48. Voltmeter



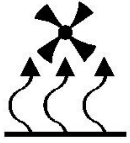
Battery:	abt. 24 V
Engine running / alternator:	abt. 28 V

49. Fuel gauge



Indicates fuel tank capacity. (Tank capacity: appr. 310 ltrs., incl. appr. 30 ltrs. reserve)

50. Tumbler switch – cabin heating



Over coolant heat exchanger.

Operation and driving instruction

2. General recommendations

2.1 Driving

2.1.1 To start:

If the driving direction and the speed is already selected, first the traction will be increased and then the brakes will be released automatically, the loco will start with brakes applied.

2.1.2 Before lifting or after a derailment of the loco check the wheel set supports for a good condition.

2.2 Engine, transmission, radiator

2.2.1 The diesel fuel must be clean, avoid water ingress.

2.2.2 Don't empty the fuel tank totally

2.2.3 Clean the radiators regularly

2.2.4 Run the hot engine with no load for a short time before stopping

2.2.5 When changing the transmission oil, drain the complete system including the oil coolers.

2.2.6 Check the transmission oil level with engine running. (see Clark service manual)

Attention: It is not allowed to use biodegradable fuel, grease, oil and hydraulic fluid!

Use only "Ultra low sulfur" diesel fuel (0,005% sulfur content – NFE 590) for best efficiency of the particulate filter system.

2.3 Service works

2.3.1 Stop the engine and take off the battery main switch before starting the service works.

2.3.2 Disconnect all electronic equipment and the alternator before any welding on the loco is done

2.3.3 Place scotch blocks in front and rear of the loco

2.3.4 Clean the sidewalks and footsteps after service works

2.1.1

3. Preparation before starting

- 3.1 Check fuel, water, sand and oil levels.
- 3.2 Once a week check the wheels, chevrons, brakes and couplers
- 3.3 Check fire suppression system pressure (see pressure gauge on the tank), if installed.

4. Start the engine and first checks

- 4.1 Switch on “battery main switch” and turn main key switch (34) to pos. “on”
- 4.2 Push “engine start“ (8) button only for a short time, lights up when the engine is running. Take off the key and put in “driver’s desk active” (7)
- 4.3 Check main air reservoir pressure, the min. air pressure is 6 bar.
- 4.4 Check service brake function
- 4.5 All trouble functions will be noted on the display
- 4.6 Check parking brake and release, it is impossible to drive the loco with parking brake applied.
- 4.7 Check signal horn, flashing lights and head lights

5. Special operating with a PLC unit

The PLC controls:

- the complete traction – engine and transmission shifting
- the direct loco brake and train brake
- the deadman device
- the antislip and –slide device
- the trouble shooting
- the radiator fan speed

For driving the loco it is only necessary to select a driving direction, the loco speed or acceleration and to operate the deadman device.

6. Start driving

- 6.1 Main air reservoir pressure > 6bar, release the parking brake (23), indicator lamp off
- 6.2 Select a driving direction (31):
 - press the side mounted deadman button and move the master switch into the desired driving direction to the first keystroke and release the deadman button. The min. speed will be noted on the display. Go back to centre and the loco will move with min. speed.
 - increase the loco speed by moving the master switch to the selected driving direction, the adjusted speed will be noted on the display
 - in the notched end position of the master switch the train brake is applied
- 6.3 For slow speed operation, press (22)
- 6.4 Operate the sanders (30) before starting with high haulage
- 6.6 Operate one of the deadman buttons in time, the yellow indicator will light and the deadman buzzer sounds for 3 – 4 secs before the brakes will be applied.

7. Driving

- 7.1 The main air pressure should be 8.5 to 10 bar.
Never exceed the max. loco speed when driving downhill.
- 7.2 The PLC unit controls the traction and braking and shows all troubles, brake cylinder pressure, speed and so on
- 7.3 The real locomotive speed compared to the track is measured by a radar sensor. The speed is shown on the Display. This kind of measurement is necessary for the anti-slip/slide protection system. So the mechanical wear is decrease and the traction force will be accelerate.

8. Stopping the loco

- 8.1 Select driving speed "0" (31), use the notched end position off the master switch (31) for max. brake performance.
- 8.2 Before leaving the cabin apply the parking brake (23)

9. Shut off the loco

- 9.1 Parking brake applied (23)
- 9.2 Press "engine stop" button (8)
- 9.3 Switch off main key switch (7) and take off the key
- 9.4 Switch off the loco (34)
- 9.5 Take off the battery main switch for a longer stationary period

10. Operating in an emergency situation

10.1 Towing the loco

The loco can be towed with stopped engine and transmission disengaged – actuate the towing disconnect lever at the transmission.

The max. towing speed of 15 kph should not be exceeded:

With PLC working (only diesel engine break down), turn key switch (28) to position "towing" the Loco can be towed like a trailer and the brakes are operating

In case of a complete break down, close shut off cocks (Pos. 26 in the pneumatic air brake equipment) and release the spring loaded parking brake by a special cock on the tool bar (Pos. 25/1 in the pneumatic air brake equipment).

If no air pressure is available, turn the spindle, fitted at the rear end of the spring brake cylinder to "release position".

Attention: Turn back before putting the loco into normal operation.

10.2 Emergency stop of the engine:

Close the cut off cock (MV) mounted at the fuel tank, if any other operation fails.

Attention: Open the cock after the engine stopped.

11. Multitraction operation (option)

- In multitraction operation several locomotives can be driven simultaneously from one machine, the "master", the other machines then are called "slave".
- Connect the pneumatic hoses between the locomotives.
- Connect the electrical cable between the locomotives.
- While key switches "desk active" (pos. 7) are switched off, turn on the main key switch (pos. 34) on all locomotives.
- The driver now chooses the machine he wants to drive, he turns the key switch "desk active" into the right position. This will now be the master machine.
- Its possible to start all engines by pressing the engine start button on the master machine.
- The driver may now drive the engine like in single operation mode (see section "start driving")
- In multitraction mode, the driving functions are not active on the slave machines but the emergency stop button still works.
- Errors that may appear on a slave machine are only indicated by the blinking red trouble lamp on the master. For trouble shooting, watch the slave machine display.
- To deactivate multitraction, turn off the "desk active" switch and disconnect the locomotives.

Maintenance Instruction Locomotive Model CFL - 180 DCL

1.) Daily Preparations:

The following checks should be made daily before putting locomotive into operation:

Fuel tank:	Check fuel level
Air reservoir:	Drain condensate
Engine oil:	Check oil level
Engine cooling water:	Check water level
Brakes:	Check function
Signal and lighting:	Check function
Sanding gear:	Check sand capacity and add dry quartz sand if required

2.) Weekly Preparations:

Transmission oil level:	Check oil level with running engine by dipstick
Axle gears:	Check oil level (sight glasses)
Battery:	Check electrolyte level, cells must be covered and add distilled water if required.
Air filter:	Check air filter elements and replace if required.
<u>Brakes:</u>	Check wearing of brake blocks. Brake blocks must be replaced when they are worn up to 20 mm. Adjust brake linkage for air brake, see wearing indicator. The max. stroke of the brake cylinder should not exceed 50mm.
Screw connections:	Check all screw connections for the tightness.
Instruments and controls:	Check function
Circuit breakers:	Check function
Hose connections:	Check for tightness
V-belts:	Check V-belt tension and adjust if required
Engine:	Clean engine externally.
Fuel pre filter	Drain
General Check	Check wheelset, brake linkage, rubber springs etc for damage and wear
Fire suppression system	Check reservoir pressure, see attached user manual

3.) Once after 100 h:

Transmission:	Replace filter elements
Axle gear drive:	Change axle gear oil

4.) Every 500 h:

	See lubrication instruction Deutz, Clark, etc.
Engine lube oil filters:	Replace filter elements
Transmission filter:	Replace filter elements
Engine valve clearance	Check and adjust if necessary
Particulate filter:	Check exhaust gas back pressure and clean soot filter if required, max. backpressure is 150 mbar at engine full throttle

5.) Every 1000 h:

	See lubrication instruction Deutz, Clark, etc.
Fuel filter:	Replace fuel filters, clean fuel pre filter
Engine monitoring, warning system	Check and replace defective parts

6.) Half Yearly Checks:

	See lubrication instruction Deutz, Clark, etc.
Wheel profile:	Check if profile is worn, Attention: the max. diameter difference of the wheels is 0.5 mm
Cardan shafts:	Check spline profile and joints
Rubber springs:	Check adjustment and replace if worn
Engine rubber mountings:	Check and replace if worn
Air intake and exhaust manifold:	Check fastenings
Alternator, starter:	Inspect alternator and starter. See engine instruction manual.

7.) Every 3000 h:

Engine:	Check injection valves
---------	------------------------

<u>8.) Every 2 years:</u>	See lubrication instruction Deutz, Clark, etc.
Flexible fuel leakage lines	Replace completely
Engine coolant	Replace incl. Additive, check coolant concentration
V-belts	Replace

Attention:

Lubrication and servicing of the loco acc. to the attached original service manuals.

Note all attached maintenance manuals and the lubrication instruction!

When any work should be done in the engine bonnet, stop the engine take off the battery main switch.

Put scotch locks to the wheels to avoid moving of the loco.

Only trained personnel should do any service works on the loco.

**Use special grease (Klüberplex BE 31-502 no. 017126) for axle bearing
when driving under bad condition, for example knee-deep water.**

Note all safety information written in the attached service manuals.

If the attached service manuals are not followed, the guarantee-claim slips.

S C H M I E R A N W E I S U N G / L U B R I C A T I O N I N S T R U C T I O N

	Menge	Zeitraum	Schmierstoff	Kontrolle	
	Quantity	Service Interval	Grease/Oil Quality	Control Interval	
Motor BF 6 M 1013	ca. 16 ltr.	500 h	Siehe KHD Betriebsanleitung Kpt. 6.1.1	täglich	(Peilstab)
Engine BF 6 M 1013	appr. 16 ltr	500 h	see KHD service manual chapter 6.1.1	daily	(dipstick)
Wandler/Getriebe HR 32000	ca. 32 ltr.	500 h	ATF, siehe Clark Betriebsanleitung	wöchentlich	(Peilstab)
Converter/ Transmission HR 32000	appr. 32 ltr.	500h	ATF, see Clark Service Manual	weekly	(dipstick)
Achsgetriebe	je 3,5 ltr.	Jährlich**	EP Getriebeöl SAE 80/ 90 GL 5	wöchentlich	(Schauglas)
Axle gear CFL 80 – 120	appr. 3,5 ltr. each one	1 year**	EP gear oil SAE 80/90 GL 5	weekly	(sight glass)
Achslager	je 0.25 kg	1 Jahr	Schmierfett nach DIN 51825 K2K-20 oder K2K-30 *	-----	
Axle bearing	appr. 0,25 kg each one	1 year	grease acc. to DIN 51825 K2K-20 or K2K-30 *	-----	
Achsgetriebelabyrinth	nachschmieren bis Fett austritt	monatlich	Schmierfett nach DIN 51825 K2K-20 oder CONDAT HBW	-----	
Axle gear box labyrinth	regreasing until grease escapes	monthly	grease acc. to DIN 51825 K2K-20 or CONDAT HBW	-----	
Gelenkwellen	-----	6 Monate	Schmierfett nach DIN 51825 K2K-20 oder K2K-30 *	-----	
Universal shafts	-----	6 month	grease acc. to DIN 51825 K2K-20 or K2K-30 *	-----	
Bremsgestänge, Kuppler	-----	je nach Einsatzbedingungen			
		2bis 4 Monate	Schmierfett nach DIN 51825 K2K-20 oder K2K-30 *	-----	
Brake linkage, Can't miss coupler	-----	2 to 4 month	Grease acc. to DIN 51825 K2K-20 or K2K-30 *	-----	

Scharniere, Türführungen	-----	6 Monate	Schmierfett nach DIN 51825 K2K-20 oder K2K-30 *	-----	
Hinges, door bearings	-----	6 month	Grease acc. to DIN 51825 K2K-20 or K2K-30 *	-----	

* Bei extremen Einsatzbedingungen Spezialfette verwenden: z.B. Klüberplex BE 31-502 Art. Nr. 017126

*Under extreme working condition use special grease: for example Klüberplex BE 31-502 Art. Nr. 017126

** Einmalig muss dieses Öl nach ca. 100 h gewechselt werden!

** Once after abt. 100 service hours this oil must be changed!

*** Einmalig muss dieser Filter nach ca. 100 h gewechselt werden!

*** Once after abt. 100 service hours this oil filter must be changed!

Achtung: Es dürfen keine biologisch abbaubaren Fette, Öle und Hydraulikflüssigkeiten und Biodiesel verwendet werden.

Attention: It is not allowed to use biodegradable fuel, grease, oil and hydraulic fluid!

FILTERWARTUNG / FILTER SERVICE

Best.-Nr.	Wartungsintervalle
Part no.	Service Interval
Trockenfilter Motor- verbrennungsluft:	K35.000054
Engine air intake cleaner	nach Anzeige Meldeleuchte see indicator lamp
Sicherheitsfilter:	K35.000053
Engine air intake cleaner safety insert	nach 5x Reinigung oder Tausch des Luftfilters oder max.nach 2 Jahren latest after 2 years or 5 times filter cleaning or changing the air intake cleaner
Kraftstoffvorfilter	K22.000675
Fuel pre filter	Reinigen, bei Bedarf wechseln nach jeweils 1000 Betriebsstunden siehe Anleitung Motorenhersteller Clean, change if required 1000 hours, see engine instruction manual
Kraftstofffilter:	K35.000116
Fuel filter	nach jeweils 1000 Betriebsstunden siehe Anleitung Motorenhersteller 1000 hours, see engine instruction manual
Motorschmierölfilter:	K35.000016
Engine oil filter	nach jeweils 500 Betriebsstunden siehe Anleitung Motorenhersteller 500 hours, see engine instruction manual
Wandlerölfilterelement:	K24.000144 ***
Transmission oil filter	nach jeweils 500 Betriebsstunden siehe Anleitung Getriebehersteller 500 hours, see transmission instruction manual
Partikelfilter DPX	K35.000125
Exhaust gas particulate filter DPX	Nach 500 Betriebsstunden oder spätestens 1 Jahr reinigen, siehe Hersteller – Wartungsanleitung clean every 500 hours, latest after 1 year, see manufacturers service manual
Lufttrocknerkartusche	K30.000530 (2x)
Air dryer container	Nach 6 Monaten wechseln Change every 6 months
Druckluftfilter	Siehe spez. Wartungsanleitung für Druckluftgeräte
Pneumatic filters	Clean, see attached special service information

DEUTZ Schmieröl-Qualitätsklassen / Deutz Quality Class

Schnelllaufende Dieselmotoren / Deutz Compact engines

Freigabeliste / Release List



Ausgabe 03/2009 — issue 03/2008

DQC I-02

Hersteller Manufacturer	Produktname Brandname	Viskositätsklasse SAE class	Verkaufsgebiet Marketing Areas	Anwendungsinformationen Remarks
BayWa AG	HDC-Motorenöl Super 2000 CD-MC	30, 40, 50 15W-40	Deutschland / Germany	Einbereichsöl / Single grade oil
	TECTROL HDC 30 TECTROL Super 2000 CD-HC	30, 40, 50 10W-30	Europa / Europe	Einbereichsöl / Single grade oil STOU-Multifunktionsöl / Tractor universal oil
FUCHS Petrolub AG	TITAN Universal HD	30, 40, 50	weltweit / worldwide	Einbereichsöl / Single grade oil
	TITAN Universal HD	15W-40		
	AGRIFARM STOU 1030 MC	10W30		
	AGRIFARM STOU 1040 MC	10W-40		STOU-Multifunktionsöl / Tractor universal oil STOU-Multifunktionsöl / Tractor universal oil

DQC II-05

Hersteller Manufacturer	Produktname Brandname	Viskositätsklasse SAE class	Verkaufsgebiet Marketing Areas	Anwendungsinformationen Remarks
DEUTZ AG	DEUTZ OEL TLS 15W40 D	15W-40	weltweit / worldwide	
ENI S.p.A.	AGIP BLITUM T	15W-40	Europa / Europe	
	AGIP SIGMA Turbo	15W-40		
BayWa AG	HDC-Motorenöl 15W-40	15W-40	Deutschland / Germany	
	Rennklasse Turbo 2000	10W-40		
	Super Truck 1540	15W-40		
	TECTROL HDC 1540	15W-40	Europa / Europe	
	TECTROL Super Truck Plus	15W-40		
	TECTROL Super Truck 15W40	15W-40		
ExxonMobile Corp.	TECTROL Turbo 1000	10W-40		
	TECTROL Turbo 2000	10W-40		
	Exxon XD-3	15W-40	Nordamerika / North America	
	Mobile Delvac MX	15W-40		
Fuchs Petrolub AG	Mobile Delvac 1300 Super	15W-40, 10W-30	Europa, Afrika, Asien-Pazifik / Europe, Africa, Asia-Pacific	
	Mobil Delvac MX ESP 15W-40	15W-40		
Fuchs Petrolub AG	TITAN Unic plus MC	10W-40	weltweit / worldwide	
	TITAN Unic MC	10W-40		
	TITAN Truck plus	15W-40		
	TITAN Truck	15W-40		
Kuwait Petroleum	Q8 T750 SAE15W-40	15W-40	weltweit / worldwide	
Lubricants UK. Ltd.	BP Vanellus Longdrain 15W-40	15W-40	Asien-Pazifik / Asia-Pacific	
Opet Petrolçülük A.Ş.	Omega Turbo Premium X5 15W-40	15W-40	Türkei / Türkiye	
Orlen Oil	Platinum Ultor CH-4 15W-40	15W-40	weltweit / worldwide	
REPSOL	REPSOL DIESEL TURBO THPD	15W-40	Europa, Asien / Europe, Asia	
Shell International	Shell Rimula R3 X 15W-40	15W-40	weltweit / worldwide	
TNK Lubricants	TNK Revolux D2 15W-40	15W-40	weltweit / worldwide	
Total Lubricants	ANTAR Agrimax FE	15W-30	Europa / Europe	
	ELF Agritec FE	15W-30	weltweit / worldwide	
	TOTAL Rubia TIR 7200 FE	15W-30		
	TOTAL Tractagri FE	15W-30		
	RTO Maxima RLD Eco	15W-30		

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DEUTZ Schmieröl-Qualitätsklassen / Deutz Quality Class

Schnelllaufende Dieselmotoren / Deutz Compact engines

Freigabeliste / Release List



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DQC III-05

Hersteller Manufacturer	Produktname Brandname	Viskositätsklasse SAE class	Verkaufsgebiet Marketing Areas	Anwendungsinformationen Remarks
DEUTZ AG	DEUTZ OEL TLX 10W40 FE	10W-40	weltweit / worldwide	
ADDINOL	ADDINOL Extra Truck MD 1049 LE ADDINOL Super Longlife MD 1047	10W-40 10W-40	Europa, Asien, Russland / Europe, Asia, Russia	aschearm / low ash oil
	ADDINOL Super Truck MD 1049	10W-40	weltweit / worldwide	
AVIA Mineralöl-AG	Turbosynth CFE 10W-40	10W-40	Europa / Europe	
BayWa AG	BayWa Turbo 4000 BayWa Super Truck 1040 MC BayWa Super Multisyn SL plus	10W-40 10W-40 10W-40	Deutschland / Germany	STOU-Multifunktionsöl / Tractor universal oil
	TECTROL Turbo 4000 TECTROL Super Multisyn Plus TECTROL Super Truck 1040 TECTROL Super Truck Plus 1040	10W-40 10W-40 10W-40 10W-40	Europa / Europe	STOU-Multifunktionsöl / Tractor universal oil aschearm / low ash oil
De Oliebron	Tor Turbosynth NF	10W-40	Europa, Asien / Europe, Asia	
ENI S.p.A.	AGIP SIGMA Truck	15W-40	Europa / Europe	
ExxonMobile Corp.	Mobile Delvac Elite Mobile Delvac 1 ESP	15W-40 5W-40	Nordamerika / North America	
FL Selenia S.p.A.	Akros Synt Gold	10W-40	Europa, USA, Australien, Asien / Europe, US, Asia, Australia	
Fuchs Petrolub AG	AGRIFARM STOU 10W-40 MC Pro TITAN Cargo Maxx TITAN Cargo MC TITAN Unic Ultra MC	10W-40 10W-40 10W-40 10W-40	weltweit / worldwide	STOU-Multifunktionsöl / Tractor universal oil aschearm / low ash oil
HUNOLD Schmierstoffe GmbH	EUROLUB Multicargo 10W/40 EUROLUB Multitec 10W/40	10W-40 10W-40	Europa	
Kuwait Petroleum	Q8 T905 10W-40 Low SAPS	10W-40	Europa, Russland, Asien / Europe, Russia, Asia	aschearm / low ash oil
LOTOS S.A.	TURDUS SEMISYNTHETIC XHPDO 10W/40	10W-40	Europa, Asien Afrika / Europe, Asia, Africa	
Lubricants UK. Ltd.	Castrol Agri Power BP Vanellus Multi-Fleet 10W-40	10W-40 10W-40	Europa, Asien-Pazifik / Europe, Asia- Pacific Europa / Europe	
Meguin GmbH & Co. KG	megol Motorenöl Super Leichtlauf FAMO	10W-40	weltweit / worldwide	
MOTUL S.A.	MOTUL Tekma Ultima+ 10W-40	10W-40	weltweit / worldwide	aschearm / low ash oil
Petro-Canada Lubricants	Duron-E Synthetic	10W-40	Nordamerika / North America	
Ravensberger Schmierstoffvertrieb	RAVENOL Expert SHPD	10W-40	weltweit / worldwide	
OMV	OMV super truck SAE 10W-40	10W-40	weltweit	
Opet Petrolcülük A.Ş.	Omega Formula Blend 10W-40	10W-40	Türkei / Türkiye	
Shell International	Pennzoil Long-Life Gold Shell Rimula Super Shell Rimula R4 L Shell Rimula RT4 L Shell Rotella T	15W-40 15W-40 15W-40 15W-40 15W-40	Nordamerika / North America weltweit / worldwide weltweit / worldwide USA, Kanada, Europa / US, Canada, Europe	
SRS Schmierstoff Vertrieb GmbH	Wintershall TFF Wintershall TFX SRS Cargolub TFF SRS Cargolub TFX SRS Cargolub TLA	10W-40 10W-40 10W-40 10W-40 10W-40	Europa, Südafrika, Asien, Australien / Europe, South Africa, Asia, Australia	aschearm / low ash oil
Swd Lubricants	Swd Favorit LMF SAE 10W-40 Swd Komparol MF SAE 10W-40 D	10W-40 10W-40	Europa, Asien / Europe, Asia Europa / Europe	
TNK Lubricants	TNK Revolux D3 15W-40	15W-40	ehemalige GUS-Staaten / Former SU	
Total Lubricants	ANTAR Agrimax Syn Claas Agrimot Ultratec 10W40 Rubia TIR 8600 ELF Agritec Syn ELF Performance TP TOTAL TP Max TOTAL Tractagri HDX Syn	10W-40 10W-40 10W-40 10W-40 10W-40 10W-40	Europa / Europe weltweit / worldwide	
Valvoline	Valvoline ProFleet LS SAE 10W-40	10W-40	Europa, Mittlerer Osten, Afrika / Europe, Middle East, Africa	aschearm / low ash oil

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DEUTZ Schmieröl-Qualitätsklassen / Deutz Quality Class

Schnelllaufende Dieselmotoren / Deutz Compact engines

Freigabeliste / Release List



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DQC IV-05

Hersteller Manufacturer	Produktname Brandname	Viskositätsklasse SAE class	Verkaufsgebiet Marketing Areas	Anwendungsinformationen Remarks
DEUTZ AG	DEUTZ OEL DQC4 - 5W30 - UHP	5W-30	weltweit / worldwide	
BayWa AG	Super Truck 530 SL	5W-30	Deutschland / Germany	
	TECTROL Super Truck 530	5W-30	Europa / Europe	
FUCHS Petrolub AG	TITAN Cargo SL	5W-30	weltweit / worldwide	
OMV	OMV super truck SAE 5W-30	5W-30	weltweit	
MOTUL S.A.	MOTUL Tekma Optima 5W-30	5W-30	weltweit / worldwide	
REPSOL	REPSOL UHPD 10W/40 MID SAPS	10W-40	Europa, Mittlerer und ferner Osten / Europe, Middle East, Far East	aschearm / low ash oil
Shell International	Shell Rimula Ultra	10W-40	Europa, Asien-Pazifik, Russland, Australien, U.E.A., Südamerika, Südafrika / Europe, Asia-Pacific, Russia, Australia, U.A.E., South America, South Africa	
	Shell Rimula R6 M	10W-40	weltweit / worldwide	
	Shell Rimula Signia	10W-40	Europa, Japan / Europe, Japan	aschearm / low ash oil
	Shell Rimula R6 LM	10W-40	Europa, Asien, Australien / Europe, Asia, Australia	aschearm / low ash oil
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TFL	5W-30	Europa, Südafrika, Asien, Australien / Europe, South Africa, Asia, Australia	

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Lube oil change intervals for built-in and marine engines

		Lube oil quality							
		DQC I-02		DQC II-05		DQC III-05		DQC IV-05	
ACEA specification		E2-96		E3-96/E5-02 E7-04		-		E4-99/E6-04	
API specification		CF/CF-4		CG-4/CH-4/C1-4		Specifications acc. to our company standard, see DQC-		-	
worldwide specification		-		DHD-1		-		-	
DEUTZ Oil		-		TLS-15W40D		TLX-10W40FE		DQC 4-5W30-UHP	
209 Liter		-		0101 6333		0101 6337		0101 7850	
20 Liter		-		0101 6332		0101 6336		0101 7849	
4 x 5 Liter		-		0101 6331		0101 6335		-	
Engine Series	Engine model	Lube oil change intervals in OH							
		Oil load							
		normal	high	normal	high	normal	high	normal	high
B/FM 1008	All engines	125	125	125	125	125	125	125	125
BFM/L 1011	Naturally aspirated engines	1000	500	1000	500	1000	500	1000	500
BFM/L 2011	Charged engines	250	125	500	250	500	250	500	250
TD/D 226	Naturally aspirated engines	500	250	500	250	500	250	500	250
BFL 413/513	Charged engines	250	125	500	250	500	250	500	250
B/FL 912	Naturally aspirated engines	500	250	500	250	500	250	500	250
B/FL 913/914	Charged engines	250	125	500	250	500	250	500	250
	BF6L913/914C with 176 kW at 2500 rpm	-	-	-	-	500	250	500	250
BFM 1012	All engines except:	250		500		500		500	
	Engines in harvesting machines, block combined power stations, electricity generators **	-		-		500		-	500
BFM 1013	All engines except:	250		500		500		500	
	Engines as of nonroad stage II	-		500		500		-	500
	Engines in harvesting machines, block combined power stations, electricity generators **	-		-		500		-	500
	BF4M1013FC	-		-		500		-	500
	BF6M1013FC (P ≤ 200 kW), crankcase ventilation open	-		500		500		-	500
	BF6M1013FC (P ≤ 200 kW), crankcase ventilation closed	-		-		500		-	500
	BF6M1013FC (P > 200 kW), crankcase ventilation open	-		250		250		-	250
	BF6M1013FC (P > 200 kW), crankcase ventilation closed	-		-		250		-	250
	BF6M1013FC Genset 200 kVA crankcase ventilation open	-		500		500		-	500
	BF6M1013FC Genset 200 kVA crankcase ventilation closed	-		-		-		-	500
BFM 2012	All engines except:	250		500		500		500	
	BF4M2012C > 95 kW	-		-		500		-	500
	BF6M2012C > 143 kW, as of non-road stage II at cylinder bore 101 or 98 mm with MV-system	-		-		500		-	500
	BF6M2012C > 135 kW, as of non-road stage II at cylinder bore 98 mm with mech. Injection system	-		-		500		-	500
	Other engines as of nonroad stage II	-		500		500		-	500
	Engines in harvesting machines, block combined power stations, electricity generators **	-		-		500		-	500
BFM 2013	All engines except:	250		500		500		500	
	Engines as of nonroad stage II	-		500		500		-	500
	BF4M2013C, P > 90 kW	-		-		500		-	500
	BF6M2013C, P > 120 kW	-		-		500		-	500
	Engines in harvesting machines, block combined power stations, electricity generators **	-		-		500		-	500
BFM 1015	All engines except:	250	125	500	250	500	250	500	250
	1015C as of nonroad stage II	-	-	500	250	500	250	500	250
	1015CP	-	-	-	-	500	250	500	250
	BF6M1015MC ≤ 300 kW	-	-	500	250	500	250	500	250
	BF8M1015MC ≤ 400 kW	-	-	500	250	500	250	500	250
	BF6M1015MC > 300 kW	-	-	-	-	500	250	500	250
	BF8M1015MC > 400 kW	-	-	-	-	500	250	500	250
BFM2015	All engines	-		-		500		-	500
D 2008	All engines	250	125	500	250	500	250	500	250
TD/D 2009	All engines	500	250	500		500		500	
D 2011	All engines	500	250	1000	500	1000	500	1000	500
TD/w 2011	All engines	250	125	500	250	500	250	500	250
TD/i 2011	All engines	250	125	500	250	500	250	500	250
TCD/w 2011	All engines	250	125	500	250	500	250	500	250
TCD 2012 2V	crankcase ventilation open	-		500		500		500	
	crankcase ventilation closed	-		-		500		500	
TCD 2012 4V	crankcase ventilation open	-		500		500		500	
	crankcase ventilation closed	-		-		500		500	
TCD 2013 2V	crankcase ventilation open	-		500		500		500	
	crankcase ventilation closed	-		-		500		500	
TCD 2013 4V	crankcase ventilation open	-		500		500		500	
	crankcase ventilation closed	-		-		500		500	
TCD 2015	crankcase ventilation closed	-		-		500		-	500

** Electricity generators here are to be understood as those with mains/parallel mode.

Emergency generators are dealt with TC 0199-99-1126.

General information: Engine oils that are released under higher DQC-classification may also be used in the next lower classes.

Remarks for built-in and marine engines

■ Normal oil load for engines with low to medium load (up to 70%):

Examples for built-in engines: Rollers, stacker trucks, rail vehicles, emergency pumps.

Examples for marine engines: Ferries, tugs, light fishing vessels, river vessels, auxiliary engines.

■ High oil load in engines with high workload (>70%) or other difficult factors, e.g. high dust load or strong dynamic operation:

Examples for built-in engines: Tractors, harvesting machines, mining machinery, wheel loaders, hydraulic diggers, graders, waste compressors, block combined power stations, mains/parallel operation, engines with 2-stage combustion.

Examples for marine engines: Speed boats, catamarans, yachts, gliders, generator drives.

■ The assignments of the workload to the applications are examples, a different assignment may apply in individual cases.

■ In the specified intervals between lubricant changes during the year have not been reached, the oil should be changed at least once a year.

■ The following conditions apply for the lube oil change intervals:

- Continuous ambient temperatures ≥ -10° C (≥ +14° F)
- sulphur content in the fuel, ≤ 0.5 weight-%

■ The lube oil change interval must be halved, at

- continuous ambient temperatures < 10° C (<14° F) or oil temperature < 60° C or
- sulphur content in the fuel > 0.5 to 1 weight-% or
- operation with bio-diesel fuel

Best.-Nr.: 0312 3141 EY 0199-99/010/07





SPICER CLARK-HURTH
Off-Highway Components Division

1 December 1998

DEXRON LUBRICANTS

The original Dexron fluid was an ATF that contained zinc dithiophosphate for oxidation stability and as an anti-wear agent. This formulation did not have particularly good oxidation stability. In about 1978 Dexron II was introduced which provided better oxidation stability and as a factory fill fluid, still contained zinc dithiophosphate. Other Dexron II formulations sold in the aftermarket contained "ashless" sources of phosphate, meaning that the phosphate was part of an organic molecule rather than a metal phosphate. Dexron IID then came out which was an ashless formulation and met the Allison C-3 spec.

About the time Dexron II started being used, there were reports of coefficient of friction loss in the Wellman HDT303. This was believed to be caused by a component of the Dexron coating out on the friction material over time. This glazing may be a result of lubricant oxidation.

Since both Dexron II and Dexron IID could have or did contain the organic phosphate, the possible source of this fluids lack of oxidation stability, both should not be used with graphitic clutch plates.

Since the introduction of Dexron III, the Dexron IID specification has been obsoleted and that designation cannot be used. In Europe, lubricants commonly referred to as "Dexron II" are formulated to meet the old specification but cannot legally use the Dexron name. These are known to be ashless formulations, like the Dexron IID.

The recommended lubricant drawing will be revised to include "Dexron IID equivalent" since this in an obsolete spec. and the name can no longer be used.



SPICER OFF-HIGHWAY PRODUCTS DIVISION

8 March 1999

RECOMMENDED LUBRICANTS FOR TRANSMISSIONS AND TORQUE CONVERTERS

Spicer Off-Highway recommends that lubricants used in our products meet the qualifications and guidelines in our Technical Service Bulletin No. USA 271 E. These recommendations supersede previously published guidelines.

Spicer Off-Highway Products recommends the use of CAT TO-4, John Deere J20 C,D and MIL-PRF – 2104G (for military applications). Where lubricants meeting these specifications are not available, there are certain Allison C-4 qualified lubricants which can be used and other C-4 lubricants which we do not recommend. **We do not recommend the use of Dexron III, engine oil, or any GL-5 lubricant.**

The lubricants qualified by TO-4 and JD 20 C,D have met specific criteria for dynamic and static coefficient of friction, shear down stability and oxidation stability. When possible, we recommend that the customer use the highest viscosity monograde lubricant possible given the anticipated ambient temperature. Typically this will be a CAT TO-4 qualified lubricant. Where large swings in ambient temperature are likely to occur, we recommend the J20 C,D multigrades which exhibits good shear stability. The multigrades should be applied at the lower viscosity rating for the prevailing ambient temperature. That is, a 10W20 should be used where we recommend the use of a 10W monograde. If a J20 qualified lubricant is not used but a C-4 multigrade is selected, we recommend that the lubricant span no more than 10 points i.e. 10W20. This lessens the severity of shear-down when the viscosity is properly selected for the average ambient temperature.

Motor oil which is C-4 qualified is not recommended due to formulation specific for engines and lack of sufficient EP additive to protect against gear wear. Dexron, which is C-4 qualified, is not recommended due to its formulation being high in VI improvers. The VI improvers are added to Dexron III formulation to limit the change in viscosity with changes in temperature. The degree to which VI improvers exist in Dexron III makes this lubricant susceptible to shear-down. The resulting loss of viscosity will reduce the lubricant film thickness and result in reduced service life.



SPICER CLARK-HURTH
Off-Highway Components Division

4 September 1998

SYNTHETIC AND SEMI-SYNTHETIC LUBRICANTS

Synthetic lubricants are generally petroleum-based fluids that are manufactured with an “engineered” molecular structure. For this reason, they are molecularly more stable. This stability imparts certain advantages to the synthetics.

1. Synthetics are more oxidation stable but still contain anti-oxidant additives that normal lubricants use. Oxidation of the lubricant usually leads to an increase in viscosity, deposit formation, and the formation of corrosive compounds. All lubricants, including synthetics, have a finite life for their anti-oxidant additives.
2. Synthetics are resistant to oil breakdown from heat and high speed operation. This characteristic may extend its service life.
3. Synthetics may help to reduce brake or differential clutch noise.
4. Multi grade synthetics typically will not have VI (viscosity index) improvers and do not shear down, leading to a loss of viscosity.
5. Most synthetics claim to lower friction resulting in better fuel economy and less heat generated.
6. Superior low temperature performance.

Synthetic lubricants are generally used in extreme operating conditions to improve component life and extend oil change intervals. Extended oil service life may result when using synthetic fluids. Appropriate change intervals should be determined for each powertrain component by measuring oil oxidation and wear metals, over time, to determine a baseline. Wear metal analysis can provide useful information but a component should not be removed from service based solely on this analysis.

Semi-synthetic oils are usually blended to address specific needs, usually low temperature performance or improved oxidation stability. The properties and performance of the semi-synthetics will also depend on the quality of the base stock oil. Generally, semi-synthetics will have some of the advantages of the fully synthetic oils. Check with your oil supplier for documented benefits for their formulation.



SPICER OFF-HIGHWAY PRODUCTS DIVISION

4 January, 2000

BIODEGRADABLE LUBRICANTS FOR AXLES AND TRANSMISSIONS

Increased environmental awareness has prompted some world governments and some business sectors to adopt the use of environmentally friendly lubricants. This is particularly true in Europe and less so in the United States. In some cases, in the United States, these lubricants are being considered for use more for due diligence to help avoid large EPA fines should accidental spills occur. At this time, the EPA has not specified a test which defines biodegradability, consequently, the industry is using European based test procedures and definitions.

There are a variety of biodegradable lubricants on the market today for specific purposes including tractor hydraulic fluids. There has been very slow growth for these products through the 90's and while we might expect growth in the future, a 500% increase would still not be a significant market.

Properly formulated biodegradable lubricants may be used in transmissions and torque converters. An axle application for which GL-4 is approved for use can also use a UTTO with the Lubrizol 9999 additive package. No appropriate biodegradable lubricant has been identified to replace GL-5. Oil drain intervals may shorten when using biodegradable lubricants.

All applications using biodegradable lubricants must be reviewed by Spicer Off-Highway Product Engineering.

Biodegradable lubricants are generally based on vegetable oil (an ester) or a synthetic ester (TMP ester). Both are 70-100% biodegradable. For comparison, mineral oils range from 15-35%, synthetic oils (PAO based) 5-30%, polyglycols are 50-80%. Vegetable oils have the advantage of lower cost over the other biodegradables but also have some inherent disadvantages compared to mineral oils. These include decreased oxidation and thermal stability, less hydrolytic stability (tendency to form acids in presence of water), and reduced low temperature performance. Proper additive packages can offset deficiencies in vegetable oil's low temperature performance and stability.

Lubrizol has developed an additive package #9999 which is currently used with Canola (Rapeseed in Europe) based lubricants. Currently this is marketed as Deere Bio-Hyguard tractor hydraulic fluid. It is more equivalent to a GL-4 than a GL-5. Tests show that it performs about the same as a typical mineral oil based UTTO (Universal Tractor Transmission Oil) in viscosity/shear stability, water sensitivity, seal compatibility, antiwear performance, spiral bevel scoring performance and friction/chatter resistance.



SPICER OFF HIGHWAY PRODUCTS

TECHNICAL SERVICE BULLETIN

No. USA 271 E

Mo - Year 4-99

RECOMMENDED LUBRICANTS FOR TORQUE CONVERTERS AND POWERSHIFT TRANSMISSIONS

TORQUE CONVERTER/TRANSMISSION LUBRICANT MUST BE QUALIFIED BY ONE OF THE FOLLOWING SPECIFICATIONS.

ORDER OF PREFERENCE:

- | | |
|---------------------------|--|
| 1. CATERPILLAR TO-4 | 4. ALLISON C-4 |
| 2. JOHN DEERE J20 C, D | 5. DEXRON II Equivalent - See Note Below |
| 3. MILITARY MIL-PRF-2104G | |

IMPORTANT:

DEXRON*II EQUIVALENT IS ACCEPTABLE; HOWEVER, IT IS NOT COMPATIBLE WITH TORQUE CONVERTERS OR TRANSMISSIONS EQUIPPED WITH GRAPHITIC FRICTION MATERIAL CLUTCH PLATES.

LUBRICANTS NOT RECOMMENDED: DEXRON III, ENGINE OIL, ANY GL-5 OILS

OIL VISCOSITY - IT IS RECOMMENDED THAT THE HIGHEST VISCOSITY MONOGRADE LUBRICANT AVAILABLE BE USED FOR THE ANTICIPATED AMBIENT TEMPERATURE. TYPICALLY THIS WILL BE A CAT TO-4 QUALIFIED LUBRICANT. WHEN LARGE SWINGS IN AMBIENT TEMPERATURE ARE PROBABLE, J20 C, D MULTIGRADES ARE RECOMMENDED. MULTIGRADE LUBRICANTS SHOULD BE APPLIED AT THE LOWER VISCOSITY RATING FOR THE PREVAILING AMBIENT TEMPERATURE, I.E. A 10W20 SHOULD BE USED WHERE A 10W MONOGRADE IS USED. IF A C-4 MULTIGRADE IS USED IN PLACE OF J20 LUBRICANT IT IS RECOMMENDED THAT THE VISCOSITY SPAN NO MORE THAN 10 POINTS, I.E. 10W20.

SYNTHETIC LUBRICANTS ARE APPROVED IF QUALIFIED BY ONE OF THE ABOVE SPECIFICATIONS. OIL VISCOSITY GUIDELINES APPLY, BUT SYNTHETIC MULTIGRADES MAY SPAN MORE THAN 10 POINTS.

FOR FIRE RESISTANT FLUID RECOMMENDATIONS PLEASE CONTACT SPICER OFF-HIGHWAY PRODUCTS.

SUMP PREHEATERS - PREHEAT THE TRANSMISSION FLUID TO THE MINIMUM TEMPERATURE FOR THE OIL VISCOSITY USED BEFORE ENGINE START UP.

NORMAL OIL CHANGE INTERVAL - DRAIN AND REFILL SYSTEM EVERY 1000 HOURS FOR AVERAGE ENVIRONMENTAL AND DUTY CYCLE CONDITIONS. SEVERE OR SUSTAINED HIGH OPERATING TEMPERATURE OR VERY DUSTY ATMOSPHERIC CONDITIONS WILL RESULT IN ACCELERATED DETERIORATION OR CONTAMINATION. JUDGEMENT MUST BE USED TO DETERMINE THE REQUIRED CHANGE INTERVALS FOR EXTREME CONDITIONS.

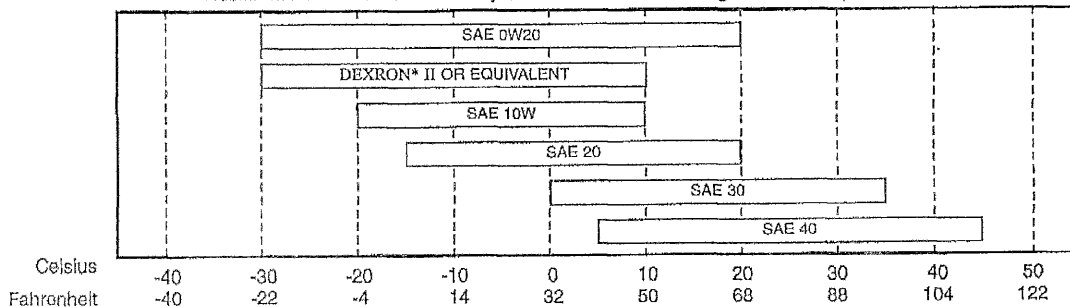
EXTENDED OIL CHANGE INTERVAL - EXTENDED OIL SERVICE LIFE MAY RESULT WHEN USING SYNTHETIC FLUIDS. APPROPRIATE CHANGE INTERVALS SHOULD BE DETERMINED FOR EACH TRANSMISSION BY MEASURING OIL OXIDATION AND WEAR METALS, OVER TIME, TO DETERMINE A BASELINE. WEAR METAL ANALYSIS CAN PROVIDE USEFUL INFORMATION BUT A TRANSMISSION SHOULD NOT BE REMOVED FROM SERVICE BASED SOLELY ON THIS ANALYSIS.

FILTERS - SERVICE OIL FILTER ELEMENT EVERY 500 HOURS UNDER NORMAL ENVIRONMENTAL AND DUTY CYCLE CONDITIONS. SERVICE THE HIGH PERFORMANCE EXTENDED LIFE FILTER ELEMENT EVERY 1000 HOURS OR UPON WARNING INDICATION FROM THE FILTER BACK PRESSURE SENSOR.

THIS RECOMMENDED LUBRICANT BULLETIN DOES NOT APPLY TO TRANSMISSION WITH ELECTRONIC MODULATION WHERE SEPARATE APPROVED OILS ARE IDENTIFIED.

ANY DEVIATION FROM THIS RECOMMENDATION MUST HAVE WRITTEN APPROVAL FROM THE APPLICATION ENGINEERING DEPARTMENT OF SPICER OFF HIGHWAY PRODUCTS.

Recommended SAE J300 Viscosity Grade Based on Prevailing Ambient Temperature



* DEXRON IS A REGISTERED TRADEMARK OF GENERAL MOTORS CORPORATION

SPICER OFF HIGHWAY PRODUCTS

POWER SHIFT TRANSMISSION AND TORQUE CONVERTER HYDRAULIC FLUID ANALYSIS

SPICER OFF HIGHWAY COMPONENTS DIVISION recommends that when chemical sampling of a power shift transmission lubrication circuit fluid is being taken that several samples be analyzed over a period of time to establish its normal base. Large changes in particle quantity from the normal level may indicate an abnormal condition within the transmission or its lubrication fluid. Any conclusion made of the transmissions actual condition, or action taken by the transmission user when interpreting the sample results, is the full responsibility of the user.

The following part per million (PPM) values represent general guidelines which may be used for references as a normal limit:

Iron	Fe	125 PPM
Copper	Cu	350 PPM
Silicon	Si	20 PPM
Aluminum	Al	15 PPM
Lead	Pb	50 PPM
Chromium	Cr	5 PPM

Aral Aktiengesellschaft

Aral Getriebeöl ATF 22 SAE 75W

Applications:

Automatic transmission fluid which fully meets the requirements of Dexron* II D type fluid. It is recommended for use in all automatic transmission and power steering systems specifying Dexron* IID and also for later Fords where a fluid meeting ESP-M2C155-H or SQM-2C9101-A is specified.

- The high thermal and oxidative stability combined with good wear control ensures transmissions are protected against rust and corrosion, which prolongs component life.
- A versatile product which meets the requirements of most ATF manufacturers, so reducing the number of products that need to be stocked.

Specification:

ZF TE-ML 03D, 04D, 11A, 14A, 17C
Voith 55.6335.3X

Approval:

MB 236.6
MAN 339 Typ Z1/V1
Ford WSS-M2C185-A

Technical Data

SAE-grade		DIN 51512	75W
ASTM-Colour		DIN ISO 2049	red
Density at 15 °C	g/ml	DIN 51757	0,870
Viscosity			
100 °C	mm ² /s	DIN 51562	7,5
40 °C	mm ² /s	DIN 51562	40
Viscosity Brookfield <150000mPa*s	°C	DIN 51398	- 40
Viscosity Index		DIN ISO 2909	>160
Flash point COC	°C	DIN ISO 2592	>210
Pourpoint	°C	DIN ISO 3016	-42

Remarks:

All data is subject to development for the product and the production process.

Version-No.: AS1111100023



Aral Aktiengesellschaft

Aral Getriebeöl ATF 22 SAE 75W

Anwendungsempfehlung:

Getriebeöl gem. früherer General Motors Spezifikation Dexron II (D) für den Einsatz in Automatik-Getrieben, Handschaltgetrieben, Kupplungs- und Lenkungssystemen, Hydrauliken oder Nebenantrieben. Einsatz in PKW, Nutzfahrzeugen (LKW, Agraraggregate, Baumaschinen), Schienenfahrzeugen oder Zweirädern (Gabelöl).

Aral Getriebeöl ATF 22 ist rot eingefärbt.

Spezifikation:

ehem. General Motors ATF Typ II D

Freigaben:

ehem. General Motors ATF Typ II D

Allison C4

Mercedes-Benz Betriebsstoff-Vorschrift Blatt 236.6

MAN 339 Type D

ZF TE-ML 03D, 04D, 11A, 14A, 17C

Voith 55.6335.xx (G 607)

Technische Daten

SAE-Klasse		DIN 51512	75W
ASTM-Farbzahl		DIN ISO 2049	rot
Dichte bei 15 °C	g/ml	DIN 51757	0,870
Viskosität			
100 °C	mm ² /s	DIN 51562	7,5
40 °C	mm ² /s	DIN 51562	40
Viskosität Brookfield	°C	DIN 51398	- 40
<150000mPa*s			
Viskositätsindex		DIN ISO 2909	> 160
Flammpunkt COC	°C	DIN ISO 2592	> 210
Pourpoint	°C	DIN ISO 3016	<- 39

Bemerkungen:

Durch Weiterentwicklung von Produkt und Produktion bedingte Datenänderungen bleiben vorbehalten.
Versions-Nr.: AS2408070019

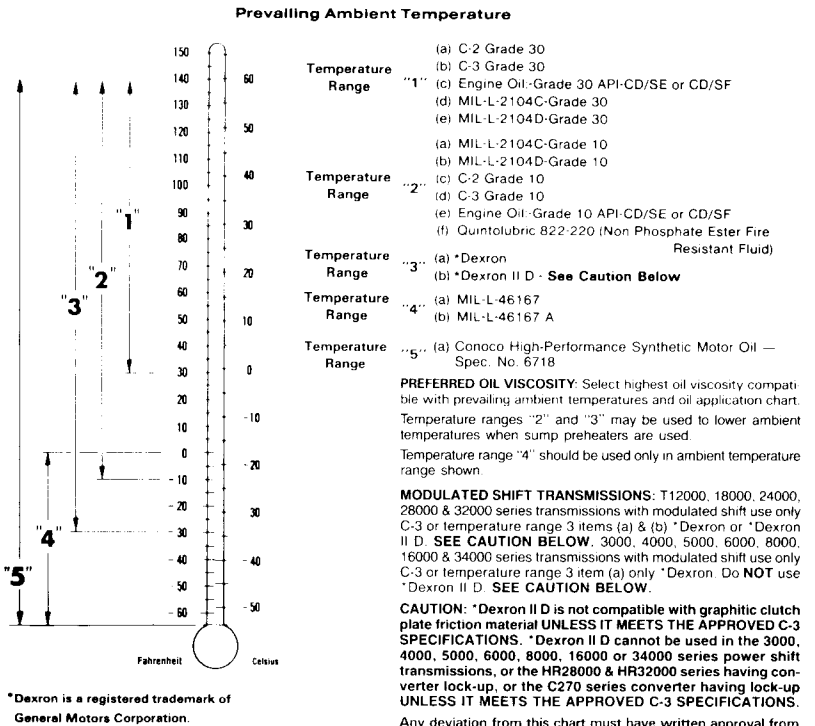
SPECIFICATIONS AND SERVICE DATA-POWER SHIFT TRANSMISSION AND TORQUE CONVERTER

<p>CONVERTER OUT PRESSURE</p> <p>CONTROLS</p> <p>CLUTCH TYPE</p> <p>CLUTCH INNER DISC</p> <p>CLUTCH OUTER DISC</p>	<p>Converter outlet oil temp. 180° - 200° F. [82,3° - 93,3° C].</p> <p>Transmission in NEUTRAL.</p> <p>Operating specifications:</p> <p>25 P.S.I. [172,4 kPa] minimum pressure at 2000 R.P.M. engine speed AND a maximum of 70 P.S.I. [482,6 kPa] outlet pressure with engine operating at no-load governed speed.</p> <p>Forward and Reverse - Manual</p> <p>Speed Selection - Manual</p> <p>Multiple discs, hydraulically actuated, spring released, automatic wear compensation and no adjustment. All clutches oil cooled and lubricated.</p> <p>Friction.</p> <p>Steel.</p>	<p>OIL FILTRATION</p> <p>Full flow oil filter safety by-pass, also strainer screen in sump at bottom of transmission case.</p> <p>CLUTCH PRESSURE</p> <p>240 - 300 psi [1654,8 - 2068,4 kPa] - With parking brake set (see note), oil temperature 180° - 200° F. [82,2° - 93,3° C], engine at idle (400 to 600 RPM), shift thru direction and speed clutches. All clutch pressure must be equal within 5 psi. [34,5 kPa]. If clutch pressure varies in any one clutch more than 5 psi [34,5 kPa] repair clutch.</p> <p>NOTE: Never use service brakes while making clutch pressure checks. Units having brake actuated declutching in forward and/or reverse will not give a true reading. ALWAYS USE PARKING BRAKE WHEN MAKING CLUTCH PRESSURE CHECKS.</p>
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LUBRICATION

RECOMMENDED LUBRICANTS FOR CLARK-HURTH COMPONENTS POWER SHIFTED TRANSMISSION AND TORQUE CONVERTERS

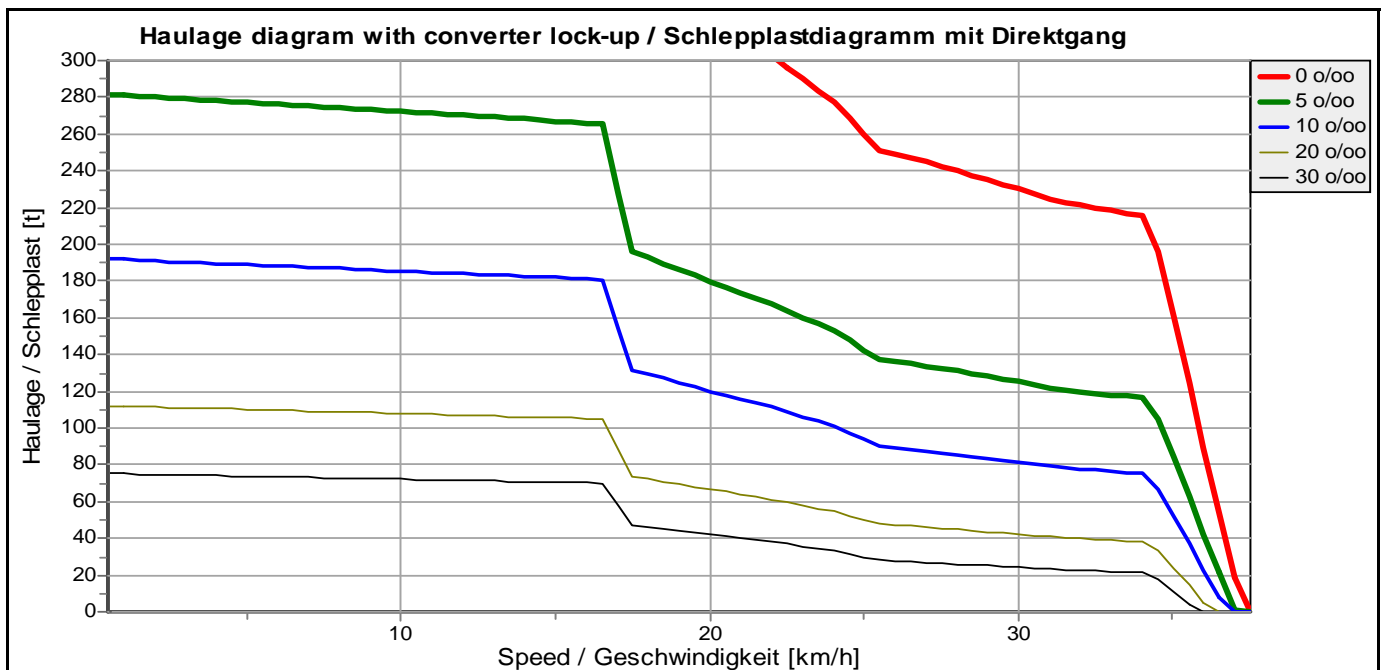
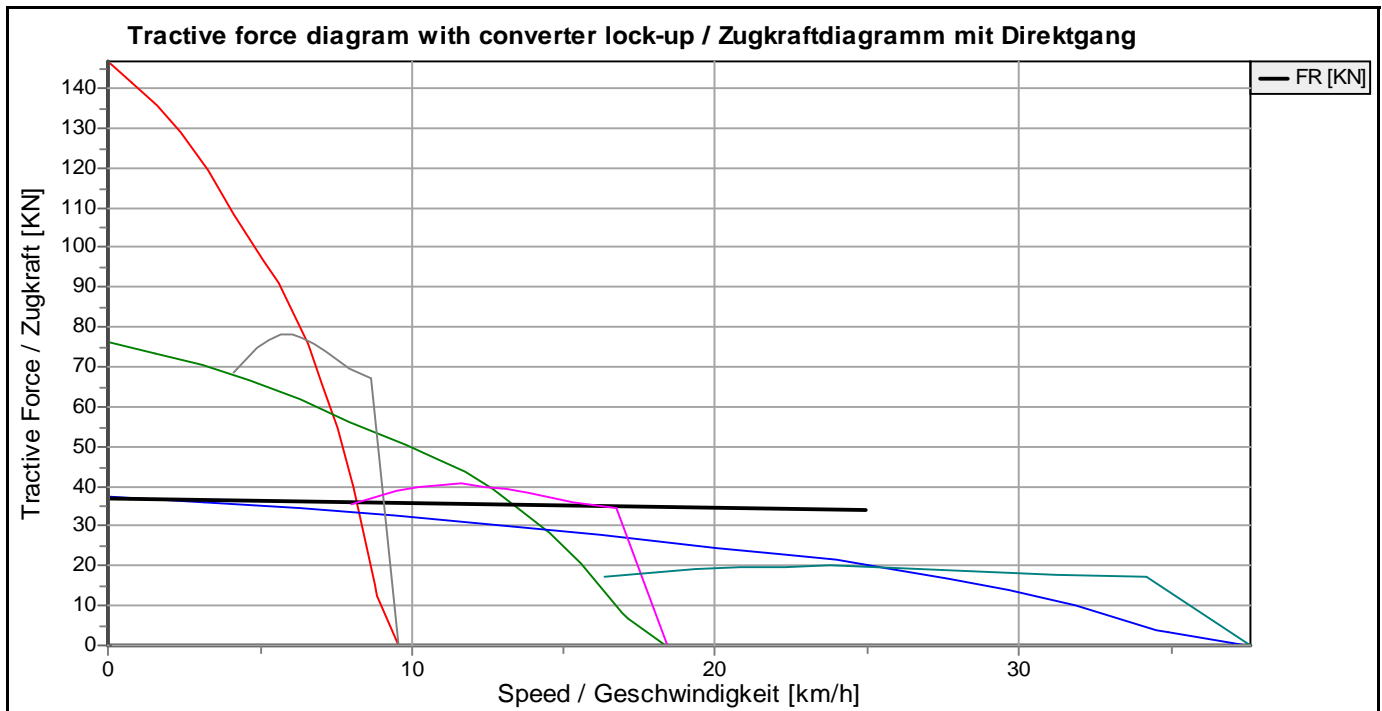
<p>TYPE OF OIL</p> <p>CAPACITY</p> <p>CHECK PERIOD</p> <p>NORMAL * DRAIN PERIOD</p>	<p>See Lube Chart.</p> <p>Consult Operator's Manual on applicable machine model for system capacity. Torque Converter, Transmission and allied hydraulic system must be considered as a whole to determine capacity.</p> <p>Check oil level DAILY with engine running at 500-600 RPM and oil at 180° to 200° F. [82,2 - 93,3° C]. Maintain oil level to FULL mark.</p> <p>Every 500 hours, change oil filter element. Every 1000 hours, drain and refill system as follows: Drain with oil at 150° to 200° F. [65,6 - 93,3° C].</p> <p>NOTE: It is recommended that filter elements be changed after 50 and 100 hours of operation on new and rebuilt or repaired units.</p> <p>(a) Drain transmission and remove sump screen. Clean screen thoroughly and replace, using new gaskets.</p> <p>(b) Drain oil filters, remove and discard filter elements. Clean filter shells and install new elements.</p> <p>(c) Refill transmission to LOW mark.</p> <p>(d) Run engine at 500-600 RPM to prime converter and lines.</p> <p>(e) Recheck level with engine running at 500 - 600 RPM and add oil to bring level to LOW mark. When oil temperature is hot (180-200° F.) [82,2-93,3° C] make final oil level check. BRING OIL LEVEL TO FULL MARK.</p>
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* Normal drain periods and filter change intervals are for average environmental and duty-cycle conditions. Severe or sustained high operating temperatures or very dusty atmospheric conditions will cause accelerated deterioration and contamination. For extreme conditions judgment must be used to determine the required change intervals.

CFL-180 DCL

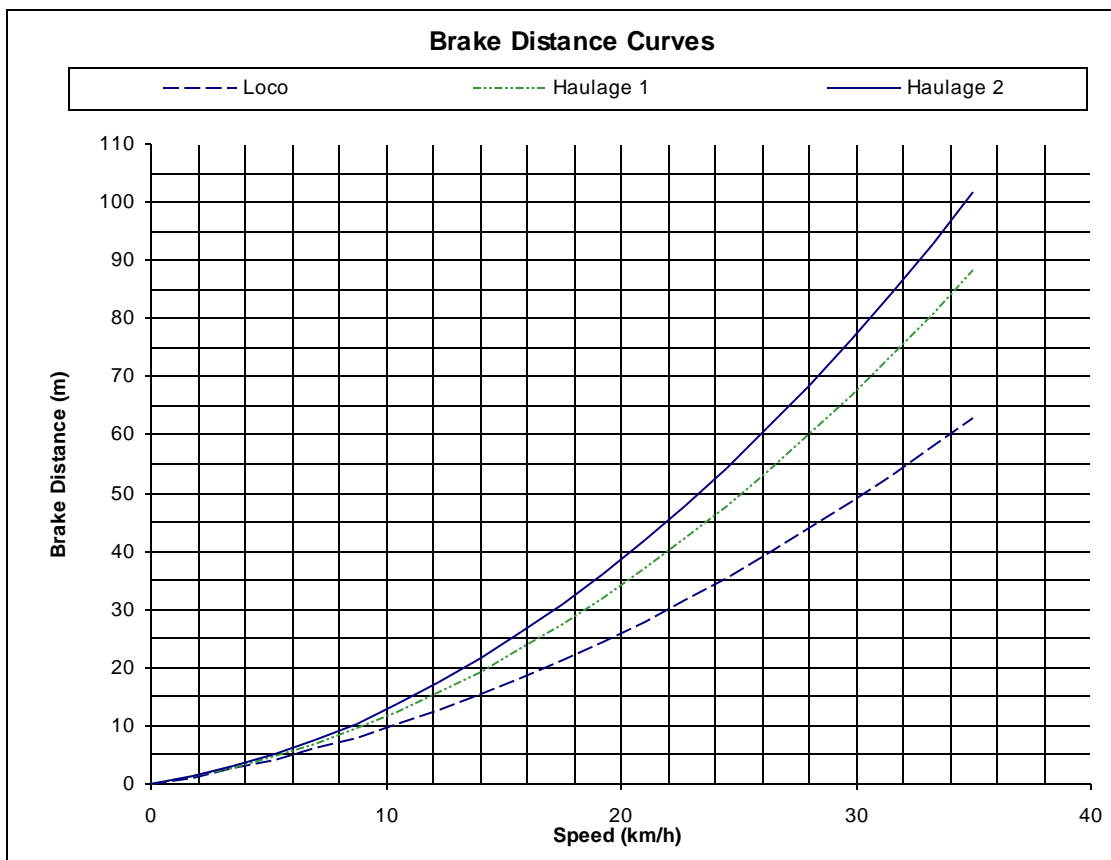
Motor / Engine: **BF6M1013CP**
 Brutto Leist. / Gross Output: **184 [KW]**
 Netto Leist. / Net Output: **184 [KW]**
 Gewicht / Weight: **25,0[t]**
 Drehmomentenwandler / Torque Conv.: **13.7/PA13-25 offset: 1,000**
 Schaltgetriebe / Transmission: **32384**
 Übersetzung / Transmission ratio: **8,93 / 4,63 / 2,27 / 0,00**
 Achsgetriebe / Axle gear ratio: **4,10**
 Raddurchm. neu / Wheel dia. new: **770 [mm]**
 Festbremspunkt / Stall speed: **2147 [U/min]**
 Reibwert / Adhesion $\mu =$ **0,15**
 Reibgrenze / Wheel Slippage $FR =$ **36,8 [KN]**

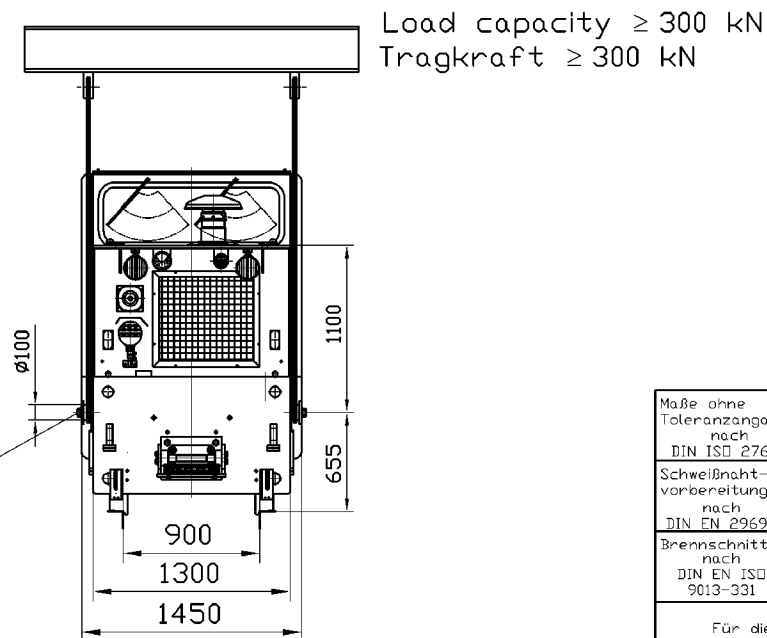
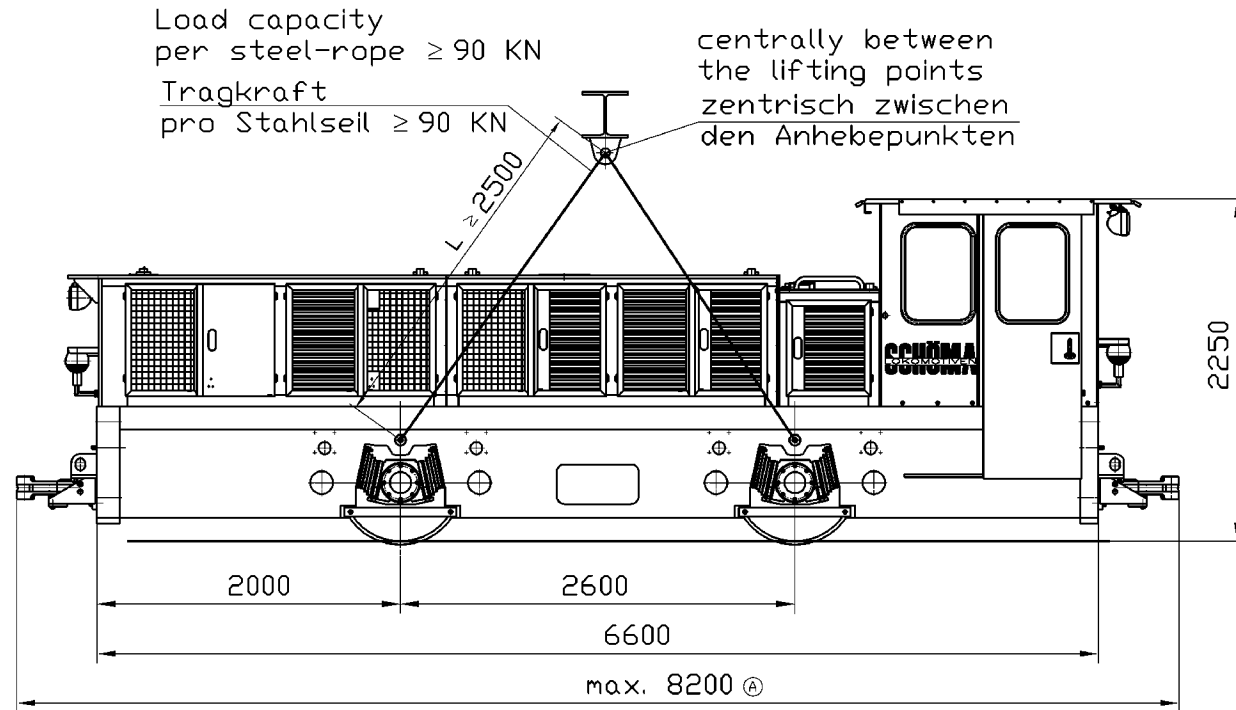


Brake Distance Curves

Project: Lee Tunnel, Thames Tideway

Type of Locomotive	CFL-180 DCL	
Weight	25	[t]
Rolling Resistance	40	[N/t]
Assumed Friction Factor (Wheel / Rail)	0,12	
Elektromagnetic Track Brake	0	[kN]
Waggon:		
Haulage 1	50	[t]
Haulage 2	140	[t]
Rolling Resistance	40	[N/t]
Assumed Friction Factor (Wheel / Rail)		
for braked axles	0,1	
Weight percentage of braked axles	50	%
General:		
Gradient (up=+, down=-)	-0,13	%
Reaction time of brake system	3	[s]
Max. speed	35	[km/h]





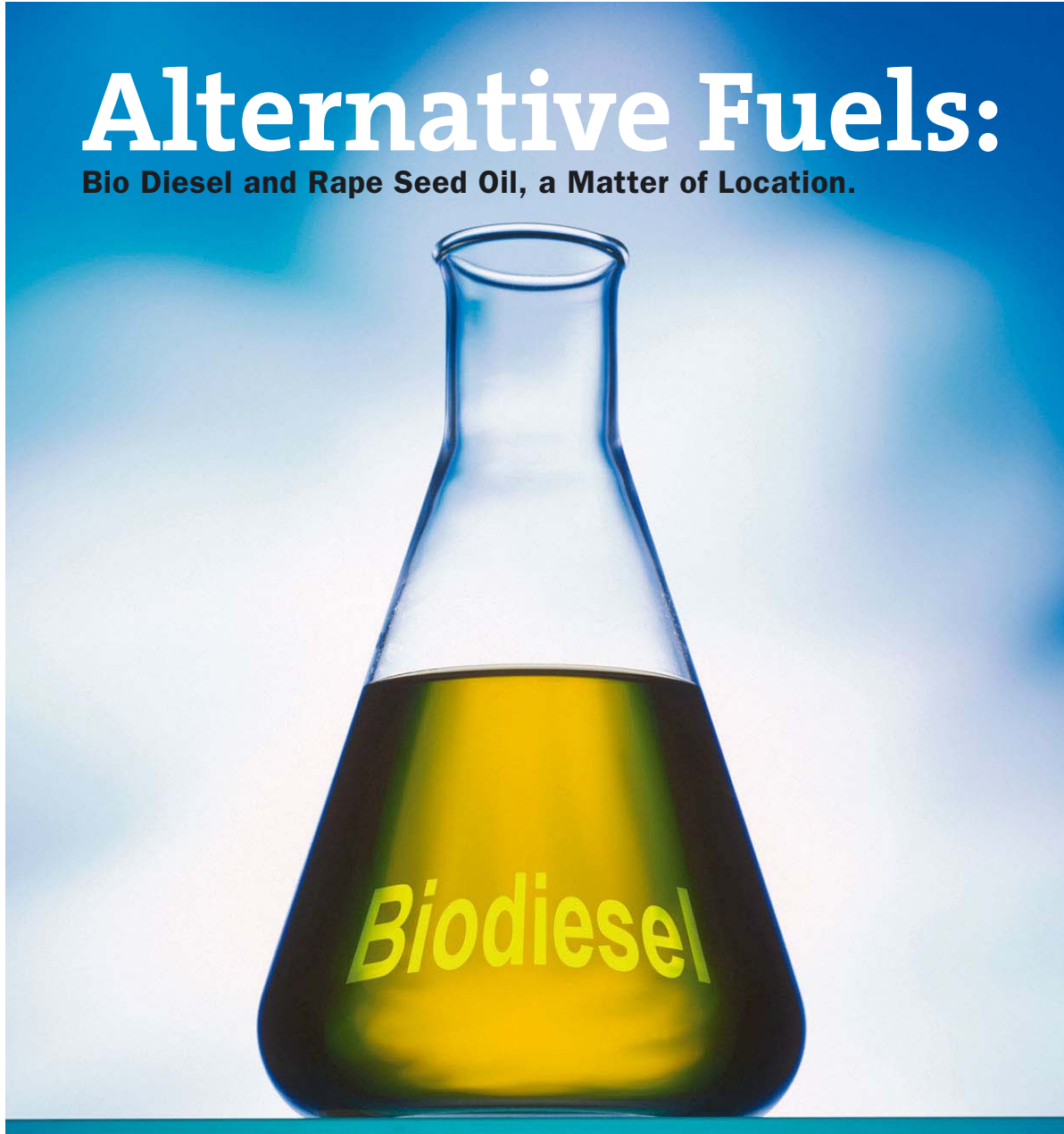
Maßangaben in mm
 Dimensions in mm

Maße ohne Toleranzangaben nach DIN ISO 2768m	Oberflächen nach DIN ISO 1302		Postfach 1509 49345 Diepholz/Germany	Blatt / Blätter: 1/1	
Schweißnaht-vorbereitung nach DIN EN 29692	Schweißen nach DIN EN ISO 13920-BF		Verwendungsbereich: CFL-180 DCL bis 30 to	Benennung: Anheben der Lok Lifting of the loco	Maßstab: %
Brennschnitt nach DIN EN ISO 9013-331		Datum	Name	Zeichnungsnummer:	
Für diese Zeichnung behalten wir uns alle Rechte nach DIN 34 vor.		Bearb. 29.11.2007	C.Bohm	01.180.099-43	Rev.-Zg: A
		Gepr. 30.11.2007	R.König		Rev.-Schaltene: -



Alternative Fuels:

Bio Diesel and Rape Seed Oil, a Matter of Location.



The engine company.



Suitability of rape seed oil methyl ester

In order to explain the fuel properties of vegetable oils (such as rape seed oil) which are important as regards application in diesel engines, reference should first be made to the chemical composition of vegetable oils. Vegetable oils are esters in which three long-chain fatty acids are bound to a trivalent alcohol (glycerol).

Certain of the characteristics of pure vegetable oils are problematic for use in diesel engine operation, primarily as a result of their very large molecules, which are approx. 60 C atoms in size. By means of interesterification with methanol, it is possible to convert the large glycerol esters, each of which has three fatty acids, into vegetable oil methyl esters with just one fatty acid per molecule. These molecules are similar in size to those of diesel fuel, and are therefore able to extensively substitute diesel fuel without problems.

The most common vegetable oil methyl ester in Europe is rape seed oil methyl ester (RME), also sold as »bio diesel«.

The following, only partially synonymous, terms are commonly used:

- Rape seed oil methyl ester (RME).
- Vegetable oil methyl ester (more general, also contains soya bean oil methyl ester, used in the USA as bio diesel).

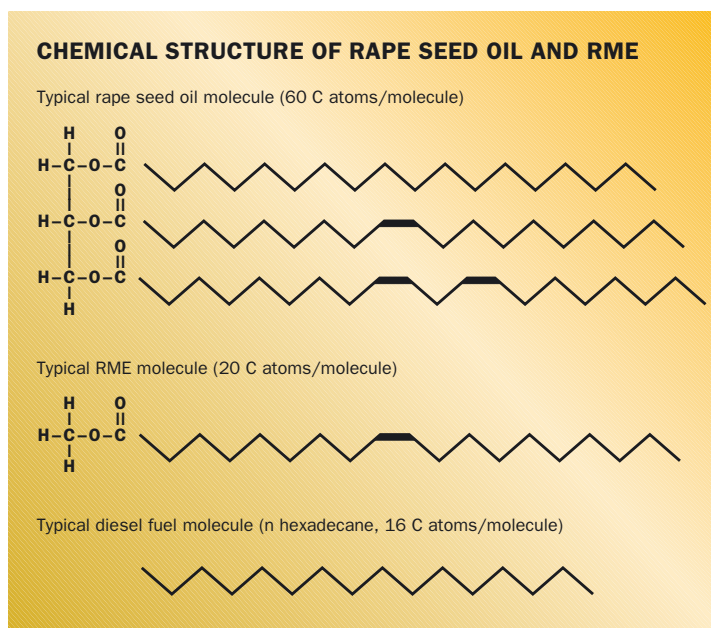
The EN 14214 standard »Fatty acid methyl esters (FAME) for diesel engines« has been in existence for several years. This has replaced DIN V 51606, which is now invalid.

The bio diesel quality management study group (registered association, AGQM), in which many German RME suppliers are amalgamated, has set down specifications which exceed those of EN 14214. Bio diesel suppliers which bear the AGQM badge are therefore particularly recommended to DEUTZ customers.

Operation with bio diesel is permissible for the majority of DEUTZ engines (912, 913, 914, 1011, 2011, 1012, 2012, 1013, 2013, 413 and 513) in accordance with the following

boundary conditions (according to DEUTZ technical circular TR 0199-99-3005):

- Only engines as of year of construction 1993 are approved.
 - Use of fuels with specifications according to EN 14214.
 - Applications with engine loads >80% (mean output >80% of rated output) are not approved for turbo-charged engines.
 - Possible loss of output of 5–7% must not be compensated by upfuelling.
 - The lube oil change interval must be halved in comparison with operation with diesel fuel according to EN 590.
 - Long downtimes must be avoided with bio diesel (e.g. winter break for equipments used in agricultural applications). Instead, the engine must be operated and shut down with diesel fuel before laying up.
 - The fuel hoses and diaphragm fuel pumps in series production engines are not permanently resistant to bio diesel, and must be replaced annually. Service kits containing the parts for annual replacement, and further service kits with bio diesel-resistant materials, which render annual replacement superfluous, are in preparation.
- Release tests have not yet been completed for the exhaust emission level III model series to be launched in 2006 (TCD 2012, TCD 2013).
- The advantages of bio diesel versus diesel fuel are listed in the following:
- Renewable fuel (high reduction of CO₂ accumulation in the atmosphere).
 - Lower soot emission (40–60% reduction) due to oxygen contained in the fuel.
 - Lower particulate emission (20–50% reduction).



- Lower sulphur content, lower SO₂ emission, therefore better exhaust gas aftertreatment prerequisites.
- Lower emission of polycyclic aromatics (PAH).
- Lower price (due to tax exemption, despite higher production costs).

These are countered by the following disadvantages:

- Restrictions (oil change intervals halved, annual replacement of fuel hoses...).
- Reduced output (5–7%).
- Increased fuel consumption (7–10%).
- Raised nitrogen oxide emissions (naturally-aspirated engines: 3–5%, turbocharged engines: up to 20%).
- Increased fuel storage effort. Due to bio diesel's ability to absorb more water, the water limit value (500 mg/kg according to EN 14214) may be exceeded easily. A higher water content also promotes bacterial growth, resulting in the total contamination limit value's (24 mg/kg) possibly being exceeded. The user is therefore recommended to consult his fuel supplier regarding the fuel storage system.
- Possible fuel filter clogging following the switch from diesel fuel to bio diesel due to the dissolution of deposits. This is perceived via a clear reduction in output approx. 100 hours following the switch. However, the problem can be permanently eliminated by a one-off filter change.

Reference is made to the results of a forestry RME vehicle fleet test (Doberlug-Kirchheim Forestry Department, Brandenburg, 1999) to demonstrate DEUTZ engines' suitability for operation with RME over long operating periods.

The following DEUTZ engines successfully took part in the test:

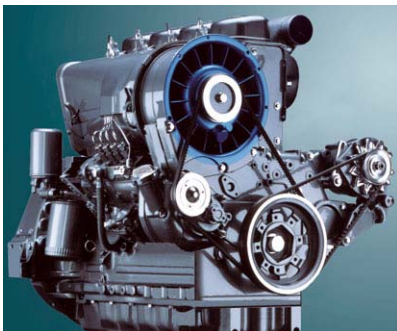
- F 3L 913 in a DEUTZ-FAHR tractor over a period of 1736 hours.
- BF 4M 1013 in forestry equipment (harvester) over a period of 5462 hours.
- BF 4M 1012 in forestry equipment (forwarder) over a period of 8764 hours.

Future use of bio diesel will depend on the future crude oil and diesel fuel price trend and on legal constraints.

Suitability of pure vegetable oils

The following, problematic fuel characteristics are attributable to the molecule size of pure vegetable oil:

- Lack of evaporability. That it is at all possible for combustion to occur in a diesel engine is due to the occurrence of chemical decomposition at the prevailing temperature, i. e. break-down into smaller fuel fractions takes place.
- Very high viscosity (10 times higher than RME and 20 times higher than



diesel fuel). The consequences are poor atomisation and air/fuel mixture formation.

- A low cetane number of 40–42, i. e. poor ignition quality. This is a consequence of the lack of evaporability and poor air/fuel mixture formation.
- High carbon residue (Conradson test). On hot surfaces, vegetable oil leads to high carbon build-up. This undesirable characteristic is attributable to the lack of evaporability (rapid escape from hot surfaces is prevented) and also to the double bonds, which may lead to polymerisation (= bonding of several molecules to form even larger units).
- Unfavourable low-temperature characteristics (problems are to be anticipated just below 0° C).

Despite the unfavourable fuel properties of pure rape seed oil, certain DEUTZ engines can be operated with this fuel: Swirl chamber engines 912

W and 413 FW. These engines employ a two-stage combustion process. In the first combustion stage, the swirl chamber, the fuel is extensively broken down, with the inclusion of air, into small fragments and gaseous fuels such as carbon monoxide and hydrogen. A second, largely complete combustion stage takes place in the main combustion chamber. Due to extensive cracking of the fuel in the swirl chamber, the rape seed oil's problematic, giant molecules no longer enter the critical regions of the engine (piston rings, lube oil).

The F6L 912 W was also used in the BMFT research project «Experimental investigation into the use of vegetable oils in diesel engines» (carried out at Porsche, concluded in 1991).

Neither the direct injection engines nor the passenger car swirl chamber engine survived the endurance test, but failed after 150–250 hours. Only the two divided-chamber engines with higher swept volumes, including the DEUTZ F6L 912 W, proved durable



and revealed no deterioration in their operating data.

The causes of the direct injection engines' failure included coking in the combustion chamber, in the piston ring grooves and at the fuel injection nozzles. Coking in the piston ring grooves resulted in piston ring sticking and piston seizure. Extremely viscous lube oil was also observed, caused by excessive entrainment of rape seed oil into the lube oil.

As has already been explained above, these coking phenomena are attributable to non-evaporability and the polymerisation tendency (double bonds), and are therefore causally connected to the basic chemical structure of vegetable oil. The phenomena which have been observed in engines can therefore be theoretically underpinned.

Due to the rise in diesel fuel prices and the reduction of agricultural diesel subsidisation, crude rape seed oil has become increasingly attractive to many users, particularly in the agricultural sector. In view of limited crude oil resources, political instances are also striving to introduce regenerative fuels. The conversion of 111 tractors to rape seed oil has been promoted by

BMVEL as part of the 100 tractors programme (running from 2001 to 2005). All conversions were carried out by small companies specialised in this field. Engine manufacturers, including DEUTZ AG, regard the risk involved in rape seed oil engines to be excessively high, and also consider the effort involved in development for a limited market to be too high.

The university of Rostock is documenting the farmers' experience with these rape seed oil tractors. Whilst the concluding report has not yet been published, interim reports have been given at several status seminars.

Up to May 2004, only 65 of the 111 tractors ran without, or with only minor, disturbances. All of the others suffered damage, up to and including total failure, primarily due to:

- Defective fuel injection pumps and nozzles,
- Seizing exhaust valves,
- In individual cases, piston seizure.

In comparison with the BMFT project from 1991, it must be stated that the more modern engines used in

the 100 tractor programme exhibit better rape seed oil suitability. The robust pump-line-nozzle systems fitted in the DEUTZ engines, in particular, proved relatively durable. Nevertheless, the incidence of damage is still far too high, and customers can hardly be expected to accept the risk of failure.

Farmers who still wish to have a tractor converted to operation with rape seed oil, despite the known risks, should demand warranty certificates from the converters.

In view of these results and the problems posed by the basic chemistry, we must expressly warn operators not to independently use vegetable oils in non-approved engines. All engines will run for a certain length of time without any conspicuous occurrences, but problems may occur after a certain period of time, and may lead to piston seizure in the worst-case scenario. Needless to say, customers cannot rely on warranty cover in such cases.

The negative assessment of pure vegetable oil also applies to use in combination with diesel fuel. The tendency to coke is merely reduced according to the mixture ratio, and remains a critical parameter.

Source:
VDBUM Information No. 6/2000 ; updated: 10/2005
Dr. Hans-Walter Knuth: Exhaust and operating media project manager
DEUTZ AG

OrderNo. 0031.1372/10/2005/WP-V

The engine company.



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Technical Bulletin

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DEUTZ engines

- All DEUTZ engines
- Product number(s) EKZ:
All product code numbers
- Assemblies:
99

Fuels

Replacement is made because of:

- introduction of engines with new emission stages Tier 4 interim and stage IIIB.
- Extension of biodiesel releases
- Revision of fuel standards and legal regulations

General

This bulletin defines for which compact engines of the DEUTZ brand the following fuels are approved:

- Diesel fuels
- MDF distillate fuels
- Light heating oils
- Jet fuels
- Biofuels

For general data on fuels, see section:

- Synthetic fuels
- Biological contamination in fuels

Note:
The part numbers indicated in this document are not subject to updating.
Binding for the identification of spare parts is exclusively the spare parts documentation.

- Fuel additives
- Fuel filters
- General information on fuel properties, exhaust gas after-treatment systems and emission regulations



This Technical Bulletin applies for all air-cooled and liquid-cooled compact engines of the DEUTZ brand. For engines which are no longer in production, this TB applies accordingly. This TB only applies up to year of production 2000 for engines of the 226 series.



Fuels must be used as regulated in the respective national regulations (e.g. in Germany in the 10th BImSchV). No fuels which deviate from these national regulations may be used (e.g. no fuel may be used in Europe if it only meets the limit values of the US standard purely by chance).

The certification measurements for compliance with the legal emission limit values are carried out with the test fuels specified in the laws. These correspond with the diesel fuels according to EN 590 and ASTM D 975 described in the following section. No emission values are guaranteed with the other fuels described in this bulletin. The owner is obliged to check the permission for the use of fuels according to the regional regulations.

Engines which are equipped with exhaust gas after-treatment by particle filters (DPF), diesel oxidation catalytic converters (DOC), particle oxidation catalytic converters or an SCR system (Selective Catalytic Reduction) may only be operated with sulphur-free diesel fuels (EN 590, ASTM D975 Grade 2-D S15, ASTM D975 Grade 1-D S15 or heating oil in EN 590 quality). Otherwise compliance with the emission requirements and durability is not guaranteed.

In a warranty case the customer must prove by a certificate from the fuel supplier that a released fuel was used.

The following list specifies the released fuels for the different series and emission stages, the following text contains further data about these releases:



List of released fuels

	413 513 912 913 914	1008 2008 2009 226 909 910	1011 2011	1012 1013 2012 2013	1015	413 513 912 913 1013M 1015M 2015M 914M Marine engines
	up to Tier 3 Stage IIIA	up to Tier 3 Stage IIIA	up to Tier 3 Stage IIIA	up to Tier 2 Stage II EURO 3	up to Tier 2 Stage II	
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204 ⁸	✓	✓	✓	✓	✓	✓
Distillate fuels for marine engines	✓	-	-	-	-	✓
Non-road fuels (light heating oils)	✓	✓	✓	✓	✓	✓
Jet fuels	✓	-	✓	✓	✓ ⁷	-
Biodiesel (up to 100 % EN14214, up to 20 % ASTM D7467)	✓	-	✓	✓	-	✓ ⁶
Diesel fuel world-wide according to appendix 11	✓	✓	✓	✓	✓	✓

	TCD 2012 2V 2012 4V	TCD 2013 2V 2013 4V	TCD 2013 4V Com- mer- cial vehicles up to Euro III	TCD 2013 4V Com- mer- cial vehicles from Euro IV	TCD 2015	DEUTZ Natural Fuel En- gine ®
	Tier 3 Stage IIIA	Tier 3 Stage IIIA			Tier 3 Stage IIIA	Stage IIIA
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204 ⁸	✓	✓	✓	✓	✓ ¹⁰	✓
Distillate fuels for marine engines	-	-	-	-	-	-
Non-road fuels (light heating oils)	✓	✓	-	-	✓	✓ ¹
Jet fuels	✓ ⁷	✓ ⁷	-	-	-	-
Biodiesel (up to 100 % EN14214, up to 20 % ASTM D7467)	✓	✓	✓	✓ ³	✓ ⁴	✓
Vegetable oil (DIN 51605)	-	-	-	-	-	✓
Diesel fuel world-wide according to appendix 11	✓	✓	✓	-	✓	-

	D/TD/ TCD 2.9 L4 TD/TDC 3.6 L4 up to Tier 3	D/TD/ TCD 2.9 L4 TD/TDC 3.6 L4 from Tier 4 in- terim Stage IIIB	TCD 4.1 L4 TCD 6.1 L6 TCD 7.8 L6 up to Tier 3	TCD 4.1 L4 TCD 6.1 L6 TCD 7.8 L6 from Tier 4 in- terim Stage IIIB	TCD 12.0 V6 TCD 16.0 V8 from Tier 4 in- terim Stage IIIB
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204 ⁸	✓	✓ ⁵	✓	✓ ⁵	✓ ⁵
Distillate fuels for marine engines	-	-	-	-	-
Non-road fuels (light heating oils)	-	✓ ²	-	✓ ²	✓ ²
Jet fuels	-	-	-	-	-
Biodiesel (up to 100 % EN14214, up to 20 % ASTM D7467)	-	-	-	✓ ¹	-
Diesel fuel world-wide according to appendix 11	✓ ⁹	-	✓ ⁹	-	-

Restrictions	
✓ ¹	Release only for Agri Power engines (Stage IIIB) with SCR exhaust gas after-treatment system
✓ ²	Release only for heating oils with EN 590 quality, see chapter Non-road fuels and light heating oils.
✓ ³	Release up to 30 % (V/V) EN14214 at replacement interval of the SCR catalytic converter of 200,000 km, see chapter Biofuels.
✓ ⁴	Release for engines as of 01.07.2010, retrofitting possible in earlier engines. US biodiesel release up to 50 % (V/V) for mine engines (MSHA)
✓ ⁵	Release for US diesel fuel according to ASTM D975 S15 only
✓ ⁶	Does not apply for the 1015M series
✓ ⁷	Only with magnet valve injection (MV system)
⁸	HFRR maximum 460 µm
✓ ⁹	Sulphur content maximum 2,000 mg/kg
✓ ¹⁰	Also applies for EURO 3



Diesel fuels

DEUTZ vehicle engines are designed for diesel fuels with a cetane number of at least 51. DEUTZ engines for mobile work machinery are designed for a cetane number of at least 45. When using fuels with a low cetane number, a disturbing formation of white smoke and ignition stutter is to be expected under some circumstances.

A cetane number of at least 40 is approved for the US market, therefore special engine versions were developed to avoid starting difficulties, extreme white smoke or increased hydrocarbon emissions. If the use of fuels with a very low cetane number is also known in advance in other countries, we recommend ordering the engines in EPA versions. It is generally recommended to use fuels with a higher cetane number than the minimum requirement of 40 in winter.

Diesel fuels are released and can be used according to the following specifications:

Fuel		Specifications
DIN EN 590	Biodiesel content max. 7 % (V/V)	Appendix 2
ASTM D 975 Grade 1-D S15	Biodiesel content max. 5 % (V/V)	Appendix 3
ASTM D 975 Grade 1-D S500		
ASTM D 975 Grade 2-D S15		
ASTM D 975 Grade 2-D S500		
JIS K 2204 No. 1, No. 2, No. 3		Appendix 4
NATO F-54		on request

US fuels in accordance with ASTM D 975 1-D S500 and ASTM D 975 2-D S500 are not released for engines from Tier 4 interim or Stage IIIB.

Japanese diesel fuels according to JIS K 2204 Grade 1 Fuel und Grade 2 Fuel are only released if the lubricating properties correspond with diesel fuel EN 590 (HFRR max. 460 micrometer according to EN ISO 12156-1).

The EN 590 standard has the status of a national standard in the countries of the EU, e.g. DIN EN 590. The NATO fuel F-54 is equivalent to diesel fuel in accordance with EN 590 but with max. 50 mg/kg sulphur.

Diesel fuels in other countries

The table in appendix 11 contains the requirements for diesel fuels for the countries in which none of the released fuels named in this bulletin exist.

Lubricating capacity for low-sulphur and sulphur-free fuels

Insufficient lubricating capacity can lead to serious wear problems, especially in common rail injection systems. Too low a lubricating capacity is particularly a problem in fuels with a low sulphur content (and in this respect sulphur contents ≤ 500 mg/kg can already be considered low). An adequate lubricating capacity is guaranteed by the appropriate additives at the refinery in low-sulphur (≤ 50 mg/kg) or sulphur-free (≤ 10 mg/kg or ≤ 15 mg/kg) diesel fuels according to EN 590 and ASTM D 975. In low-sulphur and sulphur-free diesel fuels which do not comply with this standard, the lubricating capacity may have to be guaranteed by additives. The parameter for sufficient lubricating capacity is a maximum wear spot of 460 micrometers in the HFRR test (EN ISO 12156-1).

High sulphur content in the fuel

Fuels with a sulphur content $> 0.5 \text{ \% (m/m)}$ (5,000 mg/kg) demand a shorter lubricating oil change interval (see Technical Bulletin 0199-99-1217). These fuels with a high sulphur content may not be used in engines with exhaust gas after-treatment (Tier 4 interim or Stage IIIB). Fuels with a sulphur content $> 1.0 \text{ \% (m/m)}$ are not permissible due to high corrosion and considerable shortening of the engine life. Low-ash / low SAPS engine lubricating oils (sulphate ash max. 1.0 \% (m/m)) may only be used in engines without exhaust after-treatment systems if the sulphur content in the fuel does not exceed 50 mg/kg. However, low-ash lubricating oils may be used in engines without exhaust gas after-treatment systems up to sulphur contents of 500 mg/kg if the base number (TBN) is at least 9 mg KOH/g. A corresponding note regarding suitable lubricating oils is published in the DEUTZ lubricating oil release list.

Winter operation with diesel fuel

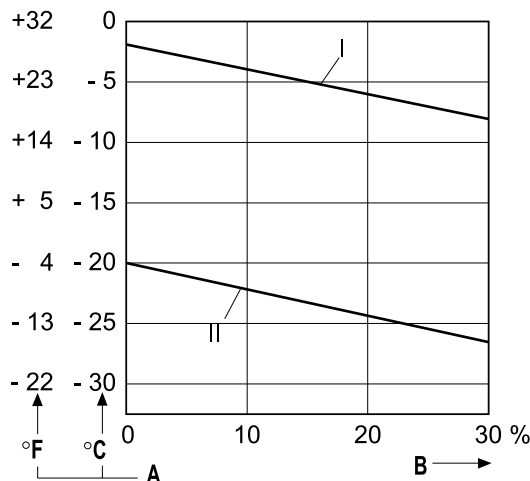
Special demands are placed on the cold behaviour (temperature limit value of the filtrability) for winter operation. Suitable fuels are available at filling stations in winter.



Mixing with petrol is not permissible for safety and technical reasons (cavitation in the injection system).

Diesel fuels up to $-44 \text{ }^\circ\text{C}$ are available for an Arctic climate. The addition of flow improvers to the diesel fuel is only allowed in exceptional cases. The choice of a suitable additive and the necessary dosing and mixing procedure must be discussed with the fuel supplier.

If only summer diesel fuel is available, petroleum or kerosene can be added to the diesel fuel up to 30 \% (V/V) at low temperatures as shown in the diagram below.



A 1 Mixing petroleum with summer diesel fuel



The mixing should take place in the engine tank. First pour in the necessary amount of petroleum or kerosene, and then add the diesel fuel.



For engines with common rail injection, the mixing of petroleum or kerosene and adding of extra low additives is not permissible. Fuels in accordance with ASTM D 975 Grade 1-D or DIN EN 590 - Arctic-Diesel may have no petroleum or kerosene added.

Marine distillate fuels

This includes distillate fuels which are used in shipping. Only marine distillate fuels which contain no residue oils (residue from the distillation process) may be used. The releases apply exclusively for DEUTZ marine engines of the 413/513/912/913/914M/1013M/1015M/2015M series.

The following marine fuels may be used:

Fuel	Specifications
DIN ISO 8217 DMX	Appendix 5
DIN ISO 8217 DMA (restriction: sulphur content max. 1.0 %(m/m))	Appendix 5
NATO F-75	Specifications available on request
NATO F-76	

- The cetane number must be at least 40, otherwise starting difficulties, extreme white smoke or increased hydrocarbon emission may occur.
- At a density of $> 0.869\text{g/cm}^3$, a return blocking in the injection pump is necessary (may only be carried out by authorised DEUTZ personnel).
- The possible high sulphur content $\geq 0.5 \text{ %(m/m)}$ requires a shorter lubricating oil change interval. Fuels with a sulphur content $> 1.0 \text{ %(m/m)}$ are not permissible due to higher corrosion and considerable shortening of the engine life. It must also be pointed out that fuels in accordance with ISO 8217 DMA are only permissible when the maximum sulphur content is 1.0 %(m/m) .
- Low-ash oils (low SAPS) are not permissible at sulphur contents $> 50 \text{ mg/kg}$ or $> 500 \text{ mg/kg}$ (see Technical Bulletin 0199-99-1217), i.e. generally not suitable for marine fuels.
- Because of the possible heavy contamination, great emphasis must be placed on fuel cleaning and possibly the installation of an additional fuel filter with a water trap to avoid biological contamination especially.

Non-road fuels and light heating oils

In some European countries, non-road fuels are defined with the same properties as heating oil but are taxed differently to diesel fuels. Systems which allow the use of heating oils and are subject to tax relief in Germany are described in the Energy Taxation Act (§3). The user must always abide by the pertinent tax regulations. These are not part of this bulletin. With regard to use in the engine (warranty rights), no differences are to be made between the appropriate non-road fuels and light heating oils.

- For engines up to Tier 2 / Stage II and engines up to Tier 3 / Stage IIIA with mechanical injection, the following light heating oil may be used:

Fuel	Specifications
DIN 51603-1	Appendix 6

- For all non-road engines operated in Europe except Germany, light heating oils or non-road fuels may only be used if all the limits of EN 590 are complied with.

Jet fuels

The following jet fuels can be used:

Fuel	Specifications
F 34 (kerosene, NATO designation)	Specifications available on request
F 35 (kerosene, NATO designation)	
F-44 (kerosene, NATO designation)	
F-63 (kerosene, NATO designation, equivalent to F-34/F-35 with additives)	
F-65 (kerosene, NATO designation, 1:1 mixture of F-54 and F-34/F-35)	
JP-8 (kerosene, US military designation)	
JP-5 (kerosene, US military designation)	
Jet A (kerosene for civil aviation)	
Jet A1 (kerosene for civil aviation)	

- Released for engine series 413/513/912/913/914/1011/1012/1013/2011/2012/2013/1015 up to Tier 2 / Stage II and Euro III (Exception: Common Rail engines). These series are also released for Tier 3 / Stage IIIA where engines with mechanical injection are concerned. The TCD 2012/2013 series with solenoid valve injection (MV-system) Tier 3 / Stage IIIA are also released.



- Individual series which already have Common Rail injection systems in Tier 2 / Stage II and all other engines with electronic injection are not released for jet fuels. All engines with exhaust gas after-treatment are not released for jet fuels either.
- The cetane number must be at least 40, otherwise starting difficulties, extreme white smoke or increased hydrocarbon emission may occur.
- Because of the lower density and the greater leak fuel volume due to lower viscosity, depending on the engine speed and torque, a power loss up to 10 % is possible.



Increasing of injection fuel quantity to compensate the lack of power is not allowed!

- There are some problematical fuel properties amongst the listed jet fuels (viscosity, lubricating capacities and low boiling point). A slight increase in wear in the injection system is to be expected which can lead to a statistically shorter life of these components. The engine guarantee is maintained when these fuels are used.
- Jet fuels can be mixed with each other.

Bio fuels

The generic term biofuels includes biodiesel and pure vegetable oils.

Bio-diesel

Biodiesel is Fatty Acid Methyl Ester (FAM) of vegetable oil. It is produced on a large scale by re-estering vegetable oil and methanol to glycerine and fatty acid methyl ester. It is possible to use different vegetable oils such as soya oil, palm oil, rape seed oil, sunflower seed oil or old fats.

In Europe biodiesel must comply with the EN 14214 standard. Because the biodiesel qualities available on the market do not always meet the requirements, DEUTZ customers in Germany are recommended to ensure the quality by buying biodiesel with an AGQM certificate (Association for Biodiesel Quality Management). The customers should also have compliance with the quality demands confirmed by the supplier by submission of a current analysis certificate of an ISO 17025 certified laboratory.



A 2 Biodiesel

The use of US biodiesel, based on soya oil methyl ester, is only permissible in mixtures with diesel fuel with a maximum biodiesel content of 20 % (V/V) in accordance with the ASTM D7467 standard. The US biodiesel greater than 20 % (V/V) used for the mixture must comply with the ASTM D6751 standard. Users are recommended to use biodiesel qualities with a quality certified in accordance with BQ 9000.

Fuel	Specifications
Biodiesel according to EN 14214	Appendix 7
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 % (V/V))	Appendix 8
US biodiesel according to ASTM D6751 (B100) (only for blends with diesel fuel of 20-50 % (V/V))	Appendix 9

Released engines

- The series 413/513/912/913/914/1011/1012/1013/2011/2012 and 2013 are released if compliant with the basic conditions specified in the text below as of the year of manufacture 1993 for biodiesel according to EN 14214 as well as B20-blend according to ASTM D7467.
- The TCD 2012 2V/4V and TCD 2013 2V/4V series for mobile work machinery up to Stage IIIA/Tier 3 are released for 100 % (V/V) biodiesel according to EN 14214 as well as B20 blend according to ASTM D7467.
- For TCD 2013 EURO III/IV/V commercial vehicles, the addition of up to 30 % (V/V) biodiesel in accordance with EN 14214 is released as of October 2009 on the condition that the SCR catalytic converter is replaced every 200,000 km. The engines prior to this date are not all equipped with biodiesel-resistant pipes.
The head office can provide further information here. Engines in which an additional diesel particle filter (DPF) is installed are excluded from the release.
- Engines of the 2015 series with MV injection system are released for operation with biodiesel from production date 01.07.2010.
The release applies for biodiesel according to EN 14214 as well as B20-Blend according to ASTM D7467. For engines operated within the area of application of the Mine Safety and Health Administration (MSHA), mixing up to 50 % (V/V) US biodiesel is permissible according to ASTM D6751.
Mixtures of US biodiesel with diesel fuel are not very suitable for cold weather and are not recommended for the winter.
Engines with an earlier production date can be retrofitted. The head office can provide information about the scope of the retrofit.
- Agri Power engines with SCR exhaust gas after-treatment systems of stage IIIB of the TCD 6.1 L6 and TCD 7.8 L6 series (2000 bar Common Rail injection system) are released for 100 % (V/V) biodiesel according to EN 14214.

The Agri Power engines of the TCD 4.1 L6 and TCD 6.1 L4 series (1600 bar Common Rail injection system) are currently on trial pending release.

In Agri Power engines, the SCR catalytic converter must be changed every 3,000 oh or after 2 years at the latest.



New customers must ensure that all the necessary basic conditions are satisfied and release by the head office is available before using biodiesel. Here too, DEUTZ customers are recommended to only use biodiesel with an AGQM certificate.

- Turbocharged engines are excepted from the release for applications which are normally operated with a high load above 80% nominal power; these are, for example, engines in block type heating power stations.

Basic conditions to be observed

- Because of the low heating value, a power loss of 5-9 % and an extra fuel consumption of 7-8 % in comparison with diesel fuel according to EN 590 is possible. Increasing of injection fuel quantity to compensate the lack of power is not allowed.
- The lubricating oil change interval must be halved in comparison with operation with diesel fuel according to EN 590.
- Standstill times of longer than 4 weeks must be avoided with biodiesel. Otherwise the engine must be started and shut down with diesel fuel.
- Engines with a low annual running time, e.g. emergency generators, are excluded from operation with bio-diesel.
- In series engines, the fuel pipes, the fuel manual supply pumps, and the LDA diaphragms (series 1012/1013/2012/2013/TCD 2012 2V mechanical and TCD 2013 2V mechanical) are not resistant to biodiesel and must be changed annually. To avoid annual replacement of the fuel hand supply pumps, a piston with an LDA diaphragm resistant to biodiesel fuel was introduced. Since the fuel pipes can dissolve prematurely at increasing fuel temperature and high running performance, they may have to be replaced before one year is up. The fuel pipes must be checked for damage (swelling) in the course of daily maintenance E 20. The use of biodiesel-resistant fuel pipes (Viton) is recommended; in this case, the annual replacement can be dispensed with.
- Biodiesel can be mixed with normal diesel fuel but the basic conditions described in this section apply for mixtures. Mixtures containing up to 7 % (V/V) biodiesel (B7) as they are permitted in EU countries according to national laws are excepted. However, the biodiesel mixtures must comply with EN 14214 in any case.
- Approx. 30-50 oh after changing over from diesel fuel to bio-diesel, the fuel filter should be changed as a precaution to avoid a drop in performance due to clogged fuel filters. Deposited fuel ageing products are dissolved by bio-diesel and transported into the fuel filter. They should not be changed immediately, but after approx. 30 to 50 hours, because the dissolving of dirt takes a certain amount of time.
- All parts carrying fuel which are installed later (by OEM or end customers, e.g. fuel pre-filter and fuel pipes) must be suitable for operation with biodiesel.

- To increase the oxidation stability of the used biodiesel and to improve the storability and reduce deposits and clogging in the injection system, it is recommended to use the DEUTZ additive "DEUTZ Clean-Diesel InSyPro" in the recommended concentration (see Technical Bulletin 0199-99-1210).

Plant oil



Pure plant oils (e.g. rape seed oil, soy oil, palm oil) are not classified as bio-diesel and exhibit problematic properties for engines which were not designed for operation with plant oils (strong tendency to coke, risk of piston seizure, extremely high viscosity, poor evaporation behaviour).

DEUTZ NATURAL FUEL ENGINE®

DEUTZ has developed the first series engine based on the TCD 2012 2V/4V series with the DEUTZ Common Rail System ® (DCR) for use with rape seed oil.

These engines are released for use of 100 % (V/V) rapeseed oil (refined or cold pressed) according to DIN 51605 (appendix 10) and biodiesel according to EN 14214 (appendix 7).

Basic conditions to be observed

- Because of the lower heating value, a power loss of 5-10 % and an extra fuel consumption of 4-5 % in comparison with diesel fuel according to EN 590 is possible. Blocking up of the injection pump is not allowed.
- The engine is a two-tank system with switching between diesel fuel and rape seed oil. Alternatively biodiesel can be used instead of rape seed oil or diesel fuel.
- At temperatures below 5 °C, rape seed oil should be replaced by diesel fuel or biodiesel.
- Shutdown periods of longer than 4 to 6 weeks must be avoided with bio-diesel and rape seed oil. Otherwise the engine must be started and stopped with diesel fuel.
- The lubricating oil change interval must be halved in comparison with operation with diesel fuel according to EN 590.
- Important fuel properties such as water content, oxidation stability, calcium, magnesium and phosphorus content and the total contamination are influenced especially by the harvest time, the pressing process in the oil mill, the storage of the rape seed oil and the further logistics chain. Because of the frequent exceeding of the limit values at distributed oil mills, the user is recommended to have the quality of the rape seed fuel delivery confirmed by an analysis certificate. In cases of doubt, the quality can be certified by an analysis carried out by a laboratory accredited according to ISO 17025, (e.g. ASG Analytik GmbH, D-86356 Neusäß, Tel. ++49 (0)821-450-423-0).



- Mixtures with other vegetable oils such as sunflower seed oil, soya oil or palm oil are not permissible because these vegetable oils can have problematic properties (strong coking tendency, danger of piston seizure, poorer cold properties, increased oxidation tendency).
- To increase the oxidation stability of the used rape seed oil and to improve the storability and reduce deposits and clogging in the injection system, it is recommended to use the DEUTZ additive "DEUTZ Clean-Diesel InSyPro" in the recommended concentration (see Technical Bulletin 0199-99-1210).

Notes for the storage of rape seed oil in fuel stations for own use:

- To be stored in dark places at constant low temperatures (maximum 20 °C, optimal in ground tanks at 5 – 10 °C). Storage temperatures below freezing point should be avoided, ground tanks are also optimal in this respect. The tanks may not be permeable to light (no polythene tanks).
- The storage time for rapeseed oil should be limited to a maximum of 6 months at storage temperatures up to 20 °C, for ground tanks < 10 °C maximum 12 months).
- Due to the hygroscopic (attracting water) properties of rape seed oil, works fuel stations should if possible be fitted with dehumidification on the air exchange system.
- Minimise contact with air with the use of thick locks.
- Contact with metals with a catalytic effect, above all copper or brass, must absolutely be avoided. These materials must not be used at all in the storage system (e.g. pipes, screws, pumps, etc).
- Avoidance of gathering of sediments by removal approx. 10cm above the tank floor.
- The tanks should be regularly cleaned, if a bacterial infestation occurs the bactericide Grotamar 71 or 82 should be used by a specialised firm.

Series diesel engines

The conversion of other DEUTZ engines to operation with pure plant oil with conversion kits and modified tanks systems of various manufacturers is not allowed and leads to loss of the guarantee rights.

Only engines of the 912W/913W/413FW/413W series with the 2-tank system from Henkelhausen, D-47809 Krefeld, Fax no. ++49 (0)2151 574 112, can be operated with rapeseed oil fuel according to DIN 51605, see appendix 10.

Synthetic fuels (GTL, CTL, BTL and HVO)

These fuels are produced synthetically from natural gas (Gas-to-Liquid), coal (Coal-to-Liquid) or biomass (Biomass-to-Liquid). At BTL one also refers to so-called biogenic fuels of the 2nd generation.

They differ from diesel fuel as follows:

- Chemical composition: pure paraffins, no aromates
- High cetane number
- Positive influences on emissions (nitric oxides and particles)
- Lower density, this results in a lower engine performance

DEUTZ has tested such fuels and confirmed the positive influences on the emissions. However, it is a well known fact that engines which are operated for longer periods with conventional diesel fuel and then converted to synthetic fuels suffer shrinkage of polymer seals in the injection system and thus from fuel leaks. The reason for this behaviour is that the aromatic-free synthetic fuels can lead to a change in the swelling behaviour of polymer seals. Therefore, conversion from diesel fuel to synthetic fuel should only take place after changing the critical seals. The problem of swelling does not occur when an engine is operated with synthetic fuel from the start.

Hydrogenated or hydrotreated vegetable oils (HVO) defines vegetable oils which are converted into hydrocarbons by a catalytic hydrogenation. Paraffins produced from the vegetable oils by this process consist of mixtures of saturated hydrocarbon chains of different lengths.

The density of these hydrogenated vegetable oils is approximately 700 kg/m^3 and is therefore much lower than mineral diesel fuel; the cetane value is much higher than that of diesel fuel with values of 80 to 90. This fuel is also free from sulphur and aromatic compounds.

Because of their very positive influences with regard to the cetane number and emission behaviour, these synthetic fuels are blended partly in small percentages in the so-called premium diesel fuels and in this case have no negative influences on the polymer compatibility.

Biological contamination in fuels

Symptoms

The following symptoms may indicate that a fuel tank is contaminated by micro-organisms:

- Corrosion of inside of tank
- Filter blockage and associated loss of power due to gel-like deposits on the fuel filter (especially after longer standstill times)

Cause

Micro-organisms (bacteria, yeast, fungi) can multiply into biosludge under favourable conditions (especially favoured by heat and water).

The water entry is usually caused by condensation of the water contained in the air. Water dissolves poorly in fuel so that the water which enters sinks to the bottom of the tank. The bacteria and fungi grow in the watery phase at the boundary with the fuel phase from which they draw their nutrition. There is an increased risk especially with biogenic fuels or biodiesel-diesel blends.



Remedial measures

- Keep storage tanks clean, regular tank cleaning (including the fuel line) by specialist companies.
- Installation of fuel pre-filters with water traps, especially in countries with frequently fluctuating fuel qualities and high percentage of water (e.g. Separ-filter or RACOR filter).

- Use of biocide Grotamar 71 or Grotamar 82 of

Schülke & Mayr GmbH,
D-22840 Norderstedt,
Tel.: +49 (0)4052 100-0,
e-mail: info@schuelke.com

if fuel system and storage tank are already contaminated by micro-organisms. The biocide must be dosed according to the manufacturer's specifications. The use is restricted exclusively to eliminating microbe contamination. Prophylactic use is not permissible.

- In suspicious cases, biological contamination according to DIN 51441 (determination of the number of colonies in mineral oil products in the boiling range below 400 °C) can be analysed by laboratories certified according to ISO 17025 (e.g. Petrolab GmbH, D-67346 Speyer, Tel.: ++49 (0) 6232-33011).
- Avoid direct radiation of sunlight on the storage tank.
- Use of smaller storage tanks with correspondingly short dwell times of the stored fuel.
- Equip the fuel tank with a drying cartridge on the air exchange system.
- The tank must be cleaned before adding the biocide if there is a clearly visible biofilm in the tank or on the tank walls.
- Appropriate quick check kits are also available from the biocide suppliers.

Fuel additives

The **DEUTZ Clean-Diesel InSyPro** additive is released exclusively for use in DEUTZ engines. See Technical Bulletin 0199-99-1210 for notes on use and dosing.



The previously mentioned flow improvers (not for DEUTZ Common Rail engines) are an exception. The use of other fuel additives is prohibited. Voiding of the warranty is to be expected when unsuitable additives are used which haven't been released.



Fuel filters

Modern diesel engines, especially with high-pressure injection and common rail injection system make very high demands on the fuel quality. The **DEUTZ original fuel filters** are adapted and tested for these demands. Continuous, trouble-free operation of the engines is only guaranteed when the original filters are used. In case of damage to the injection system within the warranty period and proof that no original filters were used, the warranty will be voided.

Please contact the following persons if you have any questions about the listed topics.

Contact:

DEUTZ Engines

E-mail: lubricants.de@deutz.com

or

E-mail: service-kompaktmotoren.de@deutz.com

This document has been created digitally and is valid without a signature.



Appendix 1

General information on fuel properties, exhaust gas after-treatment systems and emission regulations

Exhaust gas after-treatment systems

The introduction of new, stricter exhaust emission regulations demands the use of exhaust gas after-treatment systems such as the SCR technique (selective catalytic reduction), the diesel oxidation catalytic converter (DOC), and the diesel particle filter (DPF). For the trouble-free use of fuels, it is necessary to reduce ash and deposit forming elements, as well as elements which damage the catalytic converter, such as sulphur, as much as possible. Therefore, these engines may only be operated with sulphur-free diesel fuels (EN 590, ASTM D975 Grade 2-D S15, ASTM D975 Grade 1-D S15 or heating oil or non-road fuels in EN 590 quality (sulphur content max. 10 mg/kg)). Other elements such as phosphorus, calcium, magnesium, sodium and potassium, which especially biogenic fuels may contain, should also be minimised. Otherwise, compliance with the emission requirements and durability of the exhaust gas after-treatment systems is not guaranteed.

Ash

Ash is carbon-free combustion residue which can lead to wear due to deposits in the engine and turbocharger.

Bio-diesel

Biodiesel is made by re-estering of greases or oils (triglyceride) with methanol. The correct chemical name is fatty acid methyl ester, often abbreviated to FAME. In Europe it is usually produced by re-estering of rape seed oil (rape seed oil methyl ester = RME). In the USA, biodiesel comes almost exclusively from soya oil (soya methyl ester = SME). Other vegetable oils (sunflower seed oil, palm oil, jatropha oil) or animal fats are also possible.

Due to national and EU regulations biodiesel (FAME) percentages are now possible or prescribed in most diesel fuels. In the new EN 590 max. 7 % (V/V) are permissible for example, in the US-ASTM D975 max. 5 % (V/V). According to the biofuel quota law, at least 5 % (V/V) FAME must be mixed with the normal, commercially available diesel in Germany.

Cetane number/cetane index

The cetane number indicates the fuel's willingness to ignite. Too low a cetane number may lead to starting difficulties, formation of white smoke, increased carbon emission and thermal and mechanical overloading of the engine. The cetane number is determined on a test engine. The cetane index can be substituted as a value calculated from density and boiling behaviour. The cetane index serves for estimating the cetane number for the basic fuel but it does not usually take the effect of willingness to ignite improvers when the cetane number of finished fuels is determined.

Density

The density is usually specified in g/cm^3 or kg/m^3 at 15 °C and is important for converting the fuel consumption from volume ? to weight ? unit. The higher the density, the greater the weight of the injected fuel.

Flashpoint

The flashpoint has no significance for the engine operation. It applies as a value for the fire hazard and is important for classification in one of the hazard classes (decisive for storage, transport and insurance).

Heating value

The lower heating value (H_l) indicates the amount of heat which is released when burning 1 kg of fuel.

Behaviour in cold

The following parameters indicate the suitability of the fuel for low temperatures:

- The solidification point indicates at what temperature the fuel no longer flows under its own weight.
- The pour point is approx. 3 °C above the solidification point.
- The cloud point indicates at what temperature solid emissions (paraffin) are visible.
- The limit of filtrability (CFPP) indicates at what temperature filters and pipes may be blocked.

Coke residue

The coke residue serves as a reference value for the tendency for residue to form in the combustion chamber.

Copper corrosion

Diesel fuel can be corrosive, especially during prolonged storage with fluctuating temperature and formation of condensation on the tank walls. To check the limit value defined in DIN EN 590, a polished copper strip is immersed in diesel fuel at 50 °C for 3 hours. Appropriate additives ensure protection of the metals which come into contact with the fuel even under difficult conditions.

Neutralisation number

The neutralisation number is a measure of the content of free acids in the diesel fuel or bio-diesel fuel. It describes the amount of potassium lye required for neutralising the acids. Acid compounds in the fuel lead to corrosion, wear and formation of residue in the engine.



Oxidation resistance

Fuels may oxidise and polymerise partly during long storage. This can lead to the formation of insoluble (varnish like) components and the associated filter blockage. Biofuel parts are more sensitive to oxidation and also impair oxidation resistance.

Lubricity

The lubricity decreases with the degree of desulphurisation and can drop to a level that leads to considerable wear in the distributor injection pumps and common rail systems. Extremely desulphurised fuels contain special lubricity additives. The HFRR test (High Frequency Reciprocating Wear Rig) was developed for evaluating the fuels (EN ISO 12156-1). This test simulates the sliding wear in the injection pump by rubbing a ball on a polished steel plate with constant contact force. The flattening of the ball after 75 minutes is measured as an average wear diameter (limit value: max. 460 µm).

Sulfur content

High sulfur content and low component temperature can cause increased wear due to corrosion. The sulfur content influences the lubricating oil change intervals. Too low a sulfur content may impair the lubricity of the fuel if this has not had lubricity improvers added.

Sediments/total contamination

Sediments are solids (dust, rust, scale) which can cause wear in the injection system and combustion chamber as well as leaks in the valves.

Boiling curve

The boiling curve indicates how much volume% of the fuel is overdistilled at a certain temperature. The greater the boiling residue (amount remaining after evaporation), the more combustion residue may occur in the engine, especially in partial load operation.

Trace elements in the fuel (zinc, lead, copper)

Even small traces of zinc, lead and copper can lead to deposits in the injection nozzles, especially in the modern common rail injection systems.



Zinc and lead coatings are therefore not permitted in tank systems (especially in fuel stations for own use) and fuel pipes. Materials containing copper (copper pipes, brass parts) must also be avoided because they can lead to catalytic reactions in the fuel with subsequent deposits in the injection system.

Conversion ppm

The term parts per million (ppm) is often used in fuel analyses.

The term ppm alone is not a unit of measure. It usually describes the weight concentration (1 ppm (m/m) = 1 mg/kg). $1 \text{ ppm} = 10^{-6} = \text{parts per million} = 0,0001 \%$

Viscosity

The kinematic viscosity in mm^2/s at a certain temperature ($1 \text{ mm}^2/\text{s} = 1 \text{ cSt}$ [centistoke]) is specified. The viscosity must be within certain limits for engine operation. Too high viscosity requires pre-heating because otherwise a lower engine performance is to be expected.

Water

Too high a water content leads to corrosion and, in connection with corrosion products and sediments, to sludge. Disturbances in the fuel and injection system are the result.

■ Fuel quality and exhaust gas legislation

The fuel qualities to be used are closely related to the used engine and exhaust gas after-treatment technologies and these are selected in turn with regard to the emission limits of the exhaust laws of the countries in which the engines are used. Since the bulletin frequently refers to the exhaust gas law stages, these are explained below.

Emission laws for mobile work machinery (including building machinery, tractors, compressors, mobile electricity units)

Europe and the USA have largely similar emission legislations so that the stages specified for EU and the USA in one line in the following table are both satisfied by an engine developed for this. The dates for introduction and limit values differ for different performance categories. The dates for the category > 130 kW are the first respectively for a certain stage.

Designation of the emission stage		Introduction date for engines 130 - 560 kW	
EU	USA	EU	USA
Stage I	Tier 1	01.01.1999	01.01.1996
Stage II	Tier 2	01.01.2001	01.01.2001 up to 01.01.2003
Stage IIIA	Tier 3	01.01.2006	
Stage IIIB	Tier 4 interim	01.01.2011	
Stage IV	Tier 4 final	01.01.2014	



Emission laws for commercial vehicles in the EU

The emission stages EURO I to Euro VI were introduced on the following dates:

Designation of the emission stage	Introduction date for engines
EURO I	01.01.1993
EURO II	01.01.1996
EURO III	01.01.2001
EURO IV	01.01.2006
EURO V	01.01.2009
EURO VI	01.01.2014

Fuel laws have also been introduced appropriate to the emission laws. For the work machinery, the limit values from stage IIIB or Tier 4 interim are so low that exhaust gas after-treatment systems such as particle filters or SCR have to be introduced in most cases. Sulphur-free fuels are largely required for this and these are legally prescribed for the specified dates. Exhaust gas after-treatment has been introduced for commercial vehicle engines as of EURO IV.

Appendix 2

Fuel specification (requirements and test methods):

Diesel fuel according to DIN EN 590 **

May 2010 edition

Properties	Units	Limit values EN 590	Test method
Cetane number		min. 51	EN ISO 5165 or EN 15195
Cetane index		min. 46	EN ISO 4264
Density at 15 °C	kg/m ³	820 - 845	EN ISO 3675 or EN ISO 12185
Polycyclic aromatic hydrocarbons	%(m/m)	max. 8	EN 12916
Sulphur content	mg/kg	max. 10	EN ISO 20846 or EN ISO 20884
Flashpoint	°C	min. 55	EN ISO 2719
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	EN ISO 10370
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Water content	mg/kg	max. 200	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1	EN ISO 2160
Oxidation stability	g/m ³	max. 25	EN ISO 12205
Oxidation stability	h	min. 20	EN ISO 15751
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	max. 460	EN ISO 12156-1
Viscosity at 40 °C	mm ² /s	2,00 - 4,50	EN ISO 3104
Distillation			EN ISO 3405
– collected at 250 °C	%(V/V)	max. 65	
– collected at 350 °C	%(V/V)	min. 85	
– 95 vol.% starting at	°C	360	
Fatty acid methyl ester (FAME)	%(V/V)	7,0	EN 14078
Limit of filtrability *			EN 116
– 15.04. - 30.09.	°C	max. 0	
– 01.10. - 15.11.	°C	max. - 10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	max. - 20	
– 01.03. - 14.04.	°C	max. - 10	
* Specifications apply for Germany. National regulations may deviate.			
** Specification also applies for NATO fuel F-54 (except sulphur content max. 50 mg/kg)			



Appendix 3

Fuel specification (minimum requirement)
US diesel fuel according to ASTM Designation D 975-11

Properties	Units	Limit values		Test method
		Grade No. 1-D S500 Grade No. 1-D S15	Grade No. 2-D S500 Grade No. 2-D S15	
Density at 15 °C	kg/m ³	max. 860 *	max. 860 *	
Flashpoint	°C	min. 38	min. 52	ASTM D 93
Water and sediments	%(V/V)	max. 0.05	max. 0.05	ASTM D 2709
Boiling curve at 90 vol. %	°C	–	min. 282	ASTM D 86
	°C	max. 288	max. 338	
Kinematic viscosity at 40 °C	mm ² /s	1,3 - 2,4		ASTM D 445
Ash content	%(m/m)	max. 0.01	max. 0.01	ASTM D 482
Sulphur content				
	– Grade No. 1/2-D S500	%(m/m)	max. 0.05	max. 0.05	ASTM D 2622
– Grade Low Sulfur No. 1/2-D S15	%(m/m)	max. 0.0015	max. 0.0015	ASTM 5453
Corrosion effect on copper (3 h at 50 °C)	Degree of cor- rosion	No. 3	No. 3	ASTM D 130
Cetane number		min. 40	min. 40	ASTM D 613
Coke residue (from 10 % distillation residue) according to Ramsbottom	%(m/m)	0,15	0,35	ASTM D 524
Limit of filtrability	°C	**	**	
* minimum requirement DEUTZ				
** depending on the season and region				

Appendix 4
**Fuel specification (minimum requirement)
Japan diesel fuel according to JIS K 2204:2007**

Properties	Units	Limit values					Test method
		Special No. 1	No. 1	No. 2	No. 3	Special No. 3	
Flashpoint	°C	min. 50				min. 50	JIS K 2266-3
Boiling curve at 90 vol. %	°C	max. 360		max. 350	max. 330	max. 330	JIS K 2254
Pour point	°C	max.+5	max.-2.5	max.-7.5	max.-20	max.-30	JIS K 2269
Limit of filtrability	°C	-	max.-1	max.-5	max.-12	max.-19	JIS K 2288
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.1					JIS K 2270
Cetane index		min. 50		min. 45			JIS K 2280
Kinematic viscosity at 30 °C	%(V/V)	min. 2.7		min. 2.5	min. 2.0	min. 1.7	JIS K 2283
Sulphur content	mg/kg	max. 10 *					JIS K 2254-1, -2, -6, -7
Density at 15 °C	kg/m ³	max. 860					JIS K 2249



Appendix 5

Fuel specification (minimum requirement)
 Distillate fuel (requirements for marine fuels) according to DIN ISO 8217
 August 2009 edition

Properties	Units	Limit values		Test method
		Category ISO-F		
		DMX	DMA	
Density at 15 °C	kg/m ³	/	max. 890	ISO 3675 / ISO 12185
Viscosity at 40 °C	mm ² /s	1,4 - 5,5	1,5 - 6,0	ISO 3104
Flashpoint	°C	min. 43	min. 60	ISO 2719
Pour point				
– Winter quality	°C	–	max. -6	ISO 3016
– Summer quality	°C	–	max. 0	ISO 3106
Cloud point	°C	max. -16	–	ISO 3015
Sulphur content	%(m/m)	max. 1.0 **	max. 1.0 ^{*/**}	ISO 8754
Cetane number		min. 45	min. 40	ISO 5165
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	max. 0.30	ISO 10370
Ash content	%(m/m)	max. 0.01	max. 0.01	ISO 6245
Visual inspection clear and glossy (for DMX and DMA)				
* minimum requirement DEUTZ				
** observe shorter lubricating oil maintenance interval				

Appendix 6

Fuel specification (minimum requirement)
 Light heating oil EL according to DIN 51603-1
 September 2011 edition

Properties	Units	Limit values DIN 51603-1	Test method
Density at 15 °C	kg/m ³	max. 860	DIN 51757 or EN ISO 12185
Combustion point	MJ/kg	min. 45.4	DIN 51900-1 and DIN 51900-2 or DIN 51900-3 or Calculation
Flashpoint in closed pot according to Pen- sky-Martens	°C	more than 55	EN 2719
Kinematic viscosity at 20 °C	mm ² /s	max. 6.0	DIN 51562-1
Distillation curve total evaporated volume parts			EN ISO 3405
– up to 250 °C	%(V/V)	max. 65	
– up to 350 °C	%(V/V)	min. 85	
Cloud point	°C	max. 3	EN 23015
Temperature limit of filtrability (CFPP) de- pending on the cloud point			EN 116
– at cloud point = 3 °C	°C	max. -12	
– at cloud point = 2 °C	°C	max. -11	
– at cloud point <1 °C	°C	max. -10	
Coke residue (from 10 % distillation residue) according to Conradson	%(m/m)	max. 0.3	EN ISO 10370 or DIN 51551-1
Sulphur content – for heating oil EL-1 standard	%(m/m)	max. 0.10	EN 24260 or EN ISO 8754 or EN ISO 14596
Sulphur content – for heating oil EL-1 low sulphur	mg/kg	max. 50	EN ISO 20884 or EN ISO 20846
Water content	mg/kg	max. 200	DIN 51777-1 or EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Thermal stability (sediment)	mg/kg	max. 140	DIN 51371
Storage stability	mg/kg	to be specified	DIN 51471
Note: Low-sulphur heating oil according to DIN 51603-1 has sufficient lubricity (according to EN ISO 12156 - 1) of 460 µm.			



Appendix 7

Fuel specification (minimum requirement)

Fatty acid methyl ester (FAME) for diesel engines (biodiesel) according to EN 14214

April 2010 edition

Properties	Units	Limit values DIN EN 14214	Test method
Fatty acid methyl ester (FAME)	%(m/m)	min. 96.5	EN 14103
Density at 15 °C	kg/m ³	860 - 900	EN ISO 3675 EN ISO 12185
Viscosity at 40 °C	mm ² /s	3,5 - 5,0	EN ISO 3104
Flashpoint	°C	min. 101	EN ISO 2719/EN ISO 3679
Sulphur content	mg/kg	max. 10	EN ISO 20846/EN ISO 20884
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	EN ISO 10370
Cetane number		min. 51	EN ISO 5165
Ash content (Sulphate ash)	%(m/m)	max. 0.02	ISO 3987
Water content	mg/kg	max. 500	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of cor- rosion	Class 1	EN ISO 2160
Oxidation stability 110 °C	hours	min. 6	EN 15751/EN 14112
Acid number	mg KOH/g	max. 0.50	EN 14104
Iodine number	g Iodine/100g	max. 120	EN 14111
content of linolenic acid methylester	%(m/m)	max. 12.0	EN 14103
Content of polyunsaturated fatty acid methylesters with ≥ 4 double bonds	%(m/m)	max. 1.00	EN 15779
methanol content	%(m/m)	max. 0.20	EN 14110
Monoglyceride content	%(m/m)	max. 0.80	EN 14105
Diglyceride content	%(m/m)	max. 0.20	EN 14105
triglyceride content	%(m/m)	max. 0.20	EN 14105
content of free glycerine	%(m/m)	max. 0.02	EN 14105 EN 14106
content of total glycerine	%(m/m)	max. 0.25	EN 14105

Properties	Units	Limit values DIN EN 14214	Test method
Content of alkaline-metals (Na + K)	mg/kg	max. 5.0	EN 14108 EN 14109 EN 14538
Content of earth alkaline-metals (Ca + Mg)	mg/kg	max. 5.0	EN 14538
phosphor content	mg/kg	max. 4.0	EN 14107
Limit of filtrability			EN 116
– 15.04. - 30.09.	°C	max. 0	
– 01.10. - 15.11.	°C	max. - 10	
– 16.11. - 28.02.	°C	max. - 20	
– 01.03. - 14.04.	°C	max. - 10	
* Specifications apply for Germany. National regulations may deviate.			



Appendix 8

Fuel specification (minimum requirement)
US biodiesel blends according to ASTM D 7467-10 (B6-B20)

Properties	Units	Limit values ASTM D 7467	Test method
Biodiesel content	%(V/V)	6-20	ASTM D 7371
Flashpoint	°C	min. 52	ASTM D 93
Water and sediments	%(V/V)	max. 0.05	ASTM D 2709
Kinematic viscosity at 40 °C	mm ² /s	1,9 - 4,1	ASTM D 445
Ash content (oxide ash)	%(m/m)	max. 0.01	ASTM D 482
Sulphur content	%(m/m)	max. 0.0015 * max. 0.05 **	ASTM D 5453
Corrosion effect on copper	Degree of cor- rosion	No. 3	ASTM D 130
Cetane number		min. 40	ASTM D 613
Cloud point	°C	Report	ASTM D 2500
Coke residue	%(m/m)	max. 0.35	ASTM D 524
Acid number	mg KOH/g	max. 0.30	ASTM D 664
Boiling curve at 90 vol. %	°C	max. 343	ASTM D 86
Lubricity, HFRR at 60 °C	µm	max. 520	ASTM D 6079
Oxidation stability 110 °C	hours	min. 6	EN 14112
* ASTM D 7467-09a Grade S 15			
** ASTM D 7467-09a Grade S 500			

Appendix 9

Fuel specification (minimum requirement)
US biodiesel according to ASTM D6751-11a (B100)

Properties	Units	Limit values ASTM D 6751	Test method
Calcium and Magnesium (together)	mg/kg	max. 5	EN 14538
Flashpoint	°C	min. 93	ASTM D 93
Water and sediments	%(V/V)	max. 0.05	ASTM D 2709
Kinematic viscosity at 40 °C	mm ² /s	1,9 - 6,0	ASTM D 445
Ash content (oxide ash)	%(m/m)	max. 0.02	ASTM D 874
Sulphur content	%(m/m)	max. 0.0015 * max. 0.05 **	ASTM D 5453
Corrosion effect on copper	Degree of cor- rosion	No. 3	ASTM D 130
Cetane number		min. 47	ASTM D 613
Cloud point	°C	Report	ASTM D 2500
Coke residue	%(m/m)	max. 0.050	ASTM D 4530
Acid number	mg KOH/g	max. 0.50	ASTM D 664
content of free glycerine	%(m/m)	0,020	ASTM D 6584
content of total glycerine	%(m/m)	0,240	ASTM D 6584
phosphor content	%(m/m)	max. 0.001	ASTM D 4951
Boiling curve at 90 vol. %	°C	max. 360	ASTM D 1160
Sodium and potassium (together)	mg/kg	max. 5	EN 14538
Oxidation stability 110 °C	hours	min. 3	EN 14112
* ASTM D 6751-09a Grade S 15			
** ASTM D 6751-09a Grade S 500			



Appendix 10

Fuel specification (requirements, test methods and limit values)
Rapeseed oil fuel according to DIN 51605
September 2010 edition

Properties	Units	Limit values DIN 51605	Test method
Visual assessment		Free from visible contamination and sediments and free water	
Density at 15 °C	kg/m ³	min. 900.0 max. 930.0	EN ISO 3675 EN ISO 12185/C1
Flashpoint according to Pensky-Martens	°C	min. 101	EN ISO 2719
Kinematic viscosity at 40 °C	mm ² /s	max. 36.0	EN ISO 3104/C2
Heating value	kJ/kg	min. 36,000	DIN 51900-1, -2, -3
Willingness to ignite		min. 40	
Coke residue	%(m/m)	max. 0.40	EN ISO 10370
Iodine number	g Iodine/100g	max. 125	EN 14111
Sulphur content	mg/kg	max. 10	EN ISO 20884 EN ISO 20846
Total contamination	mg/kg	max. 24	EN 12662
Acid number	mg KOH/g	max. 2.0	EN 14104
Oxidation stability 110 °C	hours	min. 6	EN 14112
phosphor content	mg/kg	max. 3	DIN 51627-6
Calcium content	mg/kg	max. 1	DIN 51627-6
Magnesium content	mg/kg	max. 3	DIN 51627-6
Ash content (oxide ash)	%(m/m)	max. 0.01	EN ISO 6245
Water content	%(m/m)	max. 0.075	EN ISO 12937

Appendix 11

Minimum requirements for fuels in countries in which none of the named diesel fuels released by DEUTZ exist

Parameter	Basic condition	Test method	Units	DEUTZ requirement	
				min.	max.
Density at 15 °C	-	ISO 3675 / ISO 12185	kg/m ³	820 ¹	876 ²
Cetane number	Ambient temperatures > 0 °C	ISO 5156 / ISO 15195 / ASTM D613 / ASTM D6890	-	40,0	-
	Ambient temperatures < 0 °C			45,0	-
Kinematic viscosity at 40 °C	Ambient temperatures > 0 °C	ISO 3104 / ASTM D44	mm ² /s	1,8	5,0
	Ambient temperatures < 0 °C			1,2	4,0
Cloud point	-	-	-	Not higher than the ambient temperature	
Pour point	-	ISO 3016 / ASTM D97	-	At least 6 °C lower than the ambient temperature	
Sulphur content	Engines without exhaust gas after-treatment	ISO 20846 / ISO 20847 / ASTM D 3605 / ASTM D1552	%(m/m)	-	1,0
	Engines without exhaust gas after-treatment ⁶		mg/kg	-	2000
	Engines with exhaust gas after-treatment		mg/kg	-	15
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C		ISO 12156-1 / ASTM D6079	µm	-	460
50 %V/V boiling temperature		ISO 3405 / ASTM D86	°C	-	282
90 %V/V boiling temperature				-	360
Coke residue (from 10 % distillation residue)		ASTM D524	%(m/m)	-	0,35
Ash content	Engines without exhaust gas after-treatment	ISO 6245 / ASTM D482	%(m/m)	-	0,01
Inorganic elements (Ca+Mg+Na+K)	Engines with exhaust gas after-treatment	EN 14108 / EN 14109 / EN 14538	mg/kg	-	5



Parameter	Basic condition	Test method	Units	DEUTZ requirement	
				min.	max.
Water content		ISO 12937	mg/kg	-	200 ⁴
Total contamination		EN 12662	mg/kg	-	24 ⁵
Alternative to water content and total contamination: Water and sediment		ASTM D473	%(V/V)	-	0,05
Corrosion effect on copper (3 h at 50 °C)		ISO 2160 / ASTM D130	Degree of corrosion	-	1
¹ For Arctic diesel fuels the lower density limit is 800 kg/m ³ at 15 °C.					
² At densities >860 kg/m ³ at 15 °C return blocking of the engine power by authorised DEUTZ dealers is necessary.					
³ At sulphur contents >5000 mg/kg the oil change intervals must be halved.					
⁴ Water contents up to 1000 mg/kg are possible when water trapping fuel filters are used.					
⁵ At dirt contents >24 mg/kg fuel filters with a higher dirt capacity and very high efficiency must be used.					
⁶ D/TD/TCD 2.9 L4; TD/TCD 3.6 L4; TCD 4.1 L4; TCD 6.1 L6; TCD 7.8 L6					

5 Cleaning and Maintenance

The cleaning procedure for DPX™ units must be followed to ensure proper operation and durability. Failure to follow this procedure may void the warranty.

The DPX™ unit must be cleaned annually, every **500** hours, according to the following procedure.

Note: The System backpressure is expected not to exceed a maximum of 200 millibar at this stage.

- A. Before removing the DPX Centerbody for cleaning, mark the exhaust side (outlet) of the unit.
- B. Remove the DPX Centerbody and with compressed dry air first clean the inlet face of the unit. Then blow air from the outlet side of the unit until minimum soot is detected.

DO NOT APPLY COMPRESSED AIR NOZZLE DIRECTLY ON THE FACE OF THE FILTER.

- C. Replace the DPX Centerbody on the vehicle in the opposite Flow direction from which it was removed.

Only in Switzerland you have to use the filter always in the same flow direction.

We do not recommend cleaning DPX units with steam and / or other detergents. Use of these products may damage and / or deactivate the DPX unit.

MASK, GLOVES AND SAFETY GLASSES SHOULD BE WORN DURING CLEANING PROCEDURE.

Before normal operations are resumed, a backpressure and opacity reading should be recorded along with the Part Number/Serial Number of the Filter, and the mileage and date the maintenance took place.

Following cleaning some smoke may be emitted initially, but this will rapidly disperse.

Having removed the soot and ash particles from the filter, the operator should dispose of the contents as recommended by local regulatory legislation

Should any spare parts be required please contact Engelhard quoting the serial number of the DPX™ Catalysed Soot Filter System.

Details of Part Numbers and Prices can be found in Pricing & Delivery Section 6 below.

ECS Portable Cleaning Station for Purifilter™ and Catrap™

2004-03-24



Cable Signal lamp Cleaning station with heater

ECS Portable Cleaning

Station cleans particulate filters from soot (PM). The station is based on parts from ECS wellknown Unikat Combifilter and is manufactured of stainless steel.

The filled particulate filter center body is heated on an electrical element for 6 hours and after cooling it is ready for use again.

Operating instructions

- If the filter is totally clogged first use compressed air with low pressure or an industrial vacuum cleaner to remove ash and debris from the inlet side of the filter.
- Put the filter centerbody unit on the cleaning station and connect the electric cable. A lamp lights. **Make sure there are no combustibles close to the station which will get very hot.**
- After 6 hours the lamp will go off. Let cool.
- Repeat cleaning with compressed air or industrial vacuum cleaner.
- Remove the filter from the cleaning station and reinstall the filter in the correct flow direction and use new gaskets if needed*.

*Gaskets: Art no E30-0038 for Purifilter SC6H and SC13H
Art no E30-0039 for Purifilter SC20H, SC23H and Catrap CT23

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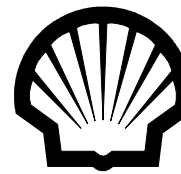
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Shell Naturelle Fluids HF-E

Environmentally considerate hydraulic fluids



Shell Naturelle HF-E fluids are advanced hydraulic fluids for use in power transmission and hydraulic systems. They are biodegradable with a low ecotoxicity, and are particularly suited for use in environmentally sensitive areas.

Synthetic esters, blended with specially tailored additive systems, provide Shell Naturelle Fluids HF-E with a superior balance of lubrication performance and compatibility with the environment.

Main Applications

- Heavy-duty hydraulic systems for construction and earth moving equipment
- Machine tool hydraulic systems
- Hydrostatic drive gears
- General industrial control equipment and hydraulic systems
- Moderately rated gearboxes where an anti-wear hydraulic oil is specified

Performance Features and Benefits

- **Readily biodegradable**
- biodegraded by >60% after 28 days when tested in OECD 301 B (CO₂ evolution test)
- **Low ecotoxicity**
- 'not harmful' to algae, invertebrates (*Daphnia*) and fish; EL₅₀/LL₅₀ >100 mg/l when tested as water-accommodated fractions in OECD 201, OECD 202 and OECD 203
- **Excellent viscosity/temperature characteristics**
Minimum change of viscosity with variation in operating temperature, giving true 'multigrade' characteristics.
- **High shear-stability**
High shear stability ensures effective lubrication and efficient system operation.
- **Excellent corrosion protection**
Long term protection for common construction materials, including most metals, non-metals and seal materials such as viton and high nitrile.

- **Good oxidation resistance**

Resists the formation of acidic products generated when working at high operating temperatures.

- **Optimum wear protection**

Effective under all operating conditions, including low and severe duty situations.

Specifications, Approvals and Recommendations

Shell Naturelle HF-E 32, 46 and 68 are environmentally acceptable hydraulic fluids based on synthetic esters and can be used where ISO 15380 or VDMA 24568 HEES fluids are specified.

Naturelle HF-E 15 is a mixture of synthetic ester and vegetable oil.

Naturelle HF-E 32 and 46 meet the environmental requirements of Swedish Standard SS 15 54 34 and are SP-listed.

Naturelle HF-E 15, 46 and 68 are on the 'Positivliste' and qualify for funding under the German 'Market Introduction Programme' for biolubricants.

Naturelle HF-E has Eaton Vickers M-2950 S and I-286 S approval.

The improved anti-wear properties, and naturally high viscosity index (VI) of Naturelle Fluids HF-E, mean that they can often be used where ISO 11158 (HM/HV) and DIN 51524 Part 2 or Part 3 (HLP/HVLP) mineral oil hydraulic fluids are specified. However, bulk fluid operating temperatures should not be allowed to exceed 90°C and optimum fluid life will be realised if operating temperatures are maintained at approximately 55°C.

Compatibility with mineral oils

Shell Naturelle Fluids HF-E is miscible with conventional mineral oil based hydraulic oils in all proportions. However, in order to ensure that the environmental properties and performance of Naturelle HF-E are maintained, the system should be drained and flushed prior to fluid change over.

Owing to the surface wetting properties of Shell Naturelle HF-E, if the system was previously operated using a mineral oil hydraulic fluid, deposits formed in the system during operation may be loosened and deposited in system filters. The filters should therefore be checked at regular intervals after fluid change over.

Seal & Paint Compatibility

Shell Naturelle HF-E is compatible with all seal materials and paints normally specified for use with petroleum mineral oils. Certain plastics

and industrial adhesives may be adversely affected and advice should be sought from the respective manufacturers.

Health & Safety

Guidance on Health and Safety are available on the appropriate Material Safety Data Sheet which can be obtained from your Shell representative.

Protect the environment

Take used oil to an authorised collection point. Do not discharge into drains, soil or water.

Advice

Advice on applications not covered in this leaflet may be obtained from your Shell Representative.

Typical Physical Characteristics

Shell Naturelle	HF-E 15	HF-E 32	HF-E 46	HF-E 68
ISO Viscosity Grade (ISO 3348)	15	32	46	68
Colour	Green	Green	Green	Green
Kinematic Viscosity @ 40°C cSt 100°C cSt (ASTM D 445)	14.1 4.2	31.6 6.3	42.4 8.4	64.9 12.1
Viscosity Index (ISO 2909)	232	156	178	187
Density @ 15°C kg/l (ISO 12185)	0.892	0.918	0.919	0.928
Pour Point °C (ISO 3016)	-54	-60	-54	-39
Flash Point (Cleveland Open Cup) °C (ISO 2592)	202	236	219	226

These characteristics are typical of current production. Whilst future production will conform to Shell's specification variations in these characteristics may occur.