

Mining

SOLUTION GUIDE



Edition 1/24, valid from 09/2024



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Solution Guide

Mining

PIONEERING THE POWER THAT MATTERS

Solution Guide

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We at Rolls-Royce provide world-class power solutions and complete life-cycle support under our product and solution brand *mtu*. Fully utilizing the potential of digitalization and electrification, we strive to develop climate-neutral drive and power generation solutions that are even cleaner and smarter and thus provide answers to the challenges posed by climate change and the rapidly growing societal demands for energy and mobility. We deliver and service comprehensive, powerful and reliable systems, based on both gas and diesel engines, as well as electrified hybrid systems.

A solution provider

For over 110 years we have provided innovative solutions for our customersd power needs, with both standard and customized options. *mtu* systems provide energy for the world's most important mission-critical applications.

An expert in technology

mtu products are known for cutting-edge innovation and technological leadership. That same spirit of innovation inspires our sustainability efforts. Our focus is on developing and implementing system solutions that both maximize efficiency and reduce emissions – at the same time.

A passionate and reliable partner

We at Rolls-Royce spend every day working together with our customers, to deliver engines, systems and complete life-cycle solutions that best fit their needs. We understand that each application is different and has its own specific demands. Every step of the way – from project planning, through design, delivery and commissioning; to the lifetime care of your equipment – we are dedicated to helping you get the most from your **mtu** investment.



EXPLANATION OF THE ENGINE DESIGNATION

Solution Guide

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GENERAL SPECIFICATIONS

Diesel engines for mobile mining applications

- Four-stroke, direct-injection
- Liquid-cooling and air-cooling
- V or In-line configuration

Power definition

Rated power of diesel engines in this sales program corresponds to ISO 3046 ICFN = ISO standard (continuous) fuel stop power IFN = ISO standard fuel stop power (ratings also apply to SAE J1995 and J1349 standard conditions)

Standard conditions for diesel engines

Barometric pressure: 1000 mbar Site altitude above sea level: 100 m

Cooling variants	
Separate circuit charge air cooling	2000/4000

We apply a policy of continual products and systems improvements. Please note, specifications are subject to change without notice. All dimensions are approximate. Details are subject to options selected. Please contact your distributor for current information and binding data.

For further information on ou Mining products please contact your distributor or visit: www.mtu-solutions.com

TYPICAL APPLICATIONS

5A -	Diesel	engines	for	heavy	duty	operation
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Rating definition: Continuous operation with up to 100% load Operating hours: unrestricted

5B - Diesel engines for medium duty operation

Rating definition: Continuous operation with variable load Operating hours: unrestricted

Engines data

Cylinder data, dimensions and masses, weight/power ratio

mtu service solutions

Extended coverage, mtu ValueCare agreements, digital solutions and support services

HVO, exhaust emissions, notes and conversion table

For information on specific on-highway certificates please contact your *mtu* distributor.

Load factor > 60%	
Fuel stop power (ICFN)	10 - 11
783 – 3000 kW	Page
Load factor < 60%	
Fuel stop power (ICFN)	12 - 15
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	30 - 37

1150 - 1865 kW

Page

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1150 - 1865 KW (1542 - 2500 BHP)

> Intake air temperature: 25°C

> Charge-air coolant temperature: 45°C

5A - Heavy duty operation

Engine model	Rated po	ower	
	ICFN		
	kW	bhp	rpm
	Separate	e circuit charge-air	cooling (SCCC)
12V 4000 C15	1150	1542	1800
12V 4000 C33R	1150	1542	1800
12V 4000 C11R	1193	1600	1800/1900
12V 4000 C13R	1193	1600	1800
12V 4000 C25	1250	1676	1800
12V 4000 C11	1286	1725	1800/1900
12V 4000 C13	1343	1800	1800
12V 4000 C13L	1425	1911	1800
12V 4000 C33	1450	1944	1800
16V 4000 C13R	1492	2000	1400
12V 4000 C35	1500	2012	1800
16V 4000 C11R	1600	2146	1800
16V 4000 C11	1715	2300	1800/1900
16V 4000 C13	1750	2347	1800/1900
16V 4000 C13L	1864	2500	1800/1900

Peak torc	que		Optimization
Nm	lb-ft	rpm	
7351	5421	1494	21
7845	5786	1400	X ¹⁾
7611	5614	1500	X ¹⁾ , 2
7595	5600	1500	X ¹⁾ , 19, 31
7990	5893	1494	21
8187	6039	1500	X ¹⁾ , 2
8550	6307	1500	
9070	6690	1500	X ¹⁾ , 19, 31
9231	6808	1500	X ¹⁾
9520	7022	1350	X ¹⁾
9588	7071	1494	21, 40
9492	7001	1500	2
10148	7485	1500	X ¹⁾ , 2
11141	8216	1500	X ¹⁾
11868	8753	1500	X1)

Optimization: X Fuel consumption optimized

2 EPA Nonroad T1 Comp (40CFR89)

19 EPA Nonroad T2 Comp (40CFR89)

21 EPA Nonroad T4 (40CFR1039)

31 China NRMM Stage III (GB20891-2014)

40 EU Nonroad St V (2016/1628)

1) non-certified

All 5A-ratings can be used for 5B applications!

5A - Heavy duty operation

Optimization

Diesel engines for Mining applications

783 - 2013 KW (1050 - 2699 BHP)

> Intake air temperature:

> Charge-air coolant temperature: 45°C

5B - Medium duty operation

Series 2000

Series 4000

Engine model	Rated power ICFN		
	kW	bhp	rpm
	Separate circ	uit charge-air c	cooling (SCCC)
12V 2000 C66R*	783	1050	1800
12V 2000 C66	783	1050	2100
16V 2000 C66	970	1301	2100
16V2000S96	1163	1560	2100
12V 4000 C21R	1398	1875	1800/1900
16V 4000 C21R	1492	2001	1900
12V 4000 C21	1510	2025	1800/1900
12V 4000 C23R	1510	2025	1800/1900
12V 4000 C23	1680	2253	1800/1900
12V 4000 C55	1750	2347	1900
12V 4000 C65	1864	2500	1800
12V 4000 C65	1864	2500	1900
16V 4000 C21	1864	2500	1800/1900
16V 4000 C45	2000	2682	1800
16V 4000 C21L	2013	2700	1800
16V 4000 C21L	2013	2700	1900

25°C

Nm	lb-ft	rpm	
4640	3422	1200	31, 38
4636	3422	1100	31, 38
5225	3854	1100	31, 38
6400	4720	1300	31, 38
8200	6048	1500	X ¹⁾ , 2
10186	7513	1500	X ¹⁾ , 2
8739	6446	1650	X ¹⁾ , 2
8482	6255	1700	X ¹⁾ , 19, 31
9435	6959	1700	X ¹⁾ , 19, 31
9258	6829	1805	21
10409	7678	1710	21
9861	7273	1805	21
10932	8063	1500	X ¹⁾ , 2
12673	9347	1507	21
11078	8064	1650	X ¹⁾
10932	8064	1500	X ¹⁾ , 2

Peak torque

Optimization: X Fuel consumption optimized

2 EPA Nonroad T1 Comp (40CFR89)

19 EPA Nonroad T2 Comp (40CFR89)

21 EPA Nonroad T4 (40CFR1039)

31 China NRMM Stage III (GB20891-2014)

38 EPA Nonroad T4i Comp (40CFR1039)

also available for 2A application

1) non-certified

Diesel engines for Mining applications

2013 - 3000 KW (2699 - 4023 BHP)

> Intake air temperature: 25°C

> Charge-air coolant temperature: 45°C

5B - Medium duty operation

Engine model	Rated powe	er	
	kW	bhp	rpm
	Separate c	ircuit charge-ai	r cooling (SCCC)
16V 4000 C23R	2013	2700	1800/1900
16V 4000 C31	2125	2850	1800/1900
16V 4000 C23	2240	3004	1800
16V 4000 C55	2240	3004	1800
16V 4000 C65	2400	3218	1800
20V 4000 C22	2720	3648	1800
20V 4000 C23	2800	3755	1800
20V 4000 C23L	3000	4023	1800

Peak toro	lue		Optimization
Nm	lb-ft	rpm	
11310	8342	1700	X ¹⁾ , 19, 31
11273	8315	1800	X ¹⁾
12566	9268	1700	X ¹⁾ , 19, 31
13123	9679	1630	21
13403	9885	1710	21
15159	11181	1500	2
15728	11600	1700	X ¹⁾ , 19, 31
16852	12429	1700	X ¹⁾ , 19, 31

Optimization: X Fuel consumption optimized

2 EPA Nonroad T1 Comp (40CFR89)

19 EPA Nonroad T2 Comp (40CFR89)

21 EPA Nonroad T4 (40CFR1039)

31 China NRMM Stage III (GB20891-2014)

1) non-certified

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ENGINES DATA



Diesel engines for Mining applications

SERIES 2000







Diesel engines for Mining applications

Engine	Cylinder data			
	Bore/Stroke	Cyl. displac.	Tot. displac.	
	mm (in)	l (cu in)	l (cu in)	
12V 2000 Cx6	135/156	2.23	26.8	
12 cyl./90°V	(5.3/6.1)	(136)	(1635)	
16V 2000 Cx6	135/156	2.23	35.7	
16 cyl./90°V	(5.3/6.1)	(136)	(2180)	

Please note, specifications are subject to change without notice. All dimensions are approximate. Details are subject to options selected. Please contact your distributor for current information and binding data.

Dimensions	Mass	Weight/Power ratio
L x W x H	(dry)	kg/kW
mm (in)	kg (lbs.)	(lbs./bhp)
2028 x 1279 x 1452	2950	3.8
(79.8 x 50.4 x 57.2)	(6504)	(6.2)
2378 x 1289 x 1480	3350	3.5
(93.6 x 50.8 x 58.3)	(7826)	(5.7)



7.

Diesel engines for Mining applications

SERIES 4000







Diesel engines for Mining applications

Engine	Cylinder data		
	Bore/Stroke	Cyl. displac.	Tot. displac.
	mm (in)	l (cu in)	l (cu in)
12V 4000 Cx1	165/190	4.06	48.7
12 cyl./90°V	(6.5/7.5)	(248)	(2972)
16V 4000 Cx1	165/190	4.06	65.0
16 cyl./90°V	(6.5/7.5)	(248)	(3967)
20V 4000 Cx2	165/210	4.49	89.8
20 cyl./90°V	(6.5/8.3)	(274)	(5480)
12V 4000 Cx3	170/210	4.77	57.2
12 cyl./90°V	(6.7/8.3)	(291)	(3491)
16V 4000 Cx3	170/210	4.77	76.3
16 cyl./90°V	(6.7/8.3)	(291)	(4656)
20V 4000 Cx3	170/210	4.77	95.4
20 cyl./90°V	(6.7/8.3)	(291)	(5822)
12V 4000 Cx5	170/210	4.77	57.2
12 cyl./90°V	(6.7/8.3)	(291)	(3491)
16V 4000 Cx5	170/210	4.77	76.3
16 cyl./90°V	(6.7/8.3)	(291)	(4656)

Please note, specifications are subject to change without notice. All dimensions are approximate. Details are subject to options selected. Please contact your distributor for current information and binding data.

Dimensions	Mass	Weight/Power ratio
L x W x H	(dry)	kg/kW
mm (in)	kg (lbs.)	(lbs./bhp)
2538 x 1588 x 1736	6045	4.0 - 5.1
(99.9 x 62.5 x 68.4)	13325	(6.6 - 8.3)
3008 x 1588 x 1736	7363	3.5 - 4.4
(118.4 x 62.5 x 68.4)	(16233)	(5.8 - 7.3)
3647 x 1609 x 2065	9865	3.6
(143.6 x 63.3 x 81.3)	(21750)	(6.0)
2810 x 1629 x 2066	7000	4.2 - 5.9
(110.6 x 64.1 x 81.3)	(15430)	(6.8 - 9.7)
3280 x 1629 x 2065	8380	3.6 - 5.4
(129.1 x 64.1 x 81.3)	(18475)	(6.0 - 8.9)
3647 x 1609 x 2065	10700	3.6 - 4.5
(143.6 x 63.3 x 81.3)	(23590)	(6.0 - 7.4)
2878 x 1686 x 1992	7960	4.3 - 6.9
(113.3 x 66.4 x 78.4)	(17549)	(7.0 - 11.4)
3348 x 1686 x 1992	9630	4.1 - 4.9
(131.8 x 66.4 x 78.4)	(21231)	(6.7 - 8.0)

mtu Service Solutions

mtu SERVICE SOLUTIONS – A LIFETIME OF VALUE

Our service solutions for engines and drive systems are designed to maximize performance, extend life, and provide expert support. These solutions are categorized into three main value propositions: Secure, Sustain, and Support.



Enjoy peace of mind with maximizing asset performance and reducing operational risks

- Extended Coverage
- *mtu* ValueCare Agreements
- Digital Solutions



Extending equipment life and reducing costs while protecting the environment

- Reman/Overhaul Solutions
- New Exchange Engine





Expert service from a reliable partner to keep operations running smoothly

- Support Services
- Genuine Spare Parts
 - & Consumables
- Training
- Maintenance & Repair

Extended Coverage

PROTECT YOUR INVESTMENT



mtu engines and systems — backed by extended coverage — provide invaluable peace of mind beyond the standard warranty.

With Extended Coverage, you can be assured that the costs of unplanned repairs are covered, with service performed by *mtu*-certified technicians — upholding resale value and ensuring long-term confidence in your *mtu* investment.

Avoid the unexpected

Extended Coverage protects you from the cost of unexpected repairs beyond your standard warranty, with professional service from *mtu*-certified technicians and coverage tailored to your needs. Packages can also be extended up to five years and are fully transferable, enhancing resale value. Coverage includes all materials and labor for troubleshooting, fault clearance, and corrective services to engines and on-engine electronics (excluding gearbox, alternators or similar components). To ensure maximum quality, all repairs are conducted using only genuine *mtu* parts.

Your benefits:

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Flexible options and local support to suit your needs (e.g. operating hours)



100 % genuine parts amd components



Protection against unexpected repair costs

mtu ValueCare Agreements

PROTECT YOUR INVESTMENT



You've got a tough job. Get the power, performance and peace of mind to get it done right with *mtu* ValueCare Agreements — tailored support throughout the life of your equipment.

In your world, every second counts. Our digitally connected drive systems, wrapped in **mtu** ValueCare Agreements, make it easy to keep your business running smoothly and reduce total cost of ownership by maximizing uptime, optimizing lifecycle costs and helping you avoid equipment-related business disruptions through preventive maintenance.

With large investments, lifecycle costs can be significant. It's often the unforeseen costs lurking below the surface - things like fuel consumption, unplanned downtime and repairs - that have the greatest potential to impact your business. That's why it pays to plan ahead by investing in a superior *mtu* system and protecting it with our ValueCare Agreement.

mtu ValueCare Agreements helps you

- Increase operational uptime
- Guarantee parts availability and service quality
- Predict equipment-related costs
- Optimize maintenance planning
- Connect to us, 24/7
- Attain peace of mind

Digital Solutions

YOUR POWER. YOUR SERVICE. CONNECTED.



Mining applications have great demands on engines and drive systems. Ensuring that propulsions are constantly available for optimum use, means making the right maintenance decisions. Our digital solutions enable you to keep track of operating hours, system alarms and maintenance schedules so you can plan service intervals more effectively.





mtu Go

Delivering actionable insights through digital solutions



Connect all your equipment Data collection from your fleet, asset, system and engine



Asset Management

Access comprehensive real-time and recent performance data for all assets worldwide, conveniently from one centralized platform



Equipment Health Management Digital solutions for your detailed data analysis on necessary actions

mtu Go links your data with our engineering knowledge and experience from thousands of other assets in one global view to provide insights that enrich your business. For details, please scan the QR Code or visit www.mtu-go.com



Support Services

SUPPORT YOUR LOCAL SUPPORT ŝ - WORLDWIDE









Emission reduction solutions

HVO - YOUR FAST TRACK TICKET TO LOWER EMISSIONS



Lower emissions

With HVO, you can significantly reduce your emissions already today using your existing **mtu** diesel engines. Take a look at our numbers: Up to 90% reduction for CO_2 , ~40% reduction for particle matter (~50-80% PM reduction in power generation applications) and ~8% reduction for NO_v.



No power loss

Our tests with HVO confirm that *mtu* engines perform equally as well when using HVO (as compared to fossil diesel) in terms of maximum power, load acceptance and fuel consumption.



Shelf life

The storage stability of pure HVO (without 1st gen. biodiesel = FAME) is significantly better than that of pure FAME, HVO/FAME mixtures or even fossil diesel, making it even more attractive to emergency power system operators.



Drop-in Fuel

HVO is a drop-in fuel, which means that there are generally no adaptions needed to the diesel genset hardware and software (fuel can be blended with fossil diesel in all proportions or pure – 100% concentration). HVO belongs to the group of paraffinic diesel fuels (EN15940 & ASTM D975). This renewable fuel is produced by hydrotreatment process and is already tested and approved for many mtu engines and systems. With HVO you can save significantly on emissions already today using your existing diesel systems.



Properties

HVO is a clear and colourless liquid with a density slightly below that of diesel. Therefore, HVO exhibits a higher cetane number, when compared to the fossil counterpart and thus burns more efficiently, cleanly and with significantly reduced soot production.

Availability

The excellent ISCC-certified HVO product of our fuel supply partner Neste called "Neste MY Renewable Diesel" is available in Germany, Finland, the Baltic countries, Sweden, Denmark, Belgium, the Netherlands and the US.

Production

HVO as a fuel is obtained by processing organic materials such as vegetable oils, animal fats or cultivated food crops. In the production from plant materials, an almost closed carbon cycle is created. As a plant, the raw material absorbs CO_2 from the atmosphere and thus reduces the effect on the CO_2 balance through subsequent use in the combustion engine.

Exhaust emissions

MINING APPLICATIONS

Many countries have implemented environmental legislation to protect people from consequences of polluted air. For this reason an increasing number of countries regulate emissions from specific mobile and stationary sources.

Emission standards may apply internationally, nationally and/or for specific areas. The enforcement of an emission legislation may depend for example on the area where the equipment is used and the way it is operated. The emission legislations may be categorized by power range and/or cylinder capacity. Emission legislations generally require a certificate "or a type approval" which states compliance. Stationary applications may require on-site approvals (on-site emission test) depending on the particular emission legislation.

Please find as follows examples of emission standards which apply to the Mining Industry applications. For details please consult the applicable legislation and/or permitting authority.

Emission legislation for Mining applications may differentiate between mobile and stationary applications/ machinery.

Nonroad mobile machinery emission legislation may differentiate between constant and variable speed applications. Nonroad mobile machinery emission legislation may differentiate between ratings and cylinder volume.

Emission legislation for mobile applications are e.g. US EPA, EU NRMM, China NRMM, MoEF India/CPCB, US CARB.

Stationary emission legislation differentiates between emergency standby and non-emergency applications. Usually non-emergency applications have more stringent emission limits. Engines for emergency standby applications are often limited by operating hours per year. The operating hour limitation may be defined differently from country to country. Especially stationary applications may be subject to more stringent regional or municipal emission limits (e.g. Non-Attainment Areas).

Emission legislation for stationary applications is highly fragmented, e.g. US EPA, EU NRMM, TA-Luft, NEA Singapore, MoEF India/CPCB, China NRMM, US CARB.

Sample for emission stages in Mining industry: EPA EPA NRMM > 560 kW



Examples for emission level description:

- US EPA Nonroad Tier 4 (40CFR1039)
 -> certified
- US EPA Nonroad Tier 2 Comp (40CFR89)
 -> compliant with emission legislation not certified
- China Nonroad Stage III (GB20891 2014)
 -> certified EU Nonroad Stage V (2016/1628)
 - -> type approved

Exhaust emissions outlook:

- Potentially future proposed emission standards for:
 - -> China Nonroad Stage V
 - -> US CARB Tier 5i
 - -> US CARB Tier 5

Monitoring functions (like OBD, OBM) and inducements like in EU Nonroad Stage V will be incorporated in other worldwide emission regulations as well.

For NRMM > 560 kW

preliminary outlined emission limits in above regulations indicate that series 4000Cx5 is already ready to achieve these new regulations as well.

Please note

That the engines and systems (only) comply with the country or region specific emission requirements and have appropriate emission certification(s) which are explicitly stated in respective defined technical specifications. Any export/import/operation of the engine in countries or regions with different applicable emission law requirements is at the customers responsibility.

NOTES

Further special solution guides

- Marine
- PowerGen
- Rail
- Oil & Gas
- Gendrive

CONVERSION TABLE

1 kW	= 1.360 PS	g	= 9.80665 m/s ²
1 kW	= 1.341 bhp	Л	= 3.14159
1 bhp	= 1.014 PS	е	= 2.71828
1 oz	= 28.35 g	е	= 2.71828
1 lb	= 453.59 g	1 lb	= 16 oz
1 short ton	= 907.18 kg	1 short ton	= 2000 lbs
1 lb/bhp	= 447.3 g/PSh	1 ft lb	= 1.356 Nm
1 lb/bhp	= 608.3 g/kWh	1 ft/min	= 0.00508 m/s
1 gal/bhp (US)	= 4264 g/kWh	pDiesel	= 0.83 kg/l
1 kWh	= 860 kcal	1 lb/sqin	= 0.069 bar (1 psi)
1 cal	= 4.187 J	1 mm Hg	= 1.333 mbar (133.3 Pa)
1 BTU	= 1.055 kJ	1 mm H ₂ O	= 0.0981 mbar (9.81 Pa)
1 inch	= 2.540 cm	Т (К)	= t (°C) + 273.15
1 sq. inch	= 6.542 cm ²	t (°C)	= 5/9 x (t (°F) -32)
1 cu. inch	= 16.387 cm ³	t (°C)	= 5/4 x t (°R)
1 foot	= 3.048 dm	1 foot	= 12 inches
1 sq. foot	= 9.290 dm ²	1 yard	= 3 feet
1 mile	= 1.609 km	1 mile	= 5280 feet
1 naut. mile	= 1.853 km	1 naut. mile	= 6080 feet
1 UK Gallon	= 4.546 l	1 US Barrel	= 0.159 m ³
1 US Gallon	= 3.785 l = 42 US Gallons		= 42 US Gallons
Energy:	1 J = 1 Ws = 1 VAs = 1 Nm		
Power:	1 W = 1 VA = 1 Nm/s		
Force:	1 N = 1 kgm/s ²		
Pressure:	1 Pa = 1 N/m² (1 bar = 10 ⁵ Pa)		
MEP (bar)	$= \frac{P_{cyl}(kW) \times 1200}{n(1/min) \times V_{cyl}(l)}$		
Torque (Nm	$= \frac{P_{ges}(kW) \times 3000}{n(1/min) \times \pi}$	0	

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