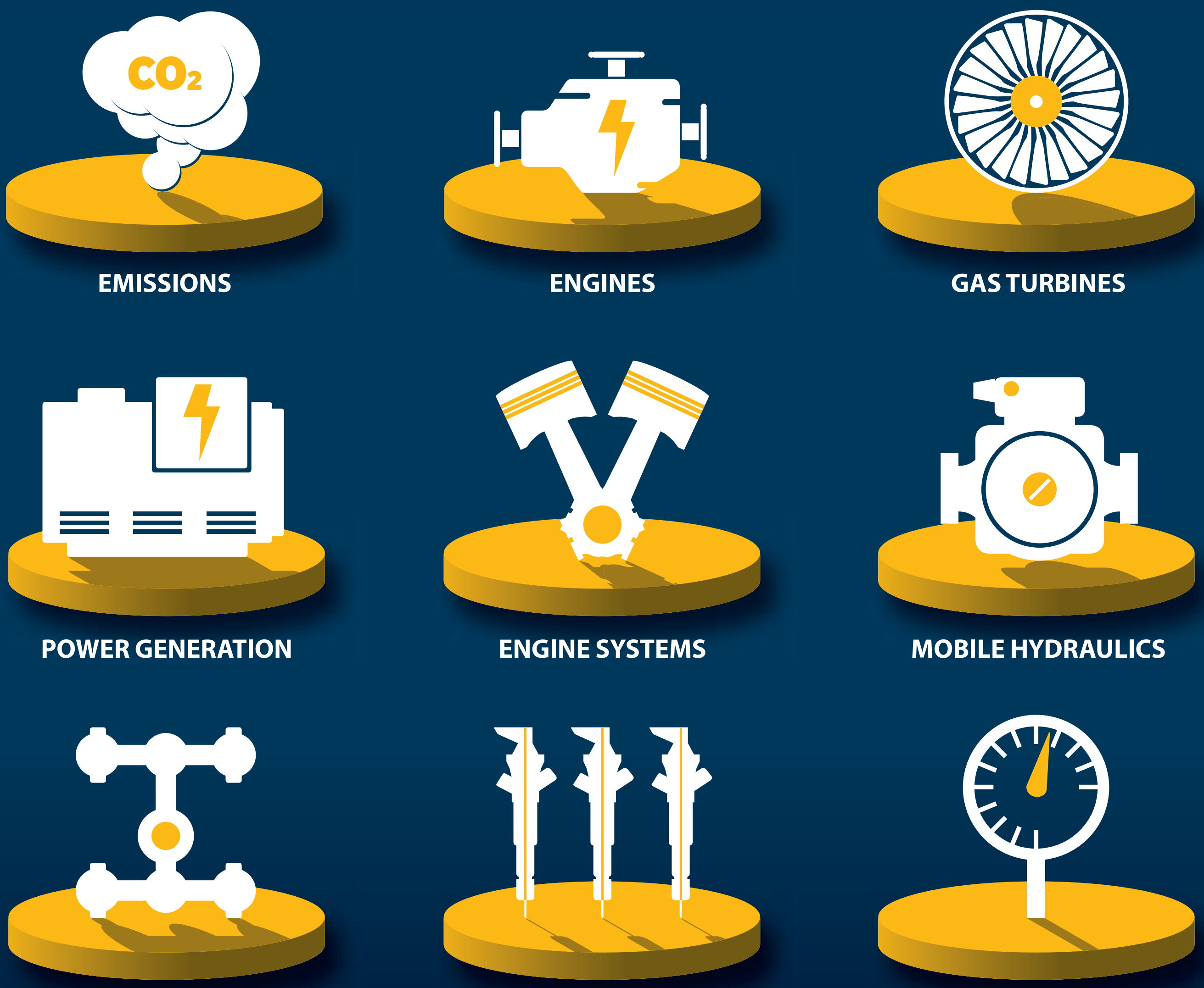
Design Begins Here

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com



EMISSIONS · ENGINES · GAS TURBINES

POWER GENERATION · ENGINE SYSTEMS · MOBILE HYDRAULICS

POWER TRANSMISSION · FUEL INJECTION · CONTROLS & INSTRUMENTATION

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS · DPI DIESEL PROGRESS INTERNATIONAL · Diesel & Gas Turbine WORLDWIDE · khl

VOLUME 86
POWER SOURCING GUIDE 2021-2022
www.powersourcingguide.com
THE GUIDE FOR DESIGN ENGINEERS

SALES TEAM
SALES TEAM
Vice President, Sales:
Alister Williams
Tel: +1 843 637 4127
Cell: +1 312 860 6775
alister.williams@khl.com
Regional Managers:
Linda Cameron
Tel: +44 20 31 79 29 79
linda.cameron@khl.com
Gabriele Dinsel
Tel: +49 711 3416 74 71
gabriele.dinsel@khl.com
Petra Kaiser
Tel: +49 151 218 52 127
petra.kaiser@khl.com
Roberta Prandi
Tel: +39 (0)0464 014 421
roberta.prandi@khl.com
Thomas Kavooras
Tel: +1 312 929 3478
Cell: +1 847 609 4393
thomas.kavooras@khl.com
Josh Kunz
Tel: +1 262 754 4139
Cell: +1 414 379 2672
josh.kunz@khl.com
Pete Balistrieri
Tel: +1 414 940 9897
pete.balistrieri@khl.com

KHL OFFICES
UNITED KINGDOM
(Head Office)
KHL Group LLP
Southfields, Southview Road,
Wadhurst, East Sussex
TN5 6TP, UK.
Tel: +44 (0)1892 784088
Fax: +44 (0)1892 784086
www.khl.com

USA OFFICES
KHL Group Americas LLC
3726 East Ember Glow Way,
Phoenix, AZ 85050 USA
Tel: +1 480 6590578
e-mail: americas@khl.com
KHL Group (Chicago Office)
205 W. Randolph St,
Suite #1320, Chicago,
IL 60606, USA
Tel: +1 312 4963644
e-mail: americas@khl.com
KHL Group (Waukesha Office)
20855 Watertown Road,
Suite 220, Waukesha,
WI 53186-1873, USA
Tel: +1 262 7544100
e-mail: americas@khl.com

Design Begins Here

WELCOME TO THE POWER SOURCING GUIDE 2021-2022

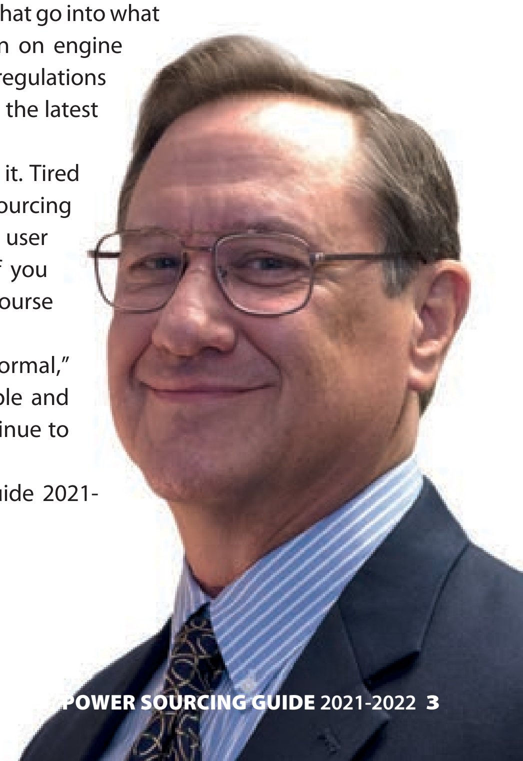
Roughly a year after we first heard the odd term "COVID-19," the pandemic has continued to wreak havoc on people, companies and the economies of virtually everywhere. And while right now many regions are beginning to show real signs of recovery, others have seen a resurgence of the virus, or worse, a mutated variant that has even some in the medical field scratching their collective heads.

Yet while so much has happened since the pandemic really took hold in the early part of 2020 – whole industries shut down, supply chain issues came to the fore and almost all of us learned the joys of remote working, with terms like MS Teams, Zoom and Google Meet becoming part of our everyday lexicon – there were some things that remained. The industries related to energy, transportation, power generation, all those segments that rely on engines of one kind or another and power system products, pretty much kept going. And while the processes may have been different than before, things were still designed, engineered and manufactured.

Which brings us to this, the 2021-2022 Power Sourcing Guide.

Pandemics or no, people who design all of the things that make societies work – everything from heavy trucks that haul our goods, construction machines that build our roads, schools and homes, power generations systems that keep the lights on, etc. – need information about the components and systems that go into their machines and equipment. And since 1935, the Power Sourcing Guide, which has existed under many names since the original "Diesel Plan Book and Engine Catalog," has provided it in a way like no other reference.

In print or online (at www.powersourcingguide.com), the Power Sourcing Guide delivers more information about all manner of reciprocating engines, gas turbines, powertrain components and many of the myriad products that go into what makes the world go. Want to find information on engine ratings? It's in here. What are the emissions regulations in the EU or Canada? It's in here. Need to know the latest NFPA hydraulic standards? That's in here, too.



And again, it's presented however you want it. Tired of looking at a screen all the time? The Power Sourcing Guide remains solidly in print as what one user called "the original desktop search engine." If you choose to do all of your research online, of course it's there too.

Whenever things once again become "normal," the Power Sourcing Guide, like so many people and companies in the industries it covers, will continue to do its job.

We hope you enjoy the Power Sourcing Guide 2021-2022.

Mike Brezonick
Vice President

VOLUME 86

POWER SOURCING GUIDE 2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

PUBLICATION STAFF

EDITORIAL

Publisher:
Mike Brezonick
mike.brezonick@khl.com
Publication Manager:
Riley Simpson
riley.simpson@khl.com

PRODUCTION

Production & Circulation Director:
Saara Rootes
saara.rootes@khl.com
Senior Production Executive:
Anita Bhakta
anita.bhakta@khl.com
Production Manager - KHL Americas:
Brenda Burbach
brenda.burbach@khl.com
Production Assistant:
Charlotte Kemp
charlotte.kemp@khl.com
Design Manager:
Jeff Gilbert
Print and Digital Designer:
Mitchell Logue
Designer:
Jade Hudson

CIRCULATION

Subscriptions:
subscriptions@khl.com
Circulation & Data Manager:
Anna Philo
anna.philo@khl.com

CHIEF EXECUTIVE OFFICER
James King

CHIEF FINANCIAL OFFICER
Paul Baker

PRESIDENT & CHIEF OPERATING OFFICER
Trevor Pease

khl

ISSN-1545-9063
Printed in the UK by: Buxton Press, UK
Published June 2021 by KHL Group Americas LLC, East Ember Glow Way, Phoenix, AZ 85050, USA.

CONTENTS

Design Begins Here

www.powersourcingguide.com

KHL's POWER PORTFOLIO

INDEX TO MANUFACTURERS' SECTIONS & PRODUCTS

A

ABC - ANGLO BELGIAN CORPORATION N.V. 218
43 WIEDAUWKAAI
9000 GENT
BELGIUM
TEL: +32 9 267 00 00
FAX: +32 9 267 00 67
EMAIL: info@abc-engines.com
WEB: www.abc-engines.com

Engines
Diesel Engines
Dual-Fuel Engines
Generator Sets
Diesel Engine Generator Sets
Dual-Fuel Engine Generator Sets
Marine Propulsion Systems
Diesel Marine Propulsion Systems
Power Plants
Diesel/Gas Engine Power Plants
Turnkey Operations Power Plants
Pump Sets
Diesel-Driven Pump Sets
Dual-Fuel Engine-Driven Pump Sets

AGCO POWER 194
LINNAVUORENTIE 8-10
FI-37240 LINNAVUORI
FINLAND
TEL: +358 3 3417111
FAX: +358 3 3417330
EMAIL: info.agcopower@agcocorp.com
WEB: www.agcopower.com/

Engines
Diesel Engines
Generator Sets
Diesel Engine Generator Sets
Pump Sets
Diesel-Driven Pump Sets

MASCHINENFABRIK ALFING KESSLER GMBH 288
AUGUSTE-KESSLER-STR. 20
73433 AALEN-WASSERALFINGEN
GERMANY
TEL: +49 0 7361 501 1340
FAX: +49 0 7361 501 4416
EMAIL: large@mafa.alfing.de
WEB: www.alfing-crankshafts.com

Crankshafts
Crankshafts
Engine Crankshaft
Reconditioning Crankshafts
Forgings
Engine Components Forgings
Shafts
Shafts
Test Equipment, Testing
Engine Systems Test Equipment

ANSALDO ENERGIA 238
VIA NICOLA LORENZI, 8
16152 GENOVA, LIGURIA
ITALY
TEL: +39 010 6551
FAX: +39
EMAIL: info@ansaldoenergia.com
WEB: www.ansaldoenergia.com/

Alternators
Generating Sets Alternators
Engines
Combined-Cycle Engines
Gas Turbines
Gas Turbines And Components
Gas Turbines
Generator Sets
Combined-Cycle Generator Sets
Gas Turbine Generator Sets
Generators
AC Generators
Power Plants
Combined-Cycle Power Plants
Gas Turbine Power Plants
Turnkey Operations Power Plants
Service Systems & Training
Power Plants Service Systems & Training
Services
Gas Turbine Overhaul & Repair Services

AVAT AUTOMATION GMBH 344
DERENDINGER STRASSE 40
72072 TUEBINGEN
GERMANY
TEL: +49 7071 9735-0
FAX: +49 7071 9735-55
EMAIL: avat@avat.de
WEB: www.avat.de

Analysis Systems
Analysis Systems
Cogeneration Systems
Cogeneration Controls
Cogeneration Systems
Service Cogeneration Systems
Controls
Cogeneration Controls
Engine Controls
Engine System Controllers
Knock Detection & Control Controls
Marine Propulsion Controls
Remote Controls
Engine Maintenance
Engine Diagnostic Systems

Overhaul & Parts Services Engine Maintenance
Measuring Equipment
Measuring Equipment
Monitoring, Monitors
Engine System Monitors
Power Plants
Combined-Cycle Power Plants
Service Systems & Training
Power Plants Service Systems & Training
Service Tools & Equipment
Service Tools & Equipment
Services
Contract Manufacturing
Engineering Services
Test Equipment, Testing
Automated Engine Test Systems
Computer-Controlled Engine Testing

AVAT ASIA PACIFIC LTD. 344
HANMIREU BUILDING NO.1410-B
YONGDANG CAMPUS, PUKYONG UNIVERSITY
365 SHINSEON-RO, NAM-GU
BUSAN 48547
KOREA (REPUBLIC)
TEL: +82 51951 9735
EMAIL: info@avat-ap.co.kr
WEB: www.avat-ap.co.kr
■ *For Product Listing, See AVAT Automation GmbH*

B

BAUDOUIN 205
TECHNOPARC DU BREGADAN CASSIS
13260 CASSIS
FRANCE
TEL: +33 4 88688500
EMAIL: hello@moteurs-baudouin.fr
WEB: baudouin.com
Engines
Diesel Engines
Gas Engines
Natural Gas (Spark-Ignited) Engines

C

CUMMINS GENERATOR TECHNOLOGIES 260
FOUNTAIN COURT
LYNCH WOOD
PETERBOROUGH PE2 6FZ
U.K.
TEL: +44 0 1733 395300
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com
Alternators
Alternators
Generating Sets Alternators
Electrical Power Generation Equipment
Electrical Power Generation Equipment
Generators
AC Generators
Power Generation Equipment
Power Generation Equipment
Regulators
Voltage Regulators

CUMMINS GENERATOR TECHNOLOGIES, AUSTRALIA 260
SOUTH PACIFIC PTY LTD
50-52 DIAGONAL ROAD
POORAKA SA 5095
AUSTRALIA
TEL: +61 8 83684300
FAX: +618 8260 3055
EMAIL: southpac.alternators@cummins.com
WEB: www.stamford-avk.com
■ *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, CANADA 260
2275 LAKESHORE BLVD.
WEST ETOBICOKE, ONTARIO M8V 3Y3
CANADA
TEL: +1 416 259 3741
FAX: +1 416 259 7167
EMAIL: cgt.usasalessupport@cummins.com
WEB: www.stamford-avk.com
■ *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, CHINA 260
NO. 2 XIN RONG ROAD
NEW DISTRICT
WUXI, JIANGSU 214028
CHINA
TEL: +86 510 81108088
FAX: +86 510 81108098
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com
■ *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, INDIA 260
CAMPUS TOWER A
SURVEY NO. 21
BALEWADI
MAHARASHTRA, PUNE 411 045
INDIA
TEL: +91 20 6706 7000
FAX: +91 20 6706 7001
EMAIL: cgtil.sales@cummins.com
WEB: www.stamford-avk.com
■ *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, ITALY 260
VIA GIOSUE, CARDUCCI 125
SESTO SAN GIOVANNI
20099 MILAN
ITALY
TEL: +39 2380 00714
FAX: +39 2380 03664

EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com
- *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, JAPAN 260

15F NEW PIER TAKESHIBA SOUTH TOWER
1-16-1, KAIGAN
MINATO-KU
TOKYO 105-0022
JAPAN
TEL: +81 36631 6401
EMAIL: apac.alternators@cummins.com
WEB: www.stamford-avk.com
- *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, NORWAY 260

OSLOVEIEN 20
1430 AS OSLO
NORWAY
TEL: +47 64 974540
FAX: +47 64 974541
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com
- *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, ROMANIA 260

B-DUL DECEBAL NR. 116A
CRAIOVA
DOLJ
ROMANIA
TEL: +40 351 443202
FAX: +40 351 443201
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com
- *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, SINGAPORE 260

85 TUAS SOUTH AVENUE 1
SINGAPORE 637419
SINGAPORE
TEL: +65 6305 3150
FAX: +65 6265 6909
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com
- *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, UAE 260

JEBEL ALI FREE ZONE
P.O. BOX 17636
DUBAI
UAE
TEL: +971 48 830461
FAX: +971 48 860518
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com
- *For Product Listing, See Cummins Generator Technologies*

CUMMINS GENERATOR TECHNOLOGIES, USA 260

1400 73RD AVENUE N.E.
MINNEAPOLIS, MINNESOTA 55432
U.S.A.
TEL: +1 763 528 7301
FAX: +1 763 574 5082
EMAIL: info@cumminsgeneratortechnologies.com
WEB: www.stamford-avk.com
- *For Product Listing, See Cummins Generator Technologies*

CUMMINS INC. .. INSIDE BACK COVER, 167, 169

500 JACKSON STREET
COLUMBUS, INDIANA 47201
U.S.A.
TEL: +1 800-CUMMINS (266-6467)
FAX: +1 812 377-3334
EMAIL: care@cummins.com
WEB: www.cummins.com

Engines
Diesel Engines
Natural Gas (Spark-Ignited) Engines
Exhaust Systems
Diesel & Gas Exhaust Systems
Diesel Particulate Filters
Selective Catalytic Reduction
Filters and Filter Systems
Crankcase Filters
Fuel Filters
Lube Filters
Generator Sets
Diesel Engine Generator Sets
Marine Propulsion Systems
Diesel Marine Propulsion Systems
Power Generation Equipment
Power Transfer Systems
Switches
Mechanical Switches
Switchgear/Switchboards
Gen. Sets Switchgear/Switchboards
Turbochargers
Exhaust Gas Turbochargers

CUMMINS WESTPORT INC. ... .. INSIDE BACK COVER, 167, 169

101 – 1750 WEST 75TH AVENUE
VANCOUVER, BRITISH COLUMBIA V6P 6G2
CANADA
TEL: +1 604 718-8100
EMAIL: info@cumminswestport.com
WEB: www.cumminswestport.com/

Engines
Diesel Engines
Natural Gas (Spark-Ignited) Engines

D

DAIHATSU DIESEL MFG. CO. LTD. 214, 245

1-30, OYODO NAKA 1-CHOME
KITA-KU, OSAKA 531-0076
JAPAN
TEL: +81 6 6454 2393

FAX: +81 6 6454 2686
EMAIL: kyoji.masutani@dhtd.co.jp
WEB: www.dhtd.co.jp/en/index.html

Engines
Diesel Engines
Gas Engines
Gas Turbines
Gas Turbines And Components
Gas Turbines
Generator Sets
Diesel Engine Generator Sets

DAIHATSU DIESEL MFG. CO., LTD. - INTERNATIONAL BUSINESS OPERATIONS 214, 245

2-10, NIHONBASHI-HONCHO, 2-CHOME
TOKYO 103-0023
JAPAN
TEL: +81 3 3279 0827
FAX: +81 3 3245 0395
WEB: www.dhtd.co.jp

■ *For Product Listing, See Daihatsu Diesel Mfg. Co. Ltd.*

DEUTZ AG 183

OTTOSTR. 1
51149 COLOGNE
GERMANY
TEL: +49 0 221 822-0
FAX: +49 0 221 822-3525
EMAIL: info@deutz.com
WEB: www.deutz.com

Engine Maintenance
Overhaul & Parts Services Engine Maintenance
Engines
Diesel Engines
Exhaust Systems
Diesel & Gas Exhaust Systems
Monitoring, Monitors
Engine System Monitors
Service Systems & Training
Diesel Engines Service Systems & Training
Service Tools & Equipment
Service Tools & Equipment

DEUTZ ASIA-PACIFIC (PTE) LTD. 183

10 GUL CRESCENT
SINGAPORE 629523
SINGAPORE
TEL: +65 667 27811
EMAIL: kok.p@deutz.com
WEB: www.deutz.com

■ *For Product Listing, See DEUTZ AG*

DEUTZ AUSTRALIA PTY. LTD. 183

UNIT 4
13-15 BROUGH STREET
SPRINVALE, VICTORIA 3171
AUSTRALIA
TEL: +61 3 95498415
EMAIL: torkar.m@deutz.com
WEB: www.deutz.com

■ *For Product Listing, See DEUTZ AG*

DEUTZ CORPORATION 183

3883 STEVE REYNOLDS BLVD.
NORCROSS, GEORGIA 30093-3066
U.S.A.
TEL: +1 770 564 7100
FAX: +1 770 564 7222
EMAIL: evans.w@deutzusa.com
WEB: www.deutzamericas.com

■ *For Product Listing, See DEUTZ AG*

DEUTZ ENGINE CO., LTD - BEIJING 183

1102 CITIC BUILDING, 19
JIAN WAI DAJIE
BEIJING 100004
CHINA
TEL: +86 10 65254186120
FAX: +86 10 65120042
EMAIL: miyouqian@deutz.com.cn
WEB: www.deutz.com

■ *For Product Listing, See DEUTZ AG*

DEUTZ FRANCE S.A. 183

115 RUE DU FOSSÉ BLANC
92234 GENNEVILLIERS
FRANCE
TEL: +33 1 461 387 82
FAX: +33 1 461 387 81
EMAIL: haevekeuser.e@deutz.com
WEB: www.deutz.com

■ *For Product Listing, See DEUTZ AG*

DEUTZ SPAIN S.A.U. 183

KM 74,6 DE LA CTRA. DE BADAJOZ-GRANADA
BADAJOZ
ZAFRA 06300
SPAIN
TEL: +34 924 103027
EMAIL: valladares.m@deutzspain.com
WEB: www.deutz.com

■ *For Product Listing, See DEUTZ AG*

LLC DEUTZ VOSTOK 183

NOVINSKY BULV.3, BLD.1
MOSCOW 121099
RUSSIAN FEDERATION
TEL: +7 495 9374211
EMAIL: logvinenko.j@deutz.ru
WEB: www.deutz.ru

■ *For Product Listing, See DEUTZ AG*

NLLE STE MAGIDEUTZ S.A. ... 183

RUE SERGENT KHALICH MOHAMED 6
CASABLANCA 20310
MOROCCO
TEL: +212 52 2300606
EMAIL: magid@deutz.ma
WEB: www.deutz.ma

■ *For Product Listing, See DEUTZ AG*

DOOSAN INFRACORE CO. LTD. ENGINE BG 222

DOOSAN TOWER 21ST FL.
18-12, EULJIRO-6 GA
JUNG-GU, SEOUL 100-730
KOREA

TEL: +82 2 3398 8578
FAX: +82 2 3398 8509
EMAIL: yongkee.kim@doosan.com
WEB: www.doosanengine.com/en

Engines
Diesel Engines
Natural Gas (Spark-Ignited) Engines

Power Generation Equipment
Power Generation Equipment

E

EUROMOT AISBL 346

RUE JOSEPH STEVENS 7
1000 BRUSSELS
BELGIUM
TEL: +32 2 8932142
EMAIL: secretariat@euromot.eu
WEB: www.euromot.eu

Engines
Research Engines

Research & Development
Marketing Research

Services
Market Research Services

H

MOTORENFABRIK HATZ GMBH & CO. KG 182

ERNST-HATZ-STR. 16
94099 RUHSTORF A. D. ROTT
GERMANY
TEL: +49 8531 3190
FAX: +49 8531 319418
EMAIL: marketing@hatz-diesel.de
WEB: hatz.com

Component Manufacturing
Component Manufacturing

Engines
Diesel Engines

Generator Sets
Diesel Engine Generator Sets

Pump Sets
Diesel-Driven Pump Sets

HATZ AUSTRALIA PTY. LTD. 182

7 HUME ROAD
SMITHFIELD, NEW SOUTH WALES 2164
AUSTRALIA
TEL: +61 2 87 88 79 99
FAX: +61 2 97 29 42 77
EMAIL: engines@hatz.com.au
WEB: www.hatz.com.au

■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

HATZ DIESEL (S.A.) PTY. LTD. 182

9 JERSEY DRIVE
LONGMEADOWS EAST, BUSINESS ESTATE
EDENVALE
SOUTH AFRICA
TEL: +27 11 5 74 09 00
FAX: +27 11 5 74 09 39
EMAIL: info@hatz.co.za
WEB: www.hatz.co.za

■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

HATZ DIESEL OF NORTH AMERICA, INC. 182

W 229 N 1645 WESTWOOD DRIVE
WAUKESHA, WISCONSIN 53187-0258
U.S.A.
TEL: +1 262 544 0254
FAX: +1 262 544 6120
EMAIL: sales@hatznorthamerica.com
WEB: www.hatznorthamerica.com

■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

HATZ FRANCE 182

5BIS, RUE LAVOISIER
69684 CHASSIEU CEDEX
FRANCE
TEL: +33 4 78 90 73 25
FAX: +33 4 78 90 72 03
EMAIL: commercial@hatz.fr
WEB: www.hatz-diesel.info

■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

HATZ GREAT BRITAIN LTD. 182

4 ALAN BRAY CLOSE
DODWELLS BRIDGE IND EST, HINCKLEY, LEICS. LE 10 3BP
U.K.
TEL: +44 1455 61 21 01
FAX: +44 1455 61 12 33
EMAIL: info@hatzgb.com
WEB: www.hatzgb.com

■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

HATZ ITALIA S.R.L. 182

VIA PAPA GIOVANNI XXIII NO.26
41100 MODENA
ITALY
TEL: +39 059 25 41 29
FAX: +39 059 25 41 37
EMAIL: info@hatzitalia.it
WEB: www.hatz-diesel.com

■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

HATZ NEDERLAND BV 182

ANTHONIE VAN DIEMENSTRAAT 38
4104 AE CULEMBORG
NETHERLANDS
TEL: +31 345 47 00 40
FAX: +31 345 47 00 44
EMAIL: info@hatz.nl
WEB: www.hatz-diesel.com

■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

MOTORENFABRIK HATZ GMBH & CO. KG 182
XIAMEN REPRESENTATIVE OFFICE
NO. 323 JIAHE ROAD
501B HUITENG METROPOLIS
XIAMEN
CHINA
TEL: +86 592 520 45 28
FAX: +86 592 520 45 98
EMAIL: rita.chen@hatz.com.cn
WEB: www.hatz.com.cn
■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

MOTORES HATZ ESPAÑA S.R.L. 182
CALLE CHOPO, S/N
COMPLEJO IND. EUROARAGÓN, NAVE 5
POLIGONO MALPICA ALFINDÉN, 50171
LA PUEBLA DE ALFINDÉN ZARAGOZA
SPAIN
TEL: +34 976 10 81 28
FAX: +34 976 10 82 76
EMAIL: info@motoreshatz.com
WEB: www.hatz-diesel.com
■ *For Product Listing, See Motorenfabrik Hatz GmbH & Co. KG*

HEINZMANN GMBH & CO. KG ....CONTROLS TAB, 335, 342
AM HASELBACH 1
79677 SCHOENAU, BADEN-WUERTTEMBERG
GERMANY
TEL: +49 7673 8208-0
FAX: +49 7673 8208-188
EMAIL: info@heinzmann.de
WEB: www.heinzmann.com

Actuators
Electric Actuators
Hydraulic Actuators
Solenoid Actuators
Controls
Air/Fuel Ratio Controls
Electronic Controls
Engine Controls
Gen-Set Paralleling Controls
Generator Controls
Knock Detection & Control Controls
Load Controls
Load Transfer Controls
Marine Propulsion Controls
Mechanical Controls
Speed Controls
Throttle Controls
Turbocharger Controls
Converters
Catalytic Converters
Converters
I/F Converters
Diesel Common Rail Systems
Diesel Common Rail Injectors
Diesel Common Rail Supply Pump
Diesel Common Rail Systems
Drives
Electrical Drives
Electrical Power Generation Equipment
Electrical Power Generation Equipment
Exhaust Systems
Diesel & Gas Exhaust Systems
Diesel & Gas Turbine Exhaust Systems
Exhaust Gas Recirculation Valves
Filters and Filter Systems
Exhaust Filters
Fuel & Lube Systems
Oil Mist Detectors
Fuel Injection
Common Rail Systems Fuel Injection
Fuel Injection Control
Fuel Injection Nozzles
Fuel Injection Timing Sensors
Fuel Pumps, Electronic
High-Pressure Common Rail Pumps Fuel
Governors
Electric/Electronic Governors
Hydraulic Governors
Mechanical Governors
Hydraulic Components
Controls Hydraulic
Indicators
Cylinder Pressure Indicators
Oil Mist Indicators
Temperature Indicators
Monitoring, Monitors
Monitoring
Motors
Electric Motors
Wheel Motors
Pump Sets
Gas Turbine-Driven Pump Sets
Pumps
Common Rail Fuel Oil Pump
Sensors
Hall-Effect Sensor
Oil Mist Sensors
Position Sensors
Pressure Sensors
Speed Sensors
Temperature Sensors
Services
Engineering Services
Gas Turbine Overhaul & Repair Services
Servomotors
Servomotors
Solenoids
AC & DC Solenoids
Synchronizers
Automatic Synchronizers
Test Equipment, Testing
Engine Systems Test Equipment
Fuel Injection Test Equipment
Valves
Fuel Valves
Solenoid Valves

CPK AUTOMOTIVE GMBH & CO. KG .... CONTROLS TAB, 335, 342
GILDENSTR. 4C
48157 MÜNSTER
GERMANY
TEL: +49 251 2394850
FAX: +49 251 2394854
EMAIL: info@cpk-automotive.com
WEB: www.cpk-automotive.com
■ *For Product Listing, See Heinzmann GmbH & Co. KG*

GIRO ENGINEERING LTD. .... CONTROLS TAB, 335, 342
TALISMAN BUSINESS CENTRE
DUNCAN ROAD, PARK GATE
SOUTHAMPTON, HAMPSHIRE SO317GA
U.K.
TEL: +44 1489 885288
FAX: +44 1489 885199
EMAIL: giro@giroeng.com
WEB: https://www.giroeng.com/
■ *For Product Listing, See Heinzmann GmbH & Co. KG*

HEINZMANN / REGULATEURS EUROPA AMERICA INC. .... CONTROLS TAB, 335, 342

SUITE 1
1305 DUFF DRIVE
FORT COLLINS, COLORADO 80524
U.S.A.
TEL: +1 970 484 1863
FAX: +1 970 484 0073
EMAIL: info.usa@heinzmann.com
WEB: www.heinzmann.com

- *For Product Listing, See Heinzmann GmbH & Co. KG*

HEINZMANN AUSTRALIA PTY LTD. .... CONTROLS TAB, 335, 342

10 VIRGINIA STREET
GEEBUNG QLD 4034, QUEENSLAND 4009
AUSTRALIA
TEL: +61 7 3868 3333
FAX: +61 7 3868 4666
EMAIL: c.staff@heinzmann.com
WEB: www.heinzmann.com.au

- *For Product Listing, See Heinzmann GmbH & Co. KG*

HEINZMANN AUTOMATION AS ....CONTROLS TAB, 335, 342

KONGENSGT. 18
8514 NARVIK
NORWAY
TEL: +47 769 610 80
FAX: +47 769 610 99
EMAIL: post@heinzmann.no
WEB: www.heinzmann.no

- *For Product Listing, See Heinzmann GmbH & Co. KG*

HEINZMANN INDIA PRIVATE LTD. .... CONTROLS TAB, 335, 342

REGD. OFFICE: 'ANTARAL' SOCIETY
BLOCK NO. 1, SANGANNA DHOTRE
MARG, MODEL COLONY
PUNE 411016
INDIA
TEL: +91 20 25675790
EMAIL: s.jog@heinzmann.in
WEB: heinzmann.com

- *For Product Listing, See Heinzmann GmbH & Co. KG*

HEINZMANN POWER CONTROL (JIAXING) CO. LTD. .... CONTROLS TAB, 335, 342

NO. 222 WEST YUN SI ROAD
DAYUN TOWN
JIASHAN 314113
CHINA
TEL: +86 573 84661358
EMAIL: hzm-sh@heinzmann.com
WEB: www.heinzmann.cn

- *For Product Listing, See Heinzmann GmbH & Co. KG*

HEINZMANN UK LTD. .... CONTROLS TAB, 335, 342

STANLEY HOUSE
WALLIS ROAD
SKIPPERS LANE INDUSTRIAL ESTATE
MIDDLESBROUGH TS6 6JB
U.K.
TEL: +44 1 642 467 484
FAX: +44 1 642 458 488
EMAIL: info@heinzmannuk.com
WEB: www.heinzmann-turbine-controls.com

- *For Product Listing, See Heinzmann GmbH & Co. KG*

REGULATEURS EUROPA B.V. .... CONTROLS TAB, 335, 342

EKKELKAMP 3
9301 ZZ RODEN
NETHERLANDS
TEL: +31 5050 19888
FAX: +31 5050 13618
EMAIL: sales@regulateurs-europa.com
WEB: www.regulateurseuropa.com

- *For Product Listing, See Heinzmann GmbH & Co. KG*

REGULATEURS EUROPA LTD. .... CONTROLS TAB, 335, 342

PORT LANE
ESSEX, COLCHESTER CO1 2NX
U.K.
TEL: +44 1206 799 556
FAX: +44 1206 792 685
EMAIL: sales@regulateurseuropa.com
WEB: www.regulateurseuropa.com

- *For Product Listing, See Heinzmann GmbH & Co. KG*

I

Impro
Reliable · Flexible · Global

IMPRO INDUSTRIES USA, INC. 278, 282, 290

21660 EAST COPLEY DRIVE, STE 100
DIAMOND BAR, CALIFORNIA 91765
U.S.A.
TEL: +1 909 396-6525
FAX: +1 909 396-1677
EMAIL: sales@improusa.com
WEB: www.improprecision.com

Castings Materials
Drive Components Castings
Engine Components Castings
Turbine Components Castings
Component Manufacturing
Component Manufacturing
Cylinders
Cylinder Heads
Engine Cylinders

IMPRO (CHINA) LIMITED 278, 282, 290

NO. 18, FURONG ROAD 5
XISHAN ECONOMY DEVELOPMENT ZONE
WUXI, JIANGSU PROVINCE
CHINA
TEL: +86 510 85165532
FAX: +86 510 85165099
EMAIL: sales@impro.com.cn
WEB: www.improprecision.com

- *For Product Listing, See Impro Industries USA, Inc.*

IMPRO EUROPE SARL 278, 282, 290

10 BOULEVARD ROYAL
L-2449 LUXEMBOURG
LUXEMBOURG
TEL: +352 26 20 06 08
FAX: +352 26 26 29 11
EMAIL: sales@impro-eu.com
WEB: www.improprecision.com

- *For Product Listing, See Impro Industries USA, Inc.*

IMPRO GERMANY GMBH 278, 282, 290

AM SCHÜRMANNSHÜTT 11
47441 MOERS
GERMANY
TEL: +49 2841 1798 98
FAX: +49 2841 1798 90
EMAIL: sales@impro-europe.com
WEB: www.improprecision.com

- *For Product Listing, See Impro Industries USA, Inc.*

IMPRO INDUSTRIES USA, INC. 278, 282, 290

1055 REMINGTON BLVD, SUITE A
BOLINGBROOK, ILLINOIS 60440
U.S.A.
TEL: +1 630 759-0280
FAX: +1 630 759-0353
EMAIL: sales@improusa.com
WEB: www.improprecision.com

- *For Product Listing, See Impro Industries USA, Inc.*

IMPRO INTERNATIONAL LIMITED 278, 282, 290

UNIT 803, SHUI ON CENTRE
6-8 HARBOUR ROAD,
WANCHAI
HONG KONG
TEL: +852 2572 8628
FAX: +852 2572 8638
EMAIL: sales@impro.com.hk
WEB: www.improprecision.com

- *For Product Listing, See Impro Industries USA, Inc.*

INNIO JENBACHER GMBH & CO OG 211

ACHENSEESTR. 1-3
A-6200 JENBACH, TYROL
AUSTRIA
TEL: +43 0 5244 600
FAX: +43 0 5244 600-527
EMAIL: communications@innio.com
WEB: www.innio.com

Cogeneration Systems
Cogeneration Systems
Service Cogeneration Systems
Drives
Compressor Drives
Engine Maintenance
Overhaul & Parts Services Engine Maintenance
Engines
Gas Engines
Natural Gas (Spark-Ignited) Engines
Generator Sets
Natural Gas Engine Generator Sets
Service Generator Sets
Motors
Generator Sets Motors

INNIO WAUKESHA GAS ENGINES INC. 211

1101 W. ST. PAUL AVE
WAUKESHA, WISCONSIN 53188
U.S.A.
TEL: +1 262 547-3311
FAX: +1 262 549-2795
EMAIL: michelle.neira@innio.com
WEB: www.innio.com/en/products/waukesha

Controls
Engine Controls
Gen-Set Paralleling Controls
Generator Controls
Electrical Power Generation Equipment
Electrical Power Generation Equipment
Engine Maintenance
Overhaul & Parts Services Engine Maintenance
Engines
Dual-Fuel Engines
Gas Engines
Natural Gas (Spark-Ignited) Engines
Generator Sets
Dual-Fuel Engine Generator Sets
Natural Gas Engine Generator Sets
Power Generation Equipment
Power Generation Equipment

INNIO WAUKESHA GAS ENGINES INC. 211

11330 CLAY ROAD
WESTWAY PLAZA
HOUSTON, TEXAS 77041
U.S.A.
TEL: +1 713 408 6930
EMAIL: communications@innio.com
WEB: www.innio.com

- *For Product Listing, See INNIO Waukesha Gas Engines Inc.*

ISOTTA FRASCHINI MOTORI S.P.A., A FINCANTIERI COMPANY 209

VIALE FRANCESCO DE BLASIO
ZONA INDUSTRIALE
70100 BARI
ITALY
TEL: +39 080 5345000
FAX: +39 080 5345153
EMAIL: isottafraschini@isottafraschini.it
WEB: www.isottafraschini.it

Engines
Diesel Engines
Generator Sets
Diesel Engine Generator Sets

The **power** behind it all.

ISUZU MOTORS AMERICA, LLC .... ENGINES TAB, 154

POWERTRAIN DIVISION
46401 COMMERCE CENTER DRIVE
PLYMOUTH, MICHIGAN 48170
U.S.A.
TEL: +1 734 582-9453
FAX: +1 734 455-7581
EMAIL: laura.blanke@isza.com
WEB: www.isuzuengines.com

Engines
Diesel Engines

ISUZU MOTORS LTD. ....ENGINES TAB, 154

6-26-1 MINAMI-OI
SHINAGAWA-KU
TOKYO 140-8722
JAPAN
TEL: +81 3 5471 1423
EMAIL: pt.marketing@isza.com
WEB: www.isuzu.co.jp

■ *For Product Listing, See Isuzu Motors America, LLC*

J

JBJ TECHNIQUES LIMITED 300, 318

28 TROWERS WAY, HOLMETHORPE
INDUSTRIAL ESTATE
REDHILL, SURREY RH1 2LW
U.K.
TEL: +44 1737 767493
EMAIL: info@jbj.co.uk
WEB: www.jbj.co.uk

Clutches and Clutch Components
Electrical Clutches
Hydraulic Clutches
Marine Clutches
Multiple Disc Clutches
Spring Loaded Clutches
Wet Clutches
Component Manufacturing
Aluminum Components
Component Manufacturing
Couplings
Flexible Couplings
Gear-Type Couplings
Hydraulic Couplings
Mechanical Couplings
Shaft Couplings
Dampers
Driveline Dampers
Drives
Hydraulic Pump Drives
Pump Drives
Heat Exchangers
Air-Cooled Heat Exchangers
Liquid-Cooled Heat Exchangers
Oil-Water Heat Exchangers
Sea Water Heat Exchangers
Shell & Tube Heat Exchangers
Hydraulic Components
Motors Hydraulic
Pumps Hydraulic
Reservoirs Hydraulic
Motors
Explosion-Proof Motors
Hydraulic Motors
Power Take-offs
Power Take-offs
Pump Sets
Motor Driven Pump Sets
Pumps
Hydraulic Gear-Type Pumps
Hydraulic Pumps
Screw Pumps
Transfer Pumps
Services
Engineering Services
Shafts
Shafts
Starting Motors
Air/Gas Starting Motors
Transmissions
Mechanical Transmissions

JCB POWER SYSTEMS LTD. ....BACK COVER, 200

DOVE VALLEY PARK
1000 PARK AVENUE, FOSTON DERBY
DE65 5BX
U.K.
TEL: +44 1889 590312
FAX: +44 1283 585630
EMAIL: engine.sales@jcb.com
WEB: www.jcbpowersystems.com

Engines
Diesel Engines

JOHN DEERE POWER SYSTEMS 178

3801 WEST RIDGEWAY AVENUE
WATERLOO, IOWA 50704-5100
U.S.A.
TEL: +1 800 533-6446
FAX: +1 319 292-5075
EMAIL: jdpower@johndeere.com
WEB: www.johndeere.com/jdpower

Axles
Drive Axles
Planetary Axles
Differentials
Differentials
Drives
Electrical Drives
Gear-Reduction Drives
Hydraulic Pump Drives
Mixer Drives
Pump Drives
Swing Drives
Engines
Diesel Engines
Marine Propulsion Systems
Diesel Marine Propulsion Systems

Transmissions
Automatic Transmissions
Hydraulic/Hydrostatic Transmissions
Manual Transmissions
Mechanical Transmissions
Powershift Transmissions
Vehicular Transmissions

INDUSTRIAS JOHN DEERE S.A. DE C.V. 178

BOULEVARD DIAZ ORDAZ NO. 500
GARZA GARCIA, NUEVO LEON 66210
MEXICO
TEL: +52 81 8288-1212
FAX: +52 81 8288-8284
EMAIL: mexweb@johndeere.com
WEB: www.johndeere.com
■ *For Product Listing, See John Deere Power Systems*

JOHN DEERE ASIA (SINGAPORE) PTE. LTD. ..178

#06-02/03 ALEXANDRA POINT
438 ALEXANDRA ROAD
119958
SINGAPORE
TEL: +65 6879 8800
FAX: +65 6278 0363
EMAIL: jdasiaengines@johndeere.com
WEB: www.johndeere.com
■ *For Product Listing, See John Deere Power Systems*

JOHN DEERE POWER SYSTEMS 178

ORLÉANS-SARAN UNIT
1, RUE JOHN DEERE – B.P. 11013
45401 , FLEURY-LES-AUBRAIS CEDEX
FRANCE
TEL: +33 238 82-61-19
FAX: +33 238 84-62-66
EMAIL: jdengine@johndeere.com
WEB: www.johndeere.com
■ *For Product Listing, See John Deere Power Systems*

K

KOHLER®

KOHLER 192

VIA CAVALIERE DEL LAVORO ADELMO LOMBARDINI, 2
42124 REGGIO EMILIA
ITALY
TEL: +39 0522 3891
FAX: +39 0522 389503
EMAIL: infodiesel@kohler.com
WEB: www.kohlerengines.com

Engines
Diesel Engines
Gas Engines
Gasoline Engines

KOHLER ENGINES - AMERICAS 192

KOHLER. CO.
444 HIGHLAND DRIVE
KOHLER, WISCONSIN 53044
U.S.A.
TEL: +1 920 457-4441
WEB: www.kohlerpower.com
■ *For Product Listing, See KOHLER*

KOHLER ENGINES - CHINA 192

NO.158, JIANG CHANG SAN ROAD
JING'AN DISTRICT
SHANGHAI
CHINA
TEL: +86 400-0120-648
EMAIL: power@kohler.com.cn
WEB: www.kohlerpower.cn/engines
■ *For Product Listing, See KOHLER*

KOHLER ENGINES EMEA - FRANCE 192

LOMBARDINI FRANCE S.A.
47 ALLÈE DE RIOTTIER
69400 LIMAS-VILLEFRANCHE S/S
FRANCE
TEL: +33 04 74626500
FAX: +33 04 74623945
EMAIL: fr.infodiesel@kohler.com
WEB: www.kohlerpower.it
■ *For Product Listing, See KOHLER*

KOHLER ENGINES EMEA - GERMANY 192

LOMBARDINI MOTOREN GMBH
FRITZ-KLATTE-STRASSE 6,
BÜROGEBÄUDE 2
D-65933 FRANKFURT AM MAIN
GERMANY
TEL: +49 69 9508160
FAX: +49 69 5073410
EMAIL: de.infodiesel@kohler.com
WEB: www.kohlerpower.it
■ *For Product Listing, See KOHLER*

KOHLER ENGINES EMEA - HEADQUARTERS 192

LOMBARDINI SRL
VIA CAV. DEL LAVORO A. LOMBARDINI, 2
42100 REGGIO EMILIA
ITALY
TEL: +39 05223891
FAX: +39 0522389357
EMAIL: infodiesel@kohler.com
WEB: www.kohlerpower.it
■ *For Product Listing, See KOHLER*

KOHLER ENGINES EMEA - SPAIN 192

LOMBARDINI ESPAÑA, S.L.
C/PARIS, 1-9 - ZONA. IND. COVA SOLERA
RUBÌ - BARCELONA 08191
SPAIN
TEL: +34 935 862111
FAX: +34 936 971613
EMAIL: es.infodiesel@kohler.com
WEB: www.kohlerpower.it
■ *For Product Listing, See KOHLER*

KOHLER ENGINES EMEA - UK 192

LOMBARDINI UK LTD
1 ROCHESTER BARN, EYNSHAM ROAD,
BOTLEY, OXFORD OX2 9NH
U.K.
TEL: +44 0 1865 793299

FAX: +44 0 1865 793301
EMAIL: uk.infodiesel@kohler.com
WEB: www.kohlerpower.it
■ *For Product Listing, See KOHLER*

KOHLER POWER INDIA PRIVATE LTD 192

J-2/1 MIDC INDUSTRIAL AREA
AURANGABAD, MAHARASTRA 431210
INDIA
TEL: +91 240 2471452
FAX: +91 240 2486234
EMAIL: infodiesel@kohler.com
WEB: www.kohlerpower.it
■ *For Product Listing, See KOHLER*

KOHLER POWER MEXICO 192

KOHLER TRADING MEXICO
NORTE 45 772 INDUSTRIAL VALLEJO
AZCAPOTZALCO, CIUDAD DE MÉXICO
45 772
MEXICO
TEL: +52 1 55 3689 1300
EMAIL: infolatam@kohler.com
WEB: www.kohlerpower.com
■ *For Product Listing, See KOHLER*

KOLBENSCHMIDT
RHEINMETALL AUTOMOTIVE

KS KOLBENSCHMIDT GMBH 284

LARGE BORE PISTONS
KARL-SCHMIDT-STR.
74172 NECKARSULM
GERMANY
TEL: +49 7132 332714
FAX: +49 7132 33 2219
EMAIL: info@de.rheinmetall.com
WEB: https://www.rheinmetall-automotive.com/marken/kolbenschmidt/

Pistons, Components

Pistons

KS LARGE BORE PISTONS INC. 284

2945 ANGWALL DRIVE
MARINETTE, WISCONSIN 54143
U.S.A.
TEL: +1 715 735 2000
FAX: +1 715 732 4222
EMAIL: floyd.baum@rheinmetall-americas.com
WEB: https://www.rheinmetall-automotive.com/marken/kolbenschmidt/
■ *For Product Listing, See KS Kolbenschmidt GmbH*

Kubota

KUBOTA CORPORATION 158

2-47, SHIKITSUHIGASHI 1-CHOME
NANIWA-KU
OSAKA 556-8601
JAPAN
TEL: +81 6-6648-3510
FAX: +81 6-6648-3158
EMAIL: kbt_g.engine@kubota.com
WEB: global.engine.kubota.co.jp/en/

Engines

Diesel Engines
Gas Engines
Gasoline Engines
Natural Gas (Spark-Ignited) Engines
NG or LPG Engines

KUBOTA (DEUTSCHLAND) GMBH - ENGINE DIVISION 158

SENEFELDER STR. 3-5
63110 RODGAU/NIEDER-RODEN
GERMANY
TEL: +49 6106 873 113
FAX: +49 6106 873 196
EMAIL: motoren@kubota.de
WEB: www.kubota.de
■ *For Product Listing, See Kubota Corporation*

KUBOTA (U.K.) LIMITED ..158

DORMER ROAD, THAME
OXFORDSHIRE OX9 3UN
U.K.
TEL: +44 1844 214500
FAX: +44 1844 216685
EMAIL: engines@kubota.co.uk
WEB: www.kubota.co.uk
■ *For Product Listing, See Kubota Corporation*

KUBOTA AGRICULTURAL MACHINERY INDIA PVT.,LTD. 158

94, TVH BELICIAA TOWERS- 1,
8TH FLOOR, MRC NAGAR
CHENNAI 600028
INDIA
TEL: +91 44-6104-1500
FAX: +91 44-6104-1600
EMAIL: kbt_g.india_engine_pr@kubota.com
WEB: www.kubota.co.in/
■ *For Product Listing, See Kubota Corporation*

KUBOTA AUSTRALIA PTY LTD. 158

25-29 PERMAS WAY
TRUGANINA 3029, VICTORIA
AUSTRALIA
TEL: +61 1300 582 582; FREECALL: 1800 334 653
EMAIL: sales@kubota.com.au
WEB: www.kubota.com.au/
■ *For Product Listing, See Kubota Corporation*

KUBOTA ENGINE (SHANGHAI) CO., LTD. 158

6F, TOWER 1, KERRY EVERBRIGHT CITY,
NO.128 TIAN MU ROAD WEST
JINGAN DISTRICT,
SHANGHAI 200070
CHINA
TEL: +86 21 6236 0606
FAX: +86 21 6236 0637
WEB: www.kubota.com.cn/kesco/
■ *For Product Listing, See Kubota Corporation*

M

FAX: +49 7541 90 77778
EMAIL: info@ps.rolls-royce.com
WEB: www.mtu-solutions.com

Cogeneration Systems
Cogeneration Systems
Engines
Diesel Engines
Gas Engines
Gas Turbines
Natural Gas (Spark-Ignited) Engines
Generator Sets
Diesel Engine Generator Sets
Gas Engine Generator Sets
Gas Turbine Generator Sets
Natural Gas Engine Generator Sets
Marine Propulsion Systems
Diesel Marine Propulsion Systems
Electric Marine Propulsion Systems
Gas Turbine Marine Propulsion Systems
Packages
Engine Power Systems Packages
Power Generation Equipment
Power-to-X

MTU AMERICA INC. .... INSIDE FRONT COVER, 217, 269

39525 MACKENZIE DRIVE
NOVI, MICHIGAN 48377
U.S.A.
TEL: +1 248 560 8888
FAX: +1 248 560 8726
EMAIL: info@mtu-online.com
WEB: www.mtu-online.com

■ *For Product Listing, See MTU Friedrichshafen GmbH*

MTU ASIA PTE LTD. .... INSIDE FRONT COVER, 217, 269

1, BENOI PLACE
SINGAPORE 629923
SINGAPORE
TEL: +65 6860 9669
FAX: +65 6860 9666
EMAIL: info@mtu-online.com
WEB: www.mtu-online.com

■ *For Product Listing, See MTU Friedrichshafen GmbH*

N

NFPA - NATIONAL FLUID POWER ASSOC. ....MOBILE HYDRAULICS TAB, 298, 310

6737 W. WASHINGTON ST., STE. 2350
MILWAUKEE, WISCONSIN 53214
U.S.A.
TEL: +1 414 778-3344
FAX: +1 414 778-3361
EMAIL: nfpa@nfpa.com
WEB: www.nfpa.com

Research & Development
Market Research Services
Marketing Research
Research & Development
Services
Market Research Services

NIDEC - KATO ENGINEERING & LEROY-SOMER 262

2075 HOWARD DR. W
NORTH MANKATO, MINNESOTA 56003
U.S.A.
TEL: +1 507 625-4011
FAX: +1 507 389-4146
EMAIL: katoengineering@mail.nidec.com
WEB: www.katoengineering.com

Alternators
Alternators
Battery Charging Alternators
Generating Sets Alternators
Cogeneration Systems
Cogeneration Systems
Controls
Gen-Set Paralleling Controls
Generator Controls
Electrical Power Generation Equipment
Electrical Power Generation Equipment
Generators
AC Generators
DC Generators
Marine Propulsion Systems
Electric Marine Propulsion Systems
Motors
Electric Motors
Explosion-Proof Motors
Power Generation Equipment
Power Generation Equipment
Starting Motors
Electric Starting Motors

KATO ENGINEERING 262

2075 HOWARD DRIVE WEST
NORTH MANKATO, MINNESOTA 56003
U.S.A.
TEL: +1 507 625-4011
FAX: +1 507 625-2798
EMAIL: katoengineering@emerson.com
WEB: www.katoengineering.com

■ *For Product Listing, See Nidec - Kato Engineering & Leroy-Somer*

NOVA WERKE AG 333

VOGELSANGSTRASSE 24
CH-8307 EFFRETIKON
SWITZERLAND
TEL: +41 52 354 16 16
FAX: +41 52 354 16 05
EMAIL: info@novaswiss.com
WEB: www.novaswiss.com

Compressors and Compressor Sets
Air-Starting Compressors
Fire Protection Systems & Components
Fire Protection Systems & Components
Fuel Injection
Common Rail Systems Fuel Injection
Fuel Injection Tubing
Pressure Pipes Fuel Injection
Starting Motors
Air/Gas Starting Motors
Valves
Relief & Safety Valves
Starting Air Valves

NOVA WERKE CHINA CO. LTD. 333

UNIT 6, 12/F, PROSPERITY MILLENNIA PLAZA
663 KING'S ROAD, NORTH POINT
HONG KONG
HONG KONG
TEL: +852 5318 3988
EMAIL: janecjcheng@yahoo.com.hk
WEB: www.novaswiss.com

■ *For Product Listing, See Nova Werke AG*

O

O.M.T. OFFICINE MECCANICHE TORINO S.P.A. ....FUEL INJECTION TAB, 323

VIA FERRERO, 67/A
10090 CASCINE VICA-RIVOLI (TO)
ITALY
TEL: +39 011 95 05 334
FAX: +39 011 95 75 474
EMAIL: omt@omt-torino.com
WEB: www.omt-torino.com

Diesel Common Rail Systems
Diesel Common Rail Injectors
Diesel Common Rail Supply Pump
Diesel Common Rail Systems
Fuel Injection
Circulation Valves Fuel Injection
Common Rail Systems Fuel Injection
Distributor Fuel Injection Pumps
Fuel Injection Control
Fuel Injection Nozzle Holders
Fuel Injection Nozzles
Fuel Injection Plungers & Barrels
Pressure Pipes Fuel Injection
Rail Fuel
Service, Fuel Injection Nozzles
Suction & Delivery Valves Fuel Injection
Unit-Type Fuel Injectors
Pumps
Fuel Oil Pumps
Research & Development
Research & Development
Test Equipment, Testing
Fuel Injection Test Equipment
Nozzle Injector Tester
Valves
Check Valves
Fuel Valves
Relief & Safety Valves

OESSE SRL 281

VIA MAESTRI DEL LAVORO, 81/83
33080 PORCIA, PN
ITALY
TEL: +39 0434 922958
FAX: +39 0434 590046
EMAIL: info@oesse.com
WEB: www.oesse.com

Coolers and Cooling Systems
Cooling Systems

OFF-HIGHWAY RESEARCH ....ENGINE SYSTEMS TAB, 347

SOUTHFIELDS, SOUTHVIEW ROAD
WADHURST, EAST SUSSEX TN5 6TP
U.K.
TEL: +44 0 1892 786270
FAX: +44 0 1892 784086
EMAIL: mail@offhighwayresearch.com
WEB: www.offhighwayresearch.com

Research & Development
Market Research Services
Marketing Research
Product Research Services
Research & Development
Services
Market Research Services
Product Research Services

OFF-HIGHWAY RESEARCH LTD. ....ENGINE SYSTEMS TAB, 347

ROOM 2102, AIR CHINA PLAZA
NO 36 XIAOYUN ROAD, CHAOYANG DISTRICT
BEIJING 100027
CHINA
TEL: +86 10 8447 5877
FAX: +86 10 8447 5878
EMAIL: china@offhighwayresearch.com
WEB: www.offhighwayresearch.com

■ *For Product Listing, See Off-Highway Research*

OFF-HIGHWAY RESEARCH LTD. ....ENGINE SYSTEMS TAB, 347

FLAT NO. 111, CHIRANJIV TOWER
43, NEHRU PLACE
NEW DELHI 110019
INDIA
TEL: +91 11 4652 5671 - 73
FAX: +91 11 4652 5674
EMAIL: india@offhighwayresearch.com
WEB: www.offhighwayresearch.com

■ *For Product Listing, See Off-Highway Research*

P

PARKER HANNIFIN CORPORATION I FILTRATION GROUP 37

1640 CUMMINS DRIVE
MODESTO, CALIFORNIA 95358
U.S.A.
TEL: +1 209 521-7860
FAX: +1 209 529-3278
EMAIL: racor@parker.com
WEB: www.parker.com/emoe

Additives
Diesel Fuel Additives

YANMAR AMERICA CORPORATION 175, 177
101 INTERNATIONAL PARKWAY
ADAIRSVILLE, GEORGIA 30103
U.S.A.
TEL: +1 770 877-9894
FAX: +1 770 877-9009
WEB: www.yanmar.com/us/
- *For Product Listing, See YANMAR POWER TECHNOLOGY CO., LTD.*

YANMAR ASIA (SINGAPORE) CORPORATION PTE. LTD. 175, 177
4 TUAS LANE
SINGAPORE 638613
SINGAPORE
TEL: +65 6595 4200
WEB: www.yanmar.com/sg/
- *For Product Listing, See YANMAR POWER TECHNOLOGY CO., LTD.*

YANMAR ENGINE (SHANGHAI) CO., LTD. 175, 177
1101-1106 GOPHER CENTER BUILDING,
NO.757 MENG ZI ROAD
HUANGPU DISTRICRT
SHANGHAI 200023
CHINA
TEL: +86 21 2312-0688
WEB: www.yanmar-china.com/cn/
- *For Product Listing, See YANMAR POWER TECHNOLOGY CO., LTD.*

YANMAR EUROPE B.V. 175, 177
BRUGPLEIN 11
1332 BS ALMERE-DE VAART
NETHERLANDS
TEL: +31 36 5493200
WEB: www.yanmar.com/eu/
- *For Product Listing, See YANMAR POWER TECHNOLOGY CO., LTD.*

YANMAR INDIA PRIVATE LIMITED 175, 177
UNIT NO.1501-1504, 15TH FLOOR,
TOWER D,
GLOBAL BUSINESS PARK, M.G. ROAD
GURUGRAM, HARYANA 122002
INDIA
TEL: +91 124 640-9000
WEB: www.yanmar.com/in/
- *For Product Listing, See YANMAR POWER TECHNOLOGY CO., LTD.*

YANMAR SOUTH AMERICA INDUSTRIA DE MAQUINAS LTDA. 175, 177
AV. PRESIDENTE VARGAS 1400
INDAIATUBA, SAO PAULO 13338-901
BRAZIL
TEL: +55 19 3801-9224
WEB: www.yanmar.com/br/
- *For Product Listing, See YANMAR POWER TECHNOLOGY CO., LTD.*

YENGST ASSOCIATES INC. 348
35 OLD RIDGEFIELD ROAD
WILTON, CONNECTICUT 06897
U.S.A.
TEL: +1 203 762-8096
EMAIL: mail@yengstassociates.com
WEB: www.yengstassociates.com

Research & Development
Market Research Services
Marketing Research
Product Research Services
Research & Development

Services
Market Research Services
Product Research Services

YENGST ASSOCIATES INC. 348
200 CLOCK TOWER PLACE
CARMEL, CALIFORNIA 93923
U.S.A.
TEL: +1 203 762-8096
EMAIL: mail@yengstassociates.com
WEB: www.yengstassociates.com
- *For Product Listing, See Yengst Associates Inc.*

CONVERSION FACTORS
SI - METRIC/DECIMAL SYSTEM

ABBREVIATIONS

abs	absolute	m	meter
ata	atmosphere absolute	mm	millimeter
Btu	British thermal unit	m^2	square meter
Btu/hr	British thermal unit/hour	m^3	cubic meter
°C	Celsius	m^3/min	cubic meter/minute
cfm	cubic foot/minute	mph	mile per hour
cm	centimeter	N	Newton
cm^2	square centimeter	N/m^2	Pascal
cm^3	cubic centimeter	Nm^3/hr	normal* cubic meter/hour
cu.ft.	cubic foot	psi	pound/square inch
°F	Fahrenheit	psia	pound/square inch absolute
ft/sec	foot/second	psig	pound/square inch gage
ft-lb	foot-pound	scf	standard* cubic foot
gal	gallon	scfm	standard* cubic foot/minute
hp	horsepower	sq	square
in	inch		
in. Hg	inch mercury		
in. H_2O	inch water		
kcal	kilocalorie		
kg	kilogram		
kJ	kilojoule		
kPa	kilopascal		
kW	kilowatt		
L	liter		

* "Normal" = 0°C and 1.01325 x 10^5 Pascals
* "Standard" = 59°F and 14.73 psia

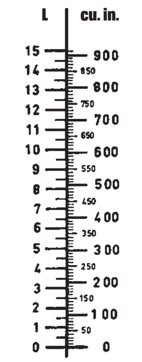
CONVERSION FACTORS

TO CONVERT FROM ENGLISH	TO S.I. METRIC	MULTIPLY BY	TO OLD METRIC	MULTIPLY BY
sq. in.	mm^2	645.16	cm^2	6.4516
sq. ft.	m^2	0.0929	m^2	0.0929
lb/cu.ft.	kg/m^3	16.0185	kg/m^3	16.0185
lb_f	N	4.4482	N	4.4482
lb_f/ft	N/m	14.5939	N/m	14.5939
Btu	kJ	1.0551	kcal	0.252
Btu/hr	W	0.2931	kcal/hr	0.252
Btu/scf	kJ/mm^3	37.2590	$kcal/nm^3$	0.1565
in	mm	25.400	cm	2.540
ft	m	0.3048	m	0.3048
yd	m	0.914	m	0.914
lb	kg	0.4536	kg	0.4536
hp	kW	0.7457	kW	0.7457
psi	kPa	6.8948	kg/cm^2	0.070
psia	kPa abs	6.8948	bars abs	0.0716
psig	kPa gage	6.8948	ata	0.070
in. Hg	kPa	3.3769	cm Hg	2.540
in. H_2O	kPa	0.2488	cm H_2O	2.540
°F	°C =	(°F -32) 5/9	°C =	(°F -32) 5/9
°F (Interval)	°C (Interval)	5/9	°C (Interval)	5/9
ft-lb	N • m	1.3558	N • m	1.3558
mph	km/hr	1.6093	km/hr	1.6093
ft/sec	m/sec	0.3048	m/sec	0.3048
cu. ft.	m^3	0.0283	m^3	0.0283
gas (US)	L	3.7854	L	3.7854
cfm	m^3/min	0.0283	m^3/min	0.0283
scfm	nm^3/min	0.0268	nm^3/hr	1.61

TO CONVERT FROM OLD METRIC	TO S.I. METRIC	MULTIPLY BY
cm^2	mm^2	100.
kcal	kJ	4.1868
kcal/hr	W	1.16279
cm	mm	10.
kg/cm^2	kPa	98.0665
bars	kPa	100.
atm	kPa	101.325
cm Hg	kPa	1.3332
cm H_2O	kPa	9.8064
nm^3/hr	nm^3/min	0.0176

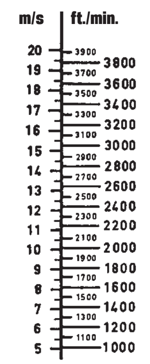
VOLUME CONVERSION FACTORS

1 L = 61.02 cu. in.
10 cu. in. = 0,164 L



PISTON SPEED CONVERSION FACTORS

1 m/s = 196.9 ft./min.
100 ft./min. = 0,51 m/s



MILLIMETERS (mm) TO INCHES (in)
(1 millimeter = 0.03937 inch)

mm	in	mm	in	mm	in	mm	in	mm	in
1	0.039	21	0.827	41	1.614	61	2.402	81	3.189
2	0.079	22	0.866	42	1.654	62	2.441	82	3.228
3	0.118	23	0.906	43	1.693	63	2.480	83	3.268
4	0.157	24	0.945	44	1.732	64	2.520	84	3.307
5	0.197	25	0.984	45	1.772	65	2.559	85	3.346
6	0.236	26	1.024	46	1.811	66	2.598	86	3.386
7	0.276	27	1.063	47	1.850	67	2.638	87	3.425
8	0.315	28	1.102	48	1.890	68	2.677	88	3.465
9	0.354	29	1.142	49	1.929	69	2.717	89	3.504
10	0.394	30	1.181	50	1.968	70	2.756	90	3.543
11	0.433	31	1.220	51	2.008	71	2.795	91	3.583
12	0.472	32	1.260	52	2.047	72	2.835	92	3.622
13	0.512	33	1.299	53	2.087	73	2.874	93	3.661
14	0.551	34	1.339	54	2.126	74	2.913	94	3.701
15	0.591	35	1.378	55	2.165	75	2.953	95	3.740
16	0.630	36	1.417	56	2.205	76	2.992	96	3.779
17	0.669	37	1.457	57	2.244	77	3.032	97	3.819
18	0.709	38	1.496	58	2.283	78	3.071	98	3.858
19	0.748	39	1.535	59	2.323	79	3.110	99	3.898
20	0.787	40	1.575	60	2.362	80	3.150	100	3.937

TEMPERATURE CONVERSION TABLES*

0 TO 100			2.78	**37**	98.6	23.9	**75**	167.0	93	**200**	392	299	**570**	1058	510	**950**	1742
-17.8	**0**	32	3.33	**38**	100.4	24.4	**76**	168.8	99	**210**	410	304	**580**	1076	516	**960**	1760
-17.2	**1**	33.8	3.89	**39**	102.2	25.0	**77**	170.6	100	**212**	413	310	**590**	1094	521	**970**	1778
-16.7	**2**	35.6	4.44	**40**	104.0	25.6	**78**	172.4	104	**220**	428	316	**600**	1112	527	**980**	1796
-16.1	**3**	37.4	5.00	**41**	105.8	26.1	**79**	174.2	110	**230**	446	321	**610**	1130	532	**990**	1814
-15.6	**4**	39.2	5.56	**42**	107.6	26.7	**80**	176.0	116	**240**	464	327	**620**	1148	538	**1000**	1832
-15.0	**5**	41.0	6.11	**43**	109.4	27.2	**81**	177.8	121	**250**	482	332	**630**	1166			
-14.4	**6**	42.8	6.67	**44**	111.2	27.8	**82**	179.6	127	**260**	500	338	**640**	1184	1000 TO 1630		
-13.9	**7**	44.9	7.22	**45**	113.0	28.3	**83**	181.4	132	**270**	518	343	**650**	1202	538	**1000**	1832
-13.3	**8**	46.4	7.78	**46**	114.8	28.9	**84**	183.2	138	**280**	536	349	**660**	1220	543	**1010**	1850
-12.8	**9**	48.2	8.33	**47**	116.6	29.4	**85**	185.0	143	**290**	554	354	**670**	1238	549	**1020**	1868
-12.1	**10**	50.0	8.89	**48**	118.4	30.0	**86**	186.8	149	**300**	572	360	**680**	1256	554	**1030**	1886
-11.7	**11**	51.8	9.44	**49**	120.0	30.6	**87**	188.6	154	**310**	590	366	**690**	1274	560	**1040**	1904
-11.1	**12**	53.6	10.0	**50**	122.0	31.1	**88**	190.4	160	**320**	608	371	**700**	1292	566	**1050**	1922
-10.6	**13**	55.4	10.6	**51**	123.8	31.7	**89**	192.2	166	**330**	626	377	**710**	1310	571	**1060**	1940
-10.0	**14**	57.2	11.1	**52**	125.6	32.2	**90**	194.0	171	**340**	644	382	**720**	1328	577	**1070**	1958
-9.44	**15**	59.0	11.7	**53**	127.4	32.8	**91**	195.8	177	**350**	662	388	**730**	1346	582	**1080**	1976
-8.89	**16**	60.8	12.2	**54**	129.2	33.3	**92**	197.6	182	**360**	680	393	**740**	1364	588	**1090**	1994
-8.33	**17**	62.6	12.8	**55**	131.0	33.9	**93**	199.4	188	**370**	698	399	**750**	1382	593	**1100**	2012
-7.78	**18**	64.4	13.3	**56**	132.8	34.4	**94**	201.2	193	**380**	716	404	**760**	1400	599	**1110**	2030
-7.22	**19**	66.2	13.9	**57**	134.6	35.0	**95**	203.0	199	**390**	734	410	**770**	1418	604	**1120**	2048
-6.67	**20**	68.0	14.4	**58**	136.4	35.6	**96**	204.8	204	**400**	752	416	**780**	1436	610	**1130**	2066
-6.11	**21**	69.8	15.0	**59**	138.2	36.1	**97**	206.6	210	**410**	770	421	**790**	1454	816	**1500**	2732
-5.56	**22**	71.6	15.6	**60**	140.0	36.7	**98**	208.4	216	**420**	788	427	**800**	1472	821	**1510**	2750
-5.00	**23**	73.4	16.1	**61**	141.8	37.2	**99**	210.2	221	**430**	806	432	**810**	1490	827	**1520**	2768
-4.44	**24**	75.2	16.7	**62**	143.6	37.8	**100**	212.0	227	**440**	824	438	**820**	1508	832	**1530**	2786
-3.89	**25**	77.0	17.2	**63**	145.4				232	**450**	842	443	**830**	1526	838	**1540**	2804
-3.33	**26**	78.8	17.8	**64**	147.2	100 TO 1000			238	**460**	860	449	**840**	1544	843	**1550**	2822
-2.78	**27**	80.6	18.3	**65**	149.0	38	**100**	212	243	**470**	878	454	**850**	1562	849	**1560**	2840
-2.22	**28**	82.4	18.9	**66**	150.8	43	**110**	230	249	**480**	896	460	**860**	1580	854	**1570**	2858
-1.67	**29**	84.2	19.4	**67**	152.6	49	**120**	248	254	**490**	914	466	**870**	1598	860	**1580**	2876
-1.11	**30**	86.0	20.0	**68**	154.4	54	**130**	266	260	**500**	932	471	**880**	1616	866	**1590**	2894
-0.56	**31**	87.8	20.6	**69**	156.2	60	**140**	284	266	**510**	950	477	**890**	1634	871	**1600**	2912
0	**32**	89.6	21.1	**70**	158.0	66	**150**	302	271	**520**	968	482	**900**	1652	877	**1610**	2930
0.56	**33**	91.4	21.7	**71**	159.8	71	**160**	320	277	**530**	986	488	**910**	1670	882	**1620**	2948
1.11	**34**	93.2	22.2	**72**	161.6	77	**170**	338	282	**540**	1004	493	**920**	1688	888	**1630**	2966
1.67	**35**	95.0	22.8	**73**	163.4	82	**180**	356	288	**550**	1022	499	**930**	1706			
2.22	**36**	96.8	23.3	**74**	165.2	88	**190**	374	293	**560**	1040	504	**940**	1724			

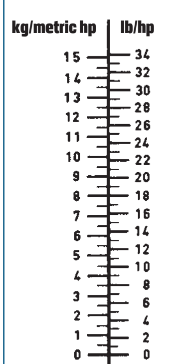
Note: The numbers in **bold** face type refer to the temperature either in degrees Centigrade or Fahrenheit which is desired to convert into the other scale. If converting from Fahrenheit degrees to Centigrade degrees, the equivalent temperatures will be found in the left column; while if converting from degrees Centigrade to degrees Fahrenheit, the answer will be found in the column on the right.

KILOGRAMS (kg) TO POUNDS (lb)
(1 kilogram = 2.20462 pounds)

kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
1	2.204	21	46.297	41	90.390	61	134.482	81	178.574
2	4.409	22	48.502	42	92.594	62	136.687	82	180.779
3	6.614	23	50.706	43	94.799	63	138.891	83	182.984
4	8.819	24	52.911	44	97.003	64	141.096	84	185.188
5	11.023	25	55.116	45	99.208	65	143.300	85	187.393
6	13.228	26	57.320	46	101.413	66	145.505	86	189.598
7	15.432	27	59.525	47	103.617	67	147.710	87	191.802
8	17.637	28	61.729	48	105.822	68	149.914	88	194.007
9	19.843	29	63.934	49	108.026	69	152.119	89	196.211
10	22.046	30	66.139	50	110.231	70	154.324	90	198.416
11	24.251	31	66.343	51	112.436	71	156.528	91	200.621
12	26.455	32	70.548	52	114.640	72	158.733	92	202.825
13	28.660	33	72.753	53	116.845	73	160.937	93	205.030
14	30.865	34	74.957	54	119.050	74	163.142	94	207.235
15	33.069	35	77.162	55	121.254	75	165.347	95	209.439
16	35.274	36	79.366	56	123.459	76	167.551	96	211.644
17	37.479	37	81.571	57	125.663	77	169.756	97	213.848
18	39.683	38	83.776	58	127.868	78	171.961	98	216.053
19	41.888	39	85.980	59	130.073	79	174.165	99	218.258
20	44.093	40	88.185	60	132.277	80	176.370	100	220.462

WEIGHT/HORSEPOWER CONVERSION FACTORS

1 kg/metric hp = 2.235 lb./hp
1 lb/hp = .4474 kg/metric hp



The system outlined here is the International System of Units (Systeme International d' Unites), for which the abbreviation SI is being used in all languages.

The SI system, which is becoming universally used, is founded on seven base units, these being:

Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	Kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

POWER

The derived SI unit for power is the Watt (W), this being based on the SI unit of work, energy and quantity of heat – the Joule (J). One Watt (1 W) is equal to one Joule per second (1 J/s). One Watt is a very small unit of power, being equivalent to just 0.00134102 horsepower, so for engine ratings the kilowatt (kW) is used, 1 kW being equal to 1.341 hp and 1 hp being the equivalent of 0.7457 kW. The British unit of horsepower is equal to 1.014 metric horsepower (CV, PS, PK, etc.).

1 kW = 1.341 hp = 1.360 metric hp
1 hp = 0.746 kW = 1.014 metric hp
1 metric hp = 0.735 kW = 0.986 hp

TORQUE

The derived SI unit for torque (or moment of force) is the Newton meter (Nm), this being based on the SI unit of force — the Newton (N) – and the SI unit of length – the meter (m). One Newton (1 N) is equivalent to 0.2248 pound-force (lbf) or 0.10197 kilogram-force (kgf), and one meter is equal to kilogram force (kgf) and one member is equal to 3.28084 feet (ft), so one Newton meter (1 N m) is equal to 0.737562 pound-force (lbf ft). or 0.101972 kilogram-force meter (kgf m).

1 Nm = 0.738 lbf ft = 0.102 kgf m
1 lbf ft = 1.356 Nm = 0.138 kgf m
1 kgf m = 9.807 Nm = 7.233 lbf ft

PRESSURE AND STRESS

Although it has been decided that the SI derived unit for pressure and stress should be the Pascal (Pa), this is a very small unit, being the same as one Newton per square meter (1 N/m^2), which is only 0.000145 lbf/in^2 or 0.0000102 kgf/cm^2. So many European engine designers favor the bar as the unit of pressure, one bar being 100,000 Pascal (100 kPa), which is the equivalent of 14,504 lbf/in^2 or 1.020 kgf/cm^2, so being virtually the same as the currently accepted metric equivalent. On the other hand, for engine performance purposes, the millibar seems to be favored to indicate barometric pressure, this unit being one thousandth of a bar. Then again, there is a school that favors the kiloNewton per square meter (kN/m^2), this being the same as a kilopascal, and equal to 0.145 lbf/in^2 or 0.0102 kgf/cm^2.

1 bar = 14.5 lbf/in^2 = 1.0197 kgf/cm^2
1 lbf/in^2 = 0.069 bar
1 kgf/cm^2 = 0.98 bar

The American Society of Mechanical Engineers in 1973 published its Performance Test Codes for Reciprocating Internal Combustion engines. Known as PTC 17, this code is intended for tests of all types of reciprocating internal combustion engines for determining power output and fuel consumption. In its Section 2, Description and Definition of Terms, both the FPS and corresponding SI units of meas-urements are given.

SPECIFIC CONSUMPTION

Fuel consumption measurements will be based on the currently accepted unit, the gram (g), and the Kilowatt Hour (kWh). Also adopted is heat units/power units so that energy consumption of an internal combustion engine referred to net power output, mechanical, is based on low unsaturated heat value of the fuel whether liquid or gaseous type. Thus the SI unit of measurement for net specific energy consumption is expressed: g/kWh.

1 g/kWh = 0.001644 lb/hph =
0.746 g/hph = 0.736 g/metric hph
1 lb/hph = 608.3 g/kWh
1 g/hph = 1.341 k/kWh
1 g/metric hph = 1.36 g/kWh

HEAT RATE

Heat Rate is a product of Lower Heating Value (LHV) of Fuel (measured in Btu/lb or kJ/g for liquid fuel and Btu/ft^3 or kJ/m^3 for gas fuel) multiplied times (sfc) specific fuel consumption (measured in lb/hph or g/kWh).

For Liquid Fuel
Heat Rate (Btu/hph) = LVH (Btu/lb) X sfc (lb/hph)

For Gaseous Fuel
Heat Rate (Btu/hph) = LVH (Btu/ft^3) X sfc (ft^3/hph)

To convert these units to SI units:
Btu/hph X 1.414 = kJ/kWh
Or
Btu/kWh X 1.055 = kJ/kWh

LUBRICATING-OIL CONSUMPTION

Although the metric liter is not officially an SI unit, its use will continue to be permitted, so measurement of lube-oil consumption will be quoted in liters per hour (liters/h).

1 liter/h = 0.22 Imp gal/h
1 Imp gal/h = 4.546 liters/h

TEMPERATURES

The SI unit of temperature is Kelvin (K), and the character is used without the degree symbol (°) normally employed with other scales of temperature. A temperature of zero degree Kelvin is equivalent to a temperature of -273.15°C on the Celsius (centigrade) scale. The Kelvin unit is identical in interval to the Celsius unit, so direct conversions can be made by adding or subtracting 273. Use of Celsius is still permitted.

0 K = 273°C; absolute zero K
1°C = 273 K

WEIGHTS AND LINEAR DIMENSIONS

For indications of "weight" the original metric kilogram (kg) will continue to be used as the unit of mass, but it is important to note that the kilogram will no longer apply for force, for which the SI unit is the Newton (N), which is a kilogram meter per second squared. The Newton is that force which, when applied to a body having a mass of one kilogram, gives it an acceleration of one meter per second squared.

"Weight" in itself will no longer apply, since this is an ambiguous term, so the kilogram in effect should only be used as the unit of mass. Undoubtedly, though, it will continue to be common parlance to use the word "weight" when referring to the mass of an object.

The base SI unit for linear dimensions will be the meter, with a wide range of multiples and sub-multiples ranging from exa (10^{18}) to atto (10^{-18}): A kilometer is a meter x 10^3, for example, while a millimeter is a meter x 10^{-3}.

To give an idea of how currently used units convert to SI units, the tables below give examples.

KILOWATTS (kW) TO HORSEPOWER (hp)
(1 Kw = 1.34102 hp)

kW	hp	kW	hp	kW	hp	kW	hp	kW	hp
1	1.341	21	28.161	41	54.982	61	81.802	81	108.623
2	2.682	22	29.502	42	56.323	62	83.143	82	109.964
3	4.023	23	30.843	43	57.664	63	84.484	83	111.305
4	5.364	24	32.184	44	59.005	64	85.825	84	112.646
5	6.705	25	33.526	45	60.346	65	87.166	85	113.987
6	8.046	26	34.867	46	61.687	66	88.507	86	115.328
7	9.387	27	36.208	47	63.028	67	89.848	87	116.669
8	10.728	28	37.549	48	64.369	68	91.189	88	118.010
9	12.069	29	38.890	49	65.710	69	92.530	89	119.351
10	13.410	30	40.231	50	67.051	70	93.871	90	120.692
11	14.751	31	41.572	51	68.392	71	95.212	91	122.033
12	16.092	32	42.913	52	69.733	72	96.553	92	123.374
13	17.433	33	44.254	53	71.074	73	97.894	93	124.715
14	18.774	34	45.595	54	72.415	74	99.235	94	126.056
15	20.115	35	46.936	55	73.756	75	100.577	95	127.397
16	21.456	36	48.277	56	75.097	76	101.918	96	128.738
17	22.797	37	49.618	57	76.438	77	103.259	97	130.079
18	24.138	38	50.959	58	77.779	78	104.600	98	131.420
19	25.479	39	52.300	59	79.120	79	105.941	99	132.761
20	26.820	40	53.641	60	80.461	80	107.282	100	134.102

POUNDS FORCE FEET (lbf ft) TO NEWTON METERS (Nm)
(1 lbf ft = 1.35582 Nm)

lbf ft	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft	Nm	lbf ft	Nm
1	1.356	21	28.472	41	55.589	61	82.705	81	109.821
2	2.712	22	29.828	42	56.944	62	84.061	82	111.177
3	4.067	23	31.184	43	58.300	63	85.417	83	112.533
4	5.423	24	32.540	44	59.656	64	86.772	84	113.889
5	6.779	25	33.896	45	61.012	65	88.128	85	115.245
6	8.135	26	35.251	46	62.368	66	89.484	86	116.601
7	9.491	27	36.607	47	63.724	67	90.840	87	117.956
8	10.847	28	37.963	48	65.079	68	92.196	88	119.312
9	12.202	29	39.319	49	66.435	69	93.552	89	120.668
10	13.558	30	40.675	50	67.791	70	94.907	90	122.024
11	14.914	31	42.030	51	69.147	71	96.263	91	123.380
12	16.270	32	43.386	52	70.503	72	97.619	92	124.715
13	17.626	33	44.742	53	71.808	73	98.975	93	126.001
14	18.981	34	46.098	54	73.214	74	100.331	94	127.447
15	20.337	35	47.454	55	74.570	75	101.687	95	128.803
16	21.693	36	48.810	56	75.926	76	103.042	96	130.159
17	23.049	37	50.165	57	77.282	77	104.398	97	131.515
18	24.405	38	51.521	58	78.638	78	105.754	98	132.870
19	25.761	39	52.877	59	79.993	79	107.110	99	134.226
20	27.116	40	54.233	60	81.349	80	108.466	100	135.582

These tables are reproduced from the booklet "Vehicle Metrics" published by Transport and Distribution Press Ltd., 118 Ewell Road, Surbiton, Surry, KT6 6HA England.

PRODUCT DIRECTORY & BUYER'S GUIDE

A

ACTUATORS

Electric Actuators

Heinzmann GmbH & Co. KG .... CONTROLS TAB, 335, 342

Hydraulic Actuators

Heinzmann GmbH & Co. KG .... CONTROLS TAB, 335, 342

Solenoid Actuators

Heinzmann GmbH & Co. KG .... CONTROLS TAB, 335, 342

ADDITIVES

Diesel Fuel Additives

Parker Hannifin Corporation, Racor Division 37

AIR CLEANERS

Air Cleaners

Parker Hannifin Corporation, Racor Division 37

ALTERNATORS

Alternators

Cummins Generator Technologies 260
Mecc Alte UK Limited 264
Nidec - Kato Engineering & Leroy-Somer 262

Battery Charging Alternators

Nidec - Kato Engineering & Leroy-Somer 262

Generating Sets Alternators

Ansaldo Energia 238
Cummins Generator Technologies 260
Lister Petter Power Systems Ltd 170
Nidec - Kato Engineering & Leroy-Somer 262

ANALYSIS SYSTEMS

Analysis Systems

AVAT Automation GmbH 344

AXLES

Drive Axles

John Deere Power Systems 178
MAN Truck & Bus AG 173

Planetary Axles

John Deere Power Systems 178
MAN Truck & Bus AG 173

Steering Axles

MAN Truck & Bus AG 173

Tandem Axles

MAN Truck & Bus AG 173

Trailer Axles

MAN Truck & Bus AG 173

B

BLENDERS

Fuel/Lube Blenders

Parker Hannifin Corporation, Racor Division 37

BOILERS

Heat Recovery Boilers

Siemens Energy Global GmbH & Co. KG 243

BRAKES, BRAKE COMPONENTS

Air Dryers For Braking Systems

Parker Hannifin Corporation, Racor Division 37

Hydraulic Brakes

TRANSFLUID S.p.A. 316

C

CASTINGS MATERIALS

Drive Components Castings

Impro Industries USA, Inc. 278, 282, 290

Engine Components Castings

Impro Industries USA, Inc. 278, 282, 290

Turbine Components Castings

Impro Industries USA, Inc. 278, 282, 290

CLUTCHES AND CLUTCH COMPONENTS

Air Actuated Clutches

TRANSFLUID S.p.A. 316

Electrical Clutches

jbj Techniques Limited 300, 318

Hydraulic Clutches

jbj Techniques Limited 300, 318
TRANSFLUID S.p.A. 316

Marine Clutches

jbj Techniques Limited 300, 318

Multiple Disc Clutches

jbj Techniques Limited 300, 318

Spring Loaded Clutches

jbj Techniques Limited 300, 318

Wet Clutches

jbj Techniques Limited 300, 318

COGENERATION SYSTEMS

Cogeneration Controls

AVAT Automation GmbH 344

Cogeneration Systems

AVAT Automation GmbH 344
INNIO Jenbacher GmbH & Co OG 211
MTU Friedrichshafen GmbH .... INSIDE FRONT COVER, 217, 269
Nidec - Kato Engineering & Leroy-Somer 262
Solar Turbines Incorporated .... GAS TURBINE TAB, 268, 273

Service Cogeneration Systems

AVAT Automation GmbH 344
INNIO Jenbacher GmbH & Co OG 211
Solar Turbines Incorporated .... GAS TURBINE TAB, 268, 273

COMPONENT MANUFACTURING

Aluminum Components

jbj Techniques Limited 300, 318

Component Manufacturing

Impro Industries USA, Inc. 278, 282, 290
jbj Techniques Limited 300, 318

COMPRESSORS AND COMPRESSOR SETS

CONTROLS

CONVERTERS

COOLERS AND COOLING SYSTEMS

Gas Filters
Parker Hannifin Corporation,
Racor Division....37
Gas Turbines Filter Houses
Parker Hannifin Corporation,
Racor Division....37
Lube Filter Elements
Parker Hannifin Corporation,
Racor Division....37
Lube Filters
Cummins Inc.
....INSIDE BACK COVER, 167, 169
Parker Hannifin Corporation,
Racor Division....37

FIRE PROTECTION SYSTEMS & COMPONENTS

Fire Protection Systems & Components
Nova Werke AG....333

FORGINGS

Engine Components Forgings
Maschinenfabrik Alfing Kessler GmbH....288

FUEL & LUBE SYSTEMS

Oil Analysis
Parker Hannifin Corporation,
Racor Division....37
Oil Mist Detectors
Heinzmann GmbH & Co. KG
.... CONTROLS TAB, 335, 342
Oil Replenishment System
Parker Hannifin Corporation,
Racor Division....37
Oil-Water Separators
Parker Hannifin Corporation,
Racor Division....37

FUEL INJECTION

Circulation Valves Fuel Injection
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Common Rail Systems Fuel Injection
Heinzmann GmbH & Co. KG
.... CONTROLS TAB, 335, 342
Liebherr-Components AG.... 202, 299, 320
Nova Werke AG....333
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Woodward L'Orange GmbH....327
Distributor Fuel Injection Pumps
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Fuel Injection Control
Heinzmann GmbH & Co. KG
.... CONTROLS TAB, 335, 342
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Woodward L'Orange GmbH....327
Fuel Injection Nozzle Holders
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Woodward L'Orange GmbH....327
Fuel Injection Nozzles
Heinzmann GmbH & Co. KG
.... CONTROLS TAB, 335, 342
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Woodward L'Orange GmbH....327
Fuel Injection Plungers & Barrels
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Woodward L'Orange GmbH....327
Fuel Injection Timing Sensors
Heinzmann GmbH & Co. KG
.... CONTROLS TAB, 335, 342
Fuel Injection Tubing
Nova Werke AG....333
Fuel Pumps, Electronic
Heinzmann GmbH & Co. KG
.... CONTROLS TAB, 335, 342
High-Pressure Common Rail Pumps Fuel
Heinzmann GmbH & Co. KG
.... CONTROLS TAB, 335, 342
Woodward L'Orange GmbH....327
Integrated Unit Pump & Injector
Woodward L'Orange GmbH....327
Multiplunger Fuel Injection Pumps
Woodward L'Orange GmbH....327
Pressure Pipes Fuel Injection
Nova Werke AG....333
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Rail Fuel
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Service, Fuel Injection Nozzles
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Woodward L'Orange GmbH....327
Service, Fuel Injection Pumps
Woodward L'Orange GmbH....327
Single-Plunger Fuel Injection Pumps
Woodward L'Orange GmbH....327
Suction & Delivery Valves Fuel Injection
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Woodward L'Orange GmbH....327
Unit-Type Fuel Injectors
O.M.T. Officine Meccaniche
Torino S.p.A. ....FUEL INJECTION TAB, 323
Woodward L'Orange GmbH....327

G

GAS TURBINES AND COMPONENTS

Gas Turbine-Driven Compressor Sets
Solar Turbines Incorporated
....GAS TURBINE TAB, 268, 273
Gas Turbines
Ansaldo Energia....238
Daihatsu Diesel Mfg. Co. Ltd.....214, 245
MAN Energy Solutions SE....206
Siemens Energy Global GmbH
& Co. KG....243
Solar Turbines Incorporated
....GAS TURBINE TAB, 268, 273
YANMAR POWER TECHNOLOGY CO., LTD
.... 175, 177

GEARS AND GEAR SYSTEMS

Gearboxes
Liebherr-Components AG.... 202, 299, 320

GENERATOR SETS

Combined-Cycle Generator Sets
Ansaldo Energia....238
Siemens Energy Global GmbH
& Co. KG....243

GENERATORS

GOVERNORS

H

HEAT EXCHANGERS

HEAT RECOVERY SYSTEMS/ EQUIPMENT

HEATERS

HYDRAULIC COMPONENTS

I

INDICATORS

INSTRUMENTATION

M

MARINE PROPULSION SYSTEMS

Diesel Marine Propulsion Systems

ABC - Anglo Belgian Corporation N.V. ...218
Cummins Inc. ...INSIDE BACK COVER, 167, 169
John Deere Power Systems ...178
Lister Petter Power Systems Ltd ...170
MTU Friedrichshafen GmbH ...INSIDE FRONT COVER, 217, 269

Electric Marine Propulsion Systems

MTU Friedrichshafen GmbH ...INSIDE FRONT COVER, 217, 269
Nidec - Kato Engineering & Leroy-Somer ...262

Gas Turbine Marine Propulsion Systems

MAN Energy Solutions SE ...206
MTU Friedrichshafen GmbH ...INSIDE FRONT COVER, 217, 269

MEASURING EQUIPMENT

Measuring Equipment

AVAT Automation GmbH ...344

MONITORING, MONITORS

Compressor Systems Monitors

MAN Energy Solutions SE ...206

Engine System Monitors

AVAT Automation GmbH ...344
DEUTZ AG ...183

Fuel Systems Monitors

Parker Hannifin Corporation, Racor Division ...37

Monitoring

Heinzmann GmbH & Co. KG ...CONTROLS TAB, 335, 342
Siemens Energy Global GmbH & Co. KG ...243

Temperature Monitors

Parker Hannifin Corporation, Racor Division ...37

MOTORS

Electric Motors

Heinzmann GmbH & Co. KG ...CONTROLS TAB, 335, 342
Liebherr-Components AG ...202, 299, 320
Nidec - Kato Engineering & Leroy-Somer ...262
Siemens Energy Global GmbH & Co. KG ...243

Explosion-Proof Motors

jbj Techniques Limited ...300, 318
Nidec - Kato Engineering & Leroy-Somer ...262

Generator Sets Motors

INNIO Jenbacher GmbH & Co OG ...211

Hydraulic Motors

jbj Techniques Limited ...300, 318
Liebherr-Components AG ...202, 299, 320

Wheel Motors

Heinzmann GmbH & Co. KG ...CONTROLS TAB, 335, 342

P

PACKAGES

Engine Compressor Packages

MAN Energy Solutions SE ...206
Solar Turbines Incorporated ...GAS TURBINE TAB, 268, 273
MAN Energy Solutions SE ...206
MTU Friedrichshafen GmbH ...INSIDE FRONT COVER, 217, 269
Solar Turbines Incorporated ...GAS TURBINE TAB, 268, 273

PISTONS, COMPONENTS

Pistons

KS Kolbenschmidt GmbH ...284

POWER GENERATION EQUIPMENT

Power Generation Equipment

Cummins Generator Technologies ...260
Doosan Infracore Co. Ltd. Engine BG ...222
INNIO Waukesha Gas Engines Inc. ...211
Nidec - Kato Engineering & Leroy-Somer ...262
Siemens Energy Global GmbH & Co. KG ...243
Solar Turbines Incorporated ...GAS TURBINE TAB, 268, 273

Power Transfer Systems

Cummins Inc. ...INSIDE BACK COVER, 167, 169

Power-to-X

MAN Energy Solutions SE ...206
MTU Friedrichshafen GmbH ...INSIDE FRONT COVER, 217, 269
Siemens Energy Global GmbH & Co. KG ...243

POWER PLANTS

Combined-Cycle Power Plants

Ansaldo Energia ...238
AVAT Automation GmbH ...344
MAN Energy Solutions SE ...206
Siemens Energy Global GmbH & Co. KG ...243
Solar Turbines Incorporated ...GAS TURBINE TAB, 268, 273

Diesel/Gas Engine Power Plants

ABC - Anglo Belgian Corporation N.V. ...218
MAN Energy Solutions SE ...206

Gas Turbine Power Plants

Ansaldo Energia ...238
MAN Energy Solutions SE ...206
Siemens Energy Global GmbH & Co. KG ...243
Solar Turbines Incorporated ...GAS TURBINE TAB, 268, 273

Turnkey Operations Power Plants

ABC - Anglo Belgian Corporation N.V. ...218
Ansaldo Energia ...238
Siemens Energy Global GmbH & Co. KG ...243
Solar Turbines Incorporated ...GAS TURBINE TAB, 268, 273

POWER TAKE-OFFS

Power Take-offs

jbj Techniques Limited ...300, 318
TRANSFLUID S.p.A. ...316

PUMP SETS

Diesel-Driven Pump Sets

ABC - Anglo Belgian Corporation N.V. ...218

PUMPS

R

REGULATORS

RESEARCH & DEVELOPMENT

S

SENSORS

SERVICE SYSTEMS & TRAINING

SERVICE TOOLS & EQUIPMENT

SERVICES

Design Begins Here

EMISSIONS

INCLUDING: **Emissions reference guide & standards**

SPONSORED BY:

DieselNet.com

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

Design Begins Here

EMISSIONS

INCLUDING: **Emissions reference guide & standards**

SPONSORED BY:

DieselNet.com

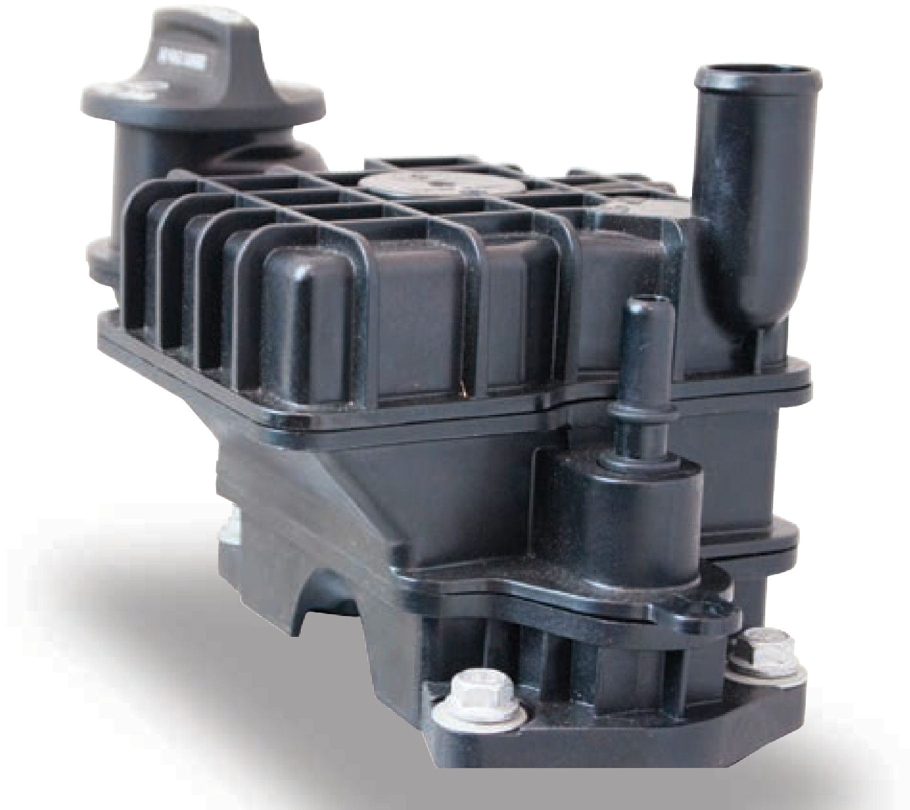
POWER SOURCING GUIDE 2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS DPI DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

khl



Emissions Reference Guide & Standards:
Table Of Contents

DieselNet

Produced in cooperation with: www.DieselNet.com

Emissions Standards: U.S.A.

On-Highway Diesel Truck And Bus Engines

Applicability and Test Cycles

The emission standards discussed here apply to new engines used in heavy-duty on-road (highway) vehicles, such as trucks and buses. These standards apply to diesel fueled engines, as well as to compression-ignition (CI) engines fueled by natural gas and other alternative fuels.

Heavy-duty vehicles are defined as vehicles of GVWR (gross vehicle weight rating) of above 8,500 lbs in the federal jurisdiction and above 14,000 lbs in California (model year 1995 and later). Diesel engines used in heavy-duty vehicles are further divided into service classes by GVWR, as follows.

- Light heavy-duty diesel engines: 8,500 < LHDDE < 19,500 (14,000 < LHDDE < 19,500 in California, 1995+).
- Medium heavy-duty diesel engines: 19,500 ≤ MHDDE ≤ 33,000.
- Heavy heavy-duty diesel engines (including urban bus): HHDDE > 33,000.

Under the federal light-duty Tier 2 regulation vehicles of GVWR up to 10,000 lbs used for personal transportation have been re-classified as “medium-duty passenger vehicles” (MDPV - primarily larger SUVs and passenger vans) and are subject to the light-duty vehicle legislation. Therefore, the same diesel engine model used for the 8,500-10,000 lbs vehicle category may be classified as either light- or heavy-duty and certified to different standards, depending on the application.

U.S. and California regulations do not require that complete heavy-duty diesel vehicles be chassis certified, instead requiring certification of their engines (as an option, complete heavy-duty diesel vehicles under 14,000 lbs can be chassis certified). Consequently, the basic standards are expressed in g/bhp-hr and require emissions testing over the Transient FTP engine dynamometer cycle (however, chassis certification may be required for complete heavy-duty gasoline vehicles with pertinent emissions standards expressed in g/mile).

Additional emissions testing requirements, phased in from 1998 to 2007, include:

- Supplemental Emissions Test (SET): A steady-state test to ensure that heavy-duty engine emissions are controlled during steady-state type driving. SET emissions limits are numerically equal to the FTP limits.
- Not-to-Exceed (NTE) testing: Driving of any type that could occur within the bounds of a pre-defined NTE control area, including operation under steady-state or transient conditions and under varying ambient conditions.

Emission Standards

The emission limits for heavy-duty engines were tightened in a number of steps, as shown in Table 1. The current mandatory emission standards for heavy-duty engines were phased-in over the period of 2007-2010. The table also covers the 2015 California Optional Low NOx Standards.

In addition to the limits shown, the following emission standards apply:

- Smoke Opacity—Smoke opacity limits of 20% / 15% / 50% at acceleration/lug/peak modes, respectively.
- Idle CO Standard—An idle CO emission standard of 0.5% applies to compression-ignition engines fueled by diesel fuel since 1988, by methanol since 1990, and by natural gas and LPG since 1994.

ABT Program. Since 1991, the emission regulations include

Table 1. US EPA & California Emission Standards for Heavy-Duty CI Engines g/bhp-hr)

Year	CO	HC[a]	HC[a]+NO_x	NO_x	PM	
					General	Urban Bus
1974	40	-	16	-	-	
1979	25	1.5	10	-	-	
1985	15.5	1.3	-	10.7	-	
1987	15.5	1.3	-	10.7[d]	0.60[f]	
1988	15.5	1.3[b]	-	10.7[d]	0.60	
1990	15.5	1.3[b]	-	6.0	0.60	
1991	15.5	1.3[c]	-	5.0	0.25	0.25[g]
1993	15.5	1.3[c]	-	5.0	0.25	0.10
1994	15.5	1.3[c]	-	5.0	0.10	0.07
1996	15.5	1.3[c]	-	5.0[e]	0.10	0.05[h]
1998	15.5	1.3	-	4.0	0.10	0.05[h]
2004[j]	15.5	-	2.4[i]	-	0.10	0.05[h]
1985	15.5	0.14[k]	-	0.20[k]	0.01	
1985	15.5	0.14	-	0.02[l]	0.01	

[a] - NMHC for 2004 and later standards
[b] - For methanol-fueled engines, the standard is for total hydrocarbon equivalent (THCE)
[c] - California: NMHC = 1.2 g/bhp-hr, in addition the THC limit
[d] - California: NOx = 6.0 g/bhp-hr
[e] - California: Urban bus NOx = 4.0 g/bhp-hr
[f] - California only, no federal PM limit
[g] - California standard 0.10 g/bhp-hr
[h] - In-use PM standard 0.07 g/bhp-hr
[i] - Alternative standard: NMHC+NOx = 2.5 g/bhp-hr and NHMC = 0.5 g/bhp-hr
[j] - Under the 1998 Consent Decrees, several manufacturers supplied 2004 compliant engines from October 2002
[k] - NOx and NHMC standards were phased-in on a percent-of-sales basis: 50% in 2007-2009 and 100% in 2010. Most manufacturers certified their 2007-2009 engines to a NOx limit of about 1.2 g/bhp-hr, based on a fleet average calculation
[l] - Optional. Manufacturers may choose to certify engines to the California Optional Low NOx Standards of 0.10, 0.05 or 0.02 g/bhp-hr

an emission averaging, banking, and trading (ABT) program for NOx and PM emissions, similar to those that have been a part of most US EPA emission control programs.

Model Year 1974-2003

Historically, the first sets of emission standards were adopted at the federal level beginning from 1974. Since 1987, California standards required on several occasions that PM and NOx emission limits be introduced in California. Some of the regulatory emission challenges of that period that required the development of new emission technologies were:

- **1991 PM emission standard of 0.25 g/bhp·hr.**
- **1994 PM emission standard of 0.10 g/bhp·hr.**
- **Gradual tightening of the NOx limit to 4 g/bhp·hr (1998).**

These challenges were generally met through in-cylinder emission control. However, the 1994 PM limit did trigger some usage of diesel oxidation catalysts, mostly on mechanically controlled heavy-duty engines. A sulfur limit of 500 ppm in diesel fuel became effective in October 1993 to enable the 1994 PM emission standard of 0.10 g/bhp·hr.

Optional Standards. Manufacturers could voluntarily certify engines to the Clean Fuel Fleet (CFF) emission standards shown in Table 2. It was a federal program that applied to 1998-2003 model year engines, both CI and SI, over 8,500 lbs GVWR.

Table 2. Clean Fuel Fleet Program for Heavy-Duty SI and CI Engines, g/bhp-hr

Category*	CO	$NMHC+NO_x$	PM	HCHO
LEV (Federal Fuel)		3.8		
LEV (California Fuel)		3.5		
ILEV	14.4	2.5		0.050
ULEV	7.2	2.5	0.05	0.025
ZLEV	0	0	0	0

* LEV - low emissions vehicle; ILEV - inherently low emissions vehicle; ULEV - ultra low emissions vehicle; ZEV - zero emissions vehicle

Model Year 2004-2006

The 2004 standards for heavy-duty engines—as adopted by the EPA in 1997 [EPA 1997]—were harmonized with California standards, with the intent that manufacturers could use a single engine or machine design for both markets. On-board diagnostic (OBD) requirements applicable to heavy-duty diesel engines and vehicles ≤ 14,000 lbs GVWR were phased-in from the 2005 through 2007 model years. Discharge of crankcase emissions was not allowed for any new 2004 or later model year engines, with the exception of turbocharged or supercharged diesel fueled engines. To achieve the 2004 emissions, most manufacturers introduced exhaust gas recirculation (EGR)—in many cases in conjunction with diesel oxidation catalysts—on heavy-duty diesel engines.

Consent Decrees. In October 1998, a court settlement was reached between the EPA, Department of Justice, California ARB and engine manufacturers (Caterpillar, Cummins, Detroit Diesel, Volvo, Mack Trucks/Renault and Navistar) over the issue of high NO_x emissions from heavy-duty diesel engines during certain driving modes. Since the early 1990's, the manufacturers used engine control software that caused engines to switch to a more fuel efficient (but higher NO_x) driving mode during steady highway cruising. The EPA considered this engine control strategy an illegal "emissions defeat device."

Provisions of the Consent Decree included civil penalties for engine manufacturers and requirements to allocate funds for pollution research; upgrading existing engines to lower NO_x emissions; supplemental emissions tests (steady-state) with a limit equal to the FTP standard and NTE limits of 1.25 x FTP (with the exception of Navistar); and meeting the 2004 emissions standards by October 2002, 15 months ahead of time.

In the aftermath of the Consent Decrees, California certifications for all model year 2005-2007 engines required SET testing and NTE limits of 1.25 Ч FTP standards. California also adopted more stringent standards for MY 2004-2006 engines for public urban bus fleets.

Model Year 2007 and Later

The EPA rule of December 21, 2000 [EPA 2001] included two components: (1) 2007 and later heavy-duty engine emission standards, and (2) diesel fuel regulations. The California ARB adopted virtually identical 2007 heavy-duty engine standards in October 2001. The emission standards included new, very stringent limits for PM (0.01 g/bhp·hr) and NOx (0.20 g/bhp·hr). The PM emission standard took full effect in 2007. The NOx standard was phased-in for diesel engines between 2007 and 2010. In the 2007-2009 period, most manufacturers opted to meet a NOx family emission limit (FEL) of around 1.2 g/bhp·hr for most of their engines. Because of this compliance path during the NOx limit phase-in period, engines produced during 2007-2009 were technologically very different from those required to comply in 2010 and later when all engines needed to comply with the 0.2 g/bhp-hr NOx limit. While it is common to refer to "2010 standards" in a way that implies they are different from "2007 standards", legally, there was not a standard for 2010 that differed from 2007.

Starting in 2007, manufacturers could choose to chassis certify complete heavy-duty diesel vehicles (HDV) with GVWR of 14,000 lb or less as an option to engine certification. Diesel engines thus certified were considered to be legally equivalent to a 0.20 g/bhp-hr NOx engine provided they met the 2008 Otto-cycle HDV limits (0.2 g/mile NOx and 0.02 g/mile PM for 8500 lb < GVWR ≤ 10000 lb and 0.4 g/mile NOx and 0.02 g/mile PM for 10000 lb < GVWR ≤ 14000 lb). After 2011, all manufacturers of complete HDVs with GVWR ≤ 14000 lb (primarily heavy pick-ups and utility vans) adopted this optional chassis certification approach because of the heavy-duty vehicle GHG regulations that came into effect for MY 2014.

In addition to the FTP testing, emission certification requirements include:

- SET test, with limits equal to the FTP standards.
- NTE limits of 1.5 Ч FTP standards (or 1.25 Ч FTP for engines with NOx FEL > 1.5 g/bhp·hr).

The diesel fuel regulation limited the sulfur content in on-highway diesel fuel to 15 ppm (wt.), down from the previous

500 ppm. The ULSD fuel has been introduced as a "technology enabler" to pave the way for sulfur-intolerant exhaust emission control technologies, such as catalytic diesel particulate filters and NOx catalysts.

Other Provisions. The 2007 emission standards and later amendments introduced a number of additional provisions:

- Crankcase Ventilation—Effective from 2007, the regulation maintains the earlier crankcase emission control exception for turbocharged heavy-duty diesel fueled engines but requires that if the emissions are discharged into the atmosphere, they be added to the exhaust emissions during all testing. The deterioration of crankcase emissions must also be accounted for in exhaust deterioration factors.
- DEF Refill Interval—For SCR-equipped heavy-duty diesel engines, a minimum DEF (urea solution) refill interval is defined as at least as far (in miles or hours) as the vehicle's fuel capacity [EPA 2014].
- Ammonia Emissions—While ammonia emissions are unregulated, the EPA recommends that ammonia slip should be below 10 ppm average over the applicable test cycles [EPA 2011].
- Emergency Vehicles—Heavy-duty engines in fire trucks, ambulances and other types of emergency vehicles can be equipped with an AECD to override performance inducements related to the emission control system.

California Optional Low NOx Standards. On October 21, 2014, California ARB adopted Optional Low NOx Standards for heavy-duty engines [CARB 2013]. Under the program, manufacturers may choose to certify their engines to three optional NOx emission standards: 0.10, 0.05 or 0.02 g/bhp·hr. Other pollutants must meet the conventional emission standards. Engine families certified to the optional NOx standards cannot be included in the ABT program for NOx. Instead, credits may be generated by an alternative mechanism proposed by the engine manufacturer and approved by the ARB.

Useful Life and Warranty Periods. Compliance with emissions standards has to be demonstrated over the useful life of the engine, which was adopted as follows (federal & California):

- LHDDE — 8 years/110,000 miles (whichever occurs first).
- MHDDE — 8 years/185,000 miles.
- HHDDE — 8 years/290,000 miles.

Federal useful life requirements were later increased to 10 years, with no change to the above mileage numbers, for the urban bus PM standard (1994+) and for the NO_x standard (1998+).

Useful Life: 2004+. The EPA established revised useful engine lives, with significantly extended requirements for the heavy heavy-duty diesel engine class, as follows:

- LHDDE—10 years/110,000 miles.
- MHDDE—10 years/185,000 miles.
- HHDDE—10 years/435,000 miles/22,000 hours.

Warranty. The mandatory emission warranty period is 5 years/100,000 miles (5 years/100,000 miles/3,000 hours in California), but no less than the basic mechanical warranty for the engine family. Since 2004, the federal warranty period for the LHDDE class has been reduced to 5 years/50,000 miles.

Emissions Standards: U.S.A.
Off-Highway Engines

Background

Tier 1-3 Standards. The first federal standards (Tier 1) for new nonroad (or off-road) diesel engines were adopted in 1994 for engines over 37 kW (50 hp), to be phased-in from 1996 to 2000. The 1998 regulation introduced Tier 1 standards for equipment under 37 kW (50 hp) and increasingly more stringent Tier 2 and Tier 3 standards for all equipment with phase-in schedules from 2000 to 2008. The Tier 1-3 standards are met through advanced engine design, with no or only limited use of exhaust gas aftertreatment (oxidation catalysts).

Tier 4 Standards. In 2004, the EPA signed the final rule introducing Tier 4 emissions standards, which were to be phased-in over the period of 2008-2015. The Tier 4 standards require that emissions of PM and NO_x be further reduced by about 90%.

Nonroad Diesel Fuel. At the Tier 1-3 stage, the sulfur content in nonroad diesel fuels was not limited. The oil industry specification was 0.5% (wt., max), with the average in-use sulfur level of about 0.3% = 3,000 ppm. To enable sulfur-sensitive control technologies in Tier 4 engines — such as catalytic particulate filters and NO_x adsorbers — the EPA mandated reductions in sulfur content in nonroad diesel fuels, as follows:

- 500 ppm effective June 2007 for nonroad, locomotive and marine (NRLM) diesel fuels;
- 15 ppm (ultra-low sulfur diesel) effective June 2010 for nonroad fuel, and June 2012 for locomotive and marine fuels.

California. In most cases, federal nonroad regulations also apply in California, whose authority to set emissions standards for new nonroad engines is limited. The federal Clean Air Act Amendments of 1990 (CAA) preempt California's authority to control emissions from new farm and construction equipment under 175 hp and require California to receive authorization from the federal EPA for controls over other off-road sources.

The U.S. nonroad emissions standards are harmonized to a certain degree with European nonroad emissions standards.

Applicability

The nonroad standards cover mobile *nonroad diesel engines* of all sizes used in a wide range of construction, agricultural and industrial equipment. The EPA definition of the *nonroad engine* is based on the principle of mobility/portability, and includes engines installed on (1) self-propelled equipment, (2) on equipment that is propelled while performing its function, or (3) on equipment that is portable or transportable, as indicated by the presence of wheels, skids, carrying handles, dolly, trailer, or platform. Nonroad engines are all internal combustion engines except motor vehicle (highway) engines, stationary engines (or engines that remain at one location for more than 12 months), engines used solely for competition, or engines used in aircraft. Effective May 14, 2003, the definition of nonroad engines was changed to also include all

Produced in cooperation with: www.DieselNet.com

diesel powered engines — including stationary ones — used in agricultural operations in California.

The nonroad diesel emissions regulations are not applicable to all nonroad diesel engines. Exempted are engines used in railway locomotives and marine vessels, both of which have their own regulations: engines used in underground mining equipment, which are regulated by the Mine Safety and Health Administration (MSHA); and hobby engines (below 50 cm^3 per cylinder).

A new definition of a compression-ignition (diesel) engine is used in the regulatory language since the 1998 rule. The definition focuses on the engine cycle, rather than the ignition mechanism, with the presence of a throttle as an indicator to distinguish between diesel-cycle and otto-cycle operation. Regulating power by controlling the fuel supply in lieu of a throttle corresponds with lean combustion and diesel-cycle operation. This language allows the possibility that a natural gas-fueled engine equipped with a sparkplug is considered a compression-ignition engine.

Tier 1-3 Emissions Standards

The 1998 nonroad engine regulations are structured as a 3-tiered progression. Each tier involves a phase in (by horsepower rating) over several years. Tier 1 standards were phased-in from 1996 to 2000. The more stringent Tier 2 standards take effect from 2001 to 2006, and yet more stringent Tier 3 standards phase-in from 2006 to 2008 (Tier 3 standards apply only for engines from 37-560 kW).

Tier 1-3 emissions standards are listed in Table 1. Nonroad regulations are in the metric system of units, with all standards expressed in grams of pollutant per kWh. Manufacturers who signed the 1998 Consent Decrees with the EPA may be required to meet the Tier 3 standards one year ahead of schedule (i.e. beginning in 2005).

Voluntary, more stringent emissions standards that manufacturers could use to earn a designation of "Blue Sky Series" engines (applicable to Tier 1-3 certifications) are listed in Table 2.

Engines of all sizes must also meet smoke standards of 20/15/50% opacity at acceleration/lug/peak modes, respectively.

The regulations include several other provisions, such as averaging, banking and trading of emissions credits and maximum "family emissions limits" (FEL) for emissions averaging.

Tier 4 Emissions Standards

The Tier 4 emissions standards — to be phased-in from 2008-2015 — introduce substantial reductions of NO_x (for engines above 56 kW) and PM (above 19 kW), as well as more stringent HC limits. CO emissions limits remain unchanged from the Tier 2-3 stage.

Engines up to 560 kW. Tier 4 emissions standards for engines up to 560 kW are listed in Table 3. In engines of 56-560 kW rated power, the NO_x and HC standards were phased-in over a few year period, as indicated in the notes to Table 3. The initial standards (PM compliance) are sometimes referred to as the 'interim Tier 4' (or 'Tier 4i'), 'transitional Tier 4' or 'Tier 4 A', while the final standards (NO_x/HC compliance) are sometimes referred to as 'Tier 4 B'.

As an alternative to introducing the required percentage of

Table 1. EPA Tier 1-3 Nonroad Diesel Engine Emissions Standards, g/kWh (g/bhp-hr)

Engine Power	Tier	Year	CO	HC	NMHC+NO_x	NO_x	PM
kW < 8 (hp < 11)	Tier 1	2000	8.0 (6.0)	-	10.5 (7.8)	-	1.0 (0.75)
	Tier 2	2005	8.0 (6.0)	-	7.5 (5.6)	-	0.8 (0.6)
8 ≤ kW < 19 (11 ≤ hp < 25)	Tier 1	2000	6.6 (4.9)	-	9.5 (7.1)	-	0.8 (0.6)
	Tier 2	2005	6.6 (4.9)	-	7.5 (5.6)	-	0.8 (0.6)
19 ≤ kW < 37 (25 ≤ hp < 50)	Tier 1	1999	5.5 (4.1)	-	9.5 (7.1)	-	0.8 (0.6)
	Tier 2	2004	5.5 (4.1)	-	7.5 (5.6)	-	0.6 (0.45)
37 ≤ kW < 75 (50 ≤ hp < 100)	Tier 1	1998	-	-	-	9.2 (6.9)	-
	Tier 2	2004	5.0 (3.7)	-	7.5 (5.6)	-	0.4 (0.3)
	Tier 3	2008	5.0 (3.7)	-	4.7 (3.5)	-	-†
75 ≤ kW < 130 (100 ≤ hp < 175)	Tier 1	1997	-	-	-	9.2 (6.9)	-
	Tier 2	2003	5.0 (3.7)	-	6.6 (4.9)	-	0.3 (0.22)
	Tier 3	2007	5.0 (3.7)	-	4.0 (3.0)	-	-†
130 ≤ kW < 225 (175 ≤ hp < 300)	Tier 1	1996	11.4 (8.5)	1.3 (1.0)	-	9.2 (6.9)	0.54 (0.4)
	Tier 2	2003	3.5 (2.6)	-	6.6 (4.9)	-	0.2 (0.15)
	Tier 3	2006	3.5 (2.6)	-	4.0 (3.0)	-	-†
225 ≤ kW < 450 (300 ≤ hp < 600)	Tier 1	1996	11.4 (8.5)	1.3 (1.0)	-	9.2 (6.9)	0.54 (0.4)
	Tier 2	2001	3.5 (2.6)	-	6.4 (4.8)	-	0.2 (0.15)
	Tier 3	2006	3.5 (2.6)	-	4.0 (3.0)	-	-†
450 ≤ kW < 560 (600 ≤ hp < 750)	Tier 1	1996	11.4 (8.5)	1.3 (1.0)	-	9.2 (6.9)	0.54 (0.4)
	Tier 2	2002	3.5 (2.6)	-	6.4 (4.8)	-	0.2 (0.15)
	Tier 3	2006	3.5 (2.6)	-	4.0 (3.0)	-	-†
kW ≥ 560 (hp ≥ 750)	Tier 1	2000	11.4 (8.5)	1.3 (1.0)	-	9.2 (6.9)	0.54 (0.4)
	Tier 2	2006	3.5 (2.6)	-	6.4 (4.8)	-	0.2 (0.15)

† Not adopted, engines must meet Tier 2 PM standard.

Table 2. EPA Voluntary Emissions Standards for Nonroad Diesel Engines, g/kWh (g/bhp-hr)

Rated Power (kW)	NMHC+NO_x	PM
kW < 8	4.6 (3.4)	0.48 (0.36)
8 ≤ kW <19	4.5 (3.4)	0.48 (0.36)
19 ≤ kW <37	4.5 (3.4)	0.36 (0.27)
37 ≤ kW < 75	4.7 (3.5)	0.24 (0.18)
75 ≤ kW <130	4.0 (3.0)	0.18 (0.13)
130 ≤ kW < 560	4.0 (3.0)	0.12 (0.09)
kW ≥ 560	3.8 (2.8)	0.12 (0.09)

Tier 4 compliant engines, manufacturers may certify all their engines to an *alternative NO_x limit* in each model year during the phase-in period. These alternative NO_x standards are:

- Engines 56-130 kW:
  - Option 1: NO_x = 2.3 g/kWh = 1.7 g/bhp-hr (Tier 2 credits used to comply, MY 2012-2013).
  - Option 2: NO_x = 3.4 g/kWh = 2.5 g/bhp-hr (no Tier 2 credits claimed, MY 2012-2014).
- Engines 130-560 kW: NO_x = 2.0 g/kWh = 1.5 g/bhp-hr (MY 2011-2013).

Table 3. Tier 4 Emissions Standards — Engines up to 560 kW, g/kWh (g/bhp-hr)

Engine Power	Year	CO	NMHC	NMHC+NO_x	NO_x	PM
kW < 8 (hp < 11)	2008	8.0 (6.0)	-	7.5 (5.6)	-	0.4[a] (0.3)
8 ≤ kW < 19 (11 ≤ hp < 25)	2008	6.6 (4.9)	-	7.5 (5.6)	-	0.4 (0.3)
19 ≤ kW < 37 (25 ≤ hp < 50)	2008	5.5 (4.1)	-	7.5 (5.6)	-	0.3 (0.22)
	2013	5.5 (4.1)	-	4.7 (3.5)	-	0.03 (0.022)
37 ≤ kW < 56 (50 ≤ hp < 75)	2008	5.0 (3.7)	-	4.7 (3.5)	-	0.3[b] (0.22)
	2013	5.0 (3.7)	-	4.7 (3.5)	-	0.03 (0.022)
56 ≤ kW < 130 (75 ≤ hp < 175)	2012-2014[c]	5.0 (3.7)	0.19 (0.14)	-	0.40 (0.30)	0.02 (0.015)
130 ≤ kW ≤ 560 (175 ≤ hp ≤ 750)	2011-2014[d]	3.5 (2.6)	0.19 (0.14)	-	0.40 (0.30)	0.02 (0.015)

[a] - hand-startable, air-cooled, DI engines may be certified to Tier 2 standards through 2009 and to an optional PM standard of 0.6 g/kWh starting in 2010
[b] - 0.4 g/kWh (Tier 2) if manufacturer complies with the 0.03 g/kWh standard from 2012
[c] - PM/CO: full compliance from 2012; NO_x/HC: Option 1 (if banked Tier 2 credits used)—50% engines must comply in 2012-2013; Option 2 (if no Tier 2 credits claimed)—25% engines must comply in 2012-2014, with full compliance from 2014.12.31
[d] - PM/CO: full compliance from 2011; NO_x/HC: 50% engines must comply in 2011-2013

Engines Above 560 kW. Tier 4 emissions standards for engines above 560 kW are listed in Table 4. The 2011 standards are sometimes referred to as 'transitional Tier 4', while the 2015 limits represent final Tier 4 standards.

Table 4. Tier 4 Emissions Standards — Engines Above 560 kW, g/kWh (g/bhp-hr)

Year	Category	CO	NMHC	NO_x	PM
2011	Generator sets > 900 kW	3.5 (2.6)	0.40 (0.30)	0.67 (0.50)	0.10 (0.075)
	All engines except gensets > 900 kW	3.5 (2.6)	0.40 (0.30)	3.5 (2.6)	0.10 (0.075)
2015	Generator sets	3.5 (2.6)	0.19 (0.14)	0.67 (0.50)	0.03 (0.022)
	All engines except gensets	3.5 (2.6)	0.19 (0.14)	3.5 (2.6)	0.04 (0.03)

Other Provisions. The Tier 4 regulation and later amendments include a number of additional provisions.

- Smoke Opacity—Existing Tier 2-3 smoke opacity standards and procedures continue to apply in some engines. Exempted from smoke emission standards are engines certified to PM emission standards at or below 0.07 g/kWh.
- Crankcase Ventilation—The Tier 4 regulation does not require closed crankcase ventilation in nonroad engines. However, in engines with open crankcases, crankcase emissions must be measured and added to exhaust emissions in assessing compliance.
- DEF Refill Interval—For SCR-equipped nonroad diesel engines, a minimum DEF (urea solution) refill interval is defined as at least as long (in engine-hours) as the vehicle's fuel capacity.
- Ammonia Emissions—While ammonia emissions are unregulated, the EPA recommends that ammonia slip should be below 10 ppm average over the applicable test cycles.
- Emergency Operation—To facilitate the use of certain nonroad engines in temporary emergency situations, the engines can be equipped with an AECD to override performance inducements related to the emission control system. This flexibility is intended primarily for engines used in construction equipment and portable equipment used for temporary power generation and flood control.
- ABT Program—Similarly to earlier standards, the Tier 4 regulation includes such provisions as averaging, banking and trading of emission credits and FEL limits for emission averaging.

Transitional Period Flexibility

Nonroad emission regulations include flexibilities that allow equipment manufacturers to install exempted engines (i.e., those not required to meet applicable standards) during the transitional period to a more stringent tier of standards. Similar to the on-road regulations, manufacturers of nonroad equipment are allowed to use their engine inventory. While the exact engine quantities are not specified, it has been the EPA practice to allow the use of exempted engines for a three-month production period and—in some cases—beyond. Under the regulations, this provision may not be used to stockpile engines that were built before new standards take effect.

The Equipment Manufacturer Flexibility, also referred to as the Transition Program for Equipment Manufacturers (TPEM), allows equipment manufacturers to install a limited number of exempted engines during a seven-year period after the Tier 4 effective dates. During the seven-year period of the general availability of allowances, manufacturers are allowed to continue using Tier 3 engines after the Tier 4i standards become effective. If a manufacturer chooses not to use this flexibility (does not use any Tier 3 engines during the specified period), he is allowed the delayed availability of allowances. During the delayed allowances period, the manufacturer can use Tier 4i engines after the effective dates of the Tier 4 final standards. The general and delayed allowances periods cannot be combined. The maximum number of exempted engines allowed for an equipment manufacturer within the seven-year period is determined by one of two options:

- Percentage-of-Production Allowance—The number of units with exempted engines is calculated using a percentage of the total sales within each power category relative to the total US-directed production volume. The sum of these percentages within a power category during the seven-year period may not exceed 80%.

- Small-Volume Allowance—Alternatively, a specific number of exempted engines may be determined using one of the following approaches:
  - Up to 700 units with exempted engines within a power category during the seven-year period, with no more than 200 units in any single year within a power category. Exempted engines within a power category must be from a single engine family within a given year.
  - For engines below 130 kW, up to 525 units within a power category during the seven-year period, with no more than 150 units in any single year within a power category. For engines ≥ 130 kW, up to 350 units within a power category during the seven-year period, with no more than 100 units in any single year within a power category. Exemptions may apply to engines from multiple engine families in a given year.

Test Cycles and Fuels

Nonroad engine emissions are measured on a steady-state test cycle that is nominally the same as the ISO 8178 C1, 8-mode steady-state test cycle. Other ISO 8178 test cycles are allowed for selected applications, such as constant-speed engines (D2 5-mode cycle), variable-speed engines rated under 19 kW (G2 cycle), and marine engines (E3 cycle).

Transient Testing. Tier 4 standards have to be met over both the steady-state test and the nonroad transient cycle, NRTC. The transient testing requirements begin with MY 2013 for engines below 56 kW, in 2012 for 56-130 kW, and in 2011 for 130-560 kW engines. Engines above 560 kW are not tested on the transient test. Also constant-speed, variable-load engines of any power category are not subject to transient testing. The NRTC protocol includes a cold start test. The cold start emissions are weighted at 5% and hot start emissions are weighted at 95% in calculating the final result.

Tier 4 nonroad engines will also have to meet not-to-exceed standards (NTE), which are measured without reference to any specific test schedule. The NTE standards became effective in 2011 for engines above 130 kW; in 2012 for 56-130 kW; and in 2013 for engines below 56 kW. In most engines, the NTE limits are set at 1.25 times the regular standard for each pollutant (in engines certified to NO_x standards below 2.5 g/kWh or PM standards below 0.07 g/kWh, the NTE multiplier is 1.5). The NTE standards apply to engines at the time of certification, as well as in use throughout the useful life of the engine. The purpose of the added testing requirements is to prevent the possibility of "defeating" the test cycle by electronic engine controls and producing off-cycle emissions.

Certification Fuels. Fuels with sulfur levels no greater than 0.2 wt% (2,000 ppm) are used for certification testing of Tier 1-3 engines. From 2011, all Tier 4 engines will be tested using fuels of 7-15 ppm sulfur content.

A change from measuring total hydrocarbons to nonmethane hydrocarbons (NMHC) has been introduced in the 1998 rule. Since there is no standardized EPA method for measuring methane in diesel engine exhaust, manufacturers can either use their own procedures to analyze nonmethane hydrocarbons or measure total hydrocarbons and subtract 2% from the measured hydrocarbon mass to correct for methane.

Engine Useful Life

Emissions standards listed in the tables must be met over the entire useful life of the engine. EPA requires the application of deterioration factors (DFs) to all engines covered by the rule. The DF is a factor applied to the certification emissions test data to represent emissions at the end of the useful life of the engine. The engine useful life and the in-use testing liability period, as defined by the EPA for emissions testing purposes, are listed in Table 5 for different engine categories. The Tier 4 rule maintains the same engine useful life periods.

Table 5. Useful Life and Recall Testing Periods

Power Rating	Rated Engine Speed	Useful Life		Recall Testing Period	
		hours	years	hours	years
< 19 kW	all	3000	5	2250	4
19-37 kW	constant speed engines ≥ 3000 rpm	3000	5	2250	4
	all others	5000	7	3750	5
>37 kW	all	8000	10	6000	7

Environmental Benefit and Cost

1998 Regulation: At the time of signing the 1998 rule, the EPA estimated that by 2010 NOx emissions would be reduced by about a million tons per year, the equivalent of taking 35 million passenger cars off the road.

The costs of meeting the emission standards were expected to add under 1% to the purchase price of typical new nonroad diesel equipment, although for some equipment the standards may cause price increases on the order of 2-3%. The program was expected to cost about $600 per ton of NOx reduced.

Tier 4 Regulation: When the full inventory of older nonroad engines are replaced by Tier 4 engines, annual emission reductions are estimated at 738,000 tons of NOx and 129,000 tons of PM. By 2030, 12,000 premature deaths would be prevented annually due to the implementation of the proposed standards.

The estimated costs for added emission controls for the vast majority of equipment was estimated at 1-3% as a fraction of total equipment price. For example, for a 175 hp bulldozer that costs approximately $230,000 it would cost up to $6900 to add the advanced emission controls and to design the bulldozer to accommodate the modified engine.

EPA estimated that the average cost increase for 15 ppm S fuel would be 7 cents per gallon. This figure would be reduced to 4 cents by anticipated savings in maintenance costs due to low sulfur diesel.

Emissions Standards: U.S.A.
Stationary Diesel Engines (NSPS)

Background

The new source performance standards (NSPS) for reciprocating internal combustion engines (RICE) establish US federal emission requirements for compression ignition (CI) stationary engines. The Compression Ignition NSPS rule was adopted in 2006 [EPA 2006] and amended on several occasions [EPA 2011][EPA 2016]. NSPS emission regulations for stationary CI engines are published in the Code of Federal Regulations (CFR), Title 40, Part 60, Subpart IIII.

The emission standards apply to engines whose construction, modification or reconstruction commenced after July 11, 2005—the date the proposed rule was published in the Federal Register.

Fuel Program. The NSPS rule introduced low sulfur fuel requirements for CI stationary engines, as follows:

- Engines below 30 liters per cylinder:
  - No more than 500 ppm sulfur by October 2007.
  - Ultra-low sulfur diesel (15 ppm sulfur) by October 2010.
- Engines ≥ 30 liters per cylinder: 1,000 ppm sulfur fuel from 2014.

These fuel requirements are consistent with those for mobile nonroad engines and marine engines. Some of the fuel quality requirements are delayed in areas of Alaska.

Economic Impact. The EPA estimated that the 2006 rule would affect 81,500 new stationary diesel engines. Emission reductions would occur gradually from 2005 to 2015, with the total nationwide annual costs for the rule to be $57 million in 2015.

The following are EPA estimates of the price increase for the compliant equipment due to the added cost of emission controls (year 2015):

- Irrigation systems: 2.3%.
- Pumps and compressors: 4.3%.
- Generator sets and welding equipment: 10.0%.

Emission Standards

The standards apply to emissions of NOx, PM, CO, and NMHC. They are expressed in units of g/kWh and smoke standards as a percentage. No new emission limits were developed for stationary engines. Rather, the engines are required to meet emission standards for various types of mobile engines, depending on the engine size and application:

- Engines of displacement below 10 liters per cylinder must meet Tier 1 through Tier 4 emission standards for mobile nonroad diesel engines (almost all stationary engines in the USA belong to this size category). Engines used only for emergencies, for example stand-by generator sets, are exempted from the most stringent Tier 4 emission requirements.
- Engines of displacement above 10 liters per cylinder must meet emission standards for marine engines.

Table 1. Emissions Requirements for Non-Emergency Stationary Engines

Displacement (D)	Power	Year	Emissions Certification
D < 10 L per cylinder	≤ 3000 hp	2007+	Nonroad Tier 2/3/4
	> 3000 hp	2007-2010	Nonroad Tier 1
		2011+	Nonroad Tier 2/4
10 ≤ D < 30 L per cylinder	All	2007+	Marine Cat. 2 Tier 2/3/4 (Tier 3/4 proposed)
D ≥ 30 L per cylinder	All	2010-2011	Marine Cat. 3 Tier 1 (proposed)
		2012+	Marine Cat. 3 Tier 2/3 (proposed)

Two groups of standards have been adopted: (1) for engine manufacturers, and (2) for engine owners/operators. Beginning with model year (MY) 2007, engine manufactures are required to emission certify stationary engines, and so they are responsible for compliance. During the transitional period before the MY 2007, engines can be sold that are not emission certified. In that case, the engine owner/operator is responsible for emission compliance.

Standards for Engine Manufacturers. Emission certification requirements for stationary non-emergency diesel engines are summarized in Table 1. All stationary engines must be certified to the respective standards, as applicable for the model year and maximum engine power (and displacement per cylinder in marine standards).

Engines in "remote areas" of Alaska are allowed to use Tier 3 engines in lieu of Tier 4 engines. The requirements to use Tier 4 engines with "add-on" emission controls were removed in two steps: in 2011 for NOx [EPA 2011] and in 2019 for PM [EPA 2019].

Stationary CI engines can be designed to allow operators to temporarily override performance inducements related to the emission control system—for instance, to allow engine operation without urea in the SCR system—in case of emergency that presents a risk to human life [EPA 2016]. This facilitates the use of stationary CI engines to perform life-saving work during fires, floods, hurricanes, and other emergency situations. During the emergency situation, the engine must meet the Tier 1 emission standards.

Emission certification requirements also apply to emergency engines from 2007, but the certification levels are less stringent:

- Emergency engines that are not fire pump engines must be certified to the standards shown in Table 1, with the exception of standards (including nonroad Tier 4 and marine Category 3 Tier 3) that require "add-on" controls such as diesel particulate filters or NOx reduction catalysts.

Produced in cooperation with: www.DieselNet.com

- Emergency fire pump engines must be certified to standards that are generally based on nonroad Tier 1 and Tier 2, with Tier 2 becoming effective around 2008-2011, depending on the engine power category.

The time allowed for maintenance and testing of emergency engines is 100 hours per year.

Standards for Engine Owners/Operators. Depending on the engine category, owners and operators are responsible for emission compliance as follows:

- Engines < 30 liters per cylinder
  - Pre-2007:
    - Engines < 10 liters per cylinder must meet nonroad Tier 1 emission standards.
    - Engines ≥ 10 liters per cylinder must meet MARPOL Annex 6 NOx limits (Tier 1 marine standards)

  - 2007 and later: owners/operators must buy emission certified engines
- Engines ≥ 30 liters per cylinder:
  - Under the 2006 rule, owners/operators are required to reduce NOx emissions by 90%, or alternatively they must limit NOx to 1.6 g/kWh (1.2 g/hp-hr).
  - Owners/operators are also required to reduce PM emissions by 60%, or alternatively they must limit PM to 0.15 g/kWh (0.11 g/hp-hr).
  - Under the 2011 rule, engines must be certified to the standards shown in Table 1.

Owners/operators of pre-2007 engines < 30 liters per cylinder can demonstrate compliance by purchasing a certified engine. If a non-certified engine is purchased, compliance may be demonstrated using emission test results from a test conducted on a similar engine; data from the engine manufacturer; data from the control device vendor; or conducting a performance test. If in-use performance test is conducted, the owner would be required to meet not-to-exceed (NTE) emission standards instead of the respective certification emission standards. Pre-2007 engines must meet NTE standards of 1.25 Ч the applicable certification emission standard. The information which demonstrates engine compliance and the appropriate maintenance records must be kept on site.

Owners/operators of engines ≥ 30 liters per cylinder must conduct an initial performance test to demonstrate emissions compliance (NOx is measured using EPA Method 7E, PM using EPA Method 5 [40 CFR part 60 appendix A]). The NTE standards do not apply to engines ≥ 30 liters per cylinder. Spark-Ignition (SI) Engines (NSPS)

The new source performance standards (NSPS) for reciprocating internal combustion engines (RICE) establish US federal emission requirements for a number of categories of spark ignition (SI) engines. The Spark Ignition NSPS rule was adopted in 2008 [EPA 2008] and amended in 2011 [EPA 2011]. NSPS emission regulations for stationary SI engines are published in the Code of Federal Regulations (CFR), Title 40, Part 60, Subpart JJJJ.

The NSPS regulations for SI engines define a number of emission standards, depending on the engine maximum power, fuel, application, and other factors. Depending on the engine category, the onus for compliance is either on the engine manufacturer or the engine owners/operators. Engines rated at 19 kW or less and non-emergency gasoline and rich burn LPG engines rated above 19 kW require the engine manufacturer to certify the engine. For non-emergency natural gas and lean burn LPG engines as well as all emergency engines rated above 19 kW, engine operators are allowed two alternative compliance methods—by either purchasing a manufacturer certified engine or else by demonstrating compliance through emission testing in the field.

Many of the SI NSPS standards are based on nonroad emission standards for the corresponding non-stationary (i.e., mobile or portable) SI engine categories. These standards are expressed in g/kWh or g/bhp-hr. Some of the in-use standards are also expressed in terms of volumetric concentrations (such as volume ppm, dry, corrected to 15% O2).

The SI NSPS standards for stationary engines are structured as follows:

- Engines ≤ 19 kW (25 hp)
- Engines > 19 kW (25 hp)

- Non-emergency engines:
  - Gasoline and rich burn liquefied petroleum gas (LPG) engines.
  - Natural gas (NG) and lean burn LPG engines.
  - Landfill/digester gas engines.
  - Emergency engines.

Fuel Requirements. In addition to emission standards, the 2008 rule introduced a requirement that owners and operators who use gasoline in their stationary SI engine must use gasoline that meets the requirements of 40 CFR 80.195, which include a gasoline sulfur per gallon cap of 80 ppm.

Test Cycles. For engines that must be certified by the manufacturer or which are voluntarily certified by the manufacturer, discreet or ramped mode cycles with 2-6 modes are used. Engines certified by the engine operator are certified within 10% of 100% peak load or the highest achievable load.

Volatile Organic Compounds (VOC). NSPS standards for some engine types limit VOC emissions. A number of different test procedures are allowed to determine VOCs. Formaldehyde should not be included when determining VOC emissions. Engine manufacturers are allowed to exclude methane and ethane from the determinations of VOCs. Some of the methods allowed for field testing for certification by operators can be operated to exclude methane and ethane.

Emissions Standards: U.S.A.

Existing Stationary Engines (NESHAP)

Background

The U.S. Environmental Protection Agency (EPA) issued a number of rules to control emissions of toxic air pollutants from existing stationary reciprocating internal combustion engines (RICE):

Over 2011-2013, the EPA introduced several amendments and clarifications to the 2010 regulations [EPA 2011][EPA 2013]. These amendments relaxed some of the emission requirements—such as by extending the allowable annual use periods for emergency engines and withdrawing emission standards for SI engines in remote are-as.

The rules, entitled National Emission Standards for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines, are intended to reduce emissions of toxic air pollutants—such as formaldehyde (HCHO), acetaldehyde, acro-lein, methanol and other air toxics—from several categories of previously unregulated stationary engines. The EPA has determined that carbon monoxide (CO) can be often used as an appropriate surrogate for formaldehyde. Since testing for CO emissions has many advantages over testing for emissions of hazardous air pollutants (HAP), many of the emission standards have been finalized in terms of CO as the only regulated pollutant.

The NESHAP regulations for stationary engines are published in Title 40, Part 63, Subpart ZZZZ (63.6580) of the Code of Federal Regulations (CFR). Regulatory docu-ments as well as fact sheets and related information can be also found in the US EPA stationary engine pages.

Applicability

The applicability of the emissions standards depends on the classification of the source of air toxics emissions. "Major sources" of air toxics are defined as those that emit 10 short tons per year of a single air toxic or 25 short tons per year of a mixture of air toxics. "Area sources" are those sources that are not "major sources".

The NESHAP rules are applicable to "existing" diesel and SI engines, as determined by their date of construction or reconstruction:

- "Area sources" of air toxics emissions: Engines constructed or reconstructed before June 12, 2006.
- "Major sources" of air toxics emissions:
  - Engines ≤ 500 hp constructed or reconstructed before June 12, 2006.
  - Engines > 500 hp constructed or reconstructed before December 19, 2002.

"New" engines or "reconstructed" engines are those constructed or reconstructed, respectively, after the above dates.

Emergency Engines. The NESHAP requirements apply to engines used for non-emergency purposes. The following operational requirements must be met by emergency engines:

- There is no time limit on the use in emergency situations (e.g., power outage, fire, flood).
- The engine may be used for up to 100 hours per calendar year for maintenance checks, testing, and for emergency demand response (i.e., blackout and brownout prevention).
- The engine may be used for up to 50 hours per year for certain non-emergency uses such as local reliability (the operation counts toward the above 100-hour limit).

Emissions Standards

The NESHAP regulations include three types of emission standards:

- Emission Limits—Limits for lean-burn engines are expressed as volumetric, dry CO concentrations (ppm) at 15% O2. Limits for rich-burn SI engines are expressed as volumetric, dry concentrations of HCHO (ppm or ppb) at 15% O2. The standards must be met during any operating conditions, except during periods of start-up (of maximum 30 minutes). Emissions are tested at 100% load.
- Percentage CO/HCHO Reductions—Alternative compliance options are available in certain engine categories, expressed as percentage CO or HCHO/THC emission reductions. These reductions can be achieved by retrofitting engines with emission controls.
- Equipment Standards—Engines must be retrofitted with

Table 1. NESHAP Emissions Requirements for Stationary Diesel (CI) Engines

Engine Category	Emissions Standard	Alternative CO Reduction
Area Sources		
Non-Emergency 300 < hp ≤ 500	49 ppmvd CO	70%
Non-Emergency > 500 hp	23 ppmvd CO	70%
Major Sources		
Non-Emergency 100 ≤ hp ≤ 300	230 ppmvd CO	-
Non-Emergency 300 < hp ≤ 500	49 ppmvd CO	70%
Non-Emergency > 500 hp	23 ppmvd CO	70%

Table 2. NESHAP Emissions Requirements for Stationary Gas (SI) Engines

Engine Category	Emissions Standard	Alternative CO/ HCHO Reduction
Area Sources		
4SLB, Non-Emergency > 500 hp	47 ppmvd CO	93% CO
4SRB, Non-Emergency > 500 hp	2.7 ppmvd HCHO	76% HCHO
Major Sources		
2SLB, Non-Emergency 100 ≤ hp ≤ 500	225 ppmvd CO	-
4SLB, Non-Emergency 100 ≤ hp ≤ 500	47 ppmvd CO	-
4SRB, Non-Emergency 100 ≤ hp ≤ 500	10.3 ppmvd HCHO	-
Landfill/Digester Gas, Non-Emergency 100 ≤ hp ≤ 500	177 ppmvd CO	-
4SRB, Non-Emergency > 500 hp	350 ppmvd HCHO	76% HCHO

Produced in cooperation with: www.DieselNet.com

Table 3. NESHAP Emissions Requirements for new CI and SI Engines at Major Sources		
Engine Category	Emissions Standard	Alternative CO/ HCHO Reduction
CI Engines		
Non-Emergency > 500 hp	580 ppb CH_2O	70% CO
SI Engines		
2SLB, Non-Emergency > 500 hp	12 ppm CH_2O	58% CO
4SLB, Non-Emergency > 250 hp	14 ppm CH_2O	93% CO
4SRB, Non-Emergency > 500 hp	350 ppb CH_2O	76% CH_2O
Note: New limited use engines >500 hp at major sources do not meet any emission standards under the NESHAP		

emission controls: oxidation catalysts on lean-burn engines and NSCR catalysts on rich-burn engines.

Engine Standards. The standards for existing stationary diesel engines are listed in Table 1. Standards for spark ignition, gas-fired stationary engines are summarized in Table 2. NESHAP standards for new engines are also applicable to certain categories of new CI and SI engines located at major sources, shown in Table 3.

Emissions Standards: U.S.A.
Locomotives

Background

U.S. emissions standards for railway locomotives apply to newly manufactured, as well as remanufactured railroad locomotives and locomotive engines. The standards have been adopted by the EPA in two regulatory actions:

- *Tier 0-2 standards:* The first emissions regulation for railroad locomotives was adopted on December 17, 1997 [63 FR 18997-19084, April 16, 1998]. The rulemaking, which became effective from 2000, applies to locomotives originally manufactured from 1973, any time they are manufactured or remanufactured. Tier 0-2 standards are met though engine design methods, without the use of exhaust gas aftertreatment.
- *Tier 3-4 standards:* A regulation signed on March 14, 2008 introduced more stringent emissions requirements [73 FR 88 25098-25352, May 6, 2008]. Tier 3 standards, to be met by engine design methods, become effective from 2011/12. Tier 4 standards, which are expected to require exhaust gas aftertreatment technologies, become effective from 2015. The 2008 regulation also includes more stringent emissions standards for remanufactured Tier 0-2 locomotives.

Table 1. Tier 0-2 Locomotive Emissions Standards, g/bhp-hr				
Duty Cycle	HC*	CO	NO_x	PM
Tier 0 (1973-2001)				
Line-haul	1.0	5.0	9.5	0.60
Switch	2.1	8.0	14.0	0.72
Tier 1 (2002-2004)				
Line-haul	0.55	2.2	7.4	0.45
Switch	1.2	2.5	11.0	0.54
Tier 2 (2005 and later)				
Line-haul	0.3	1.5	5.5	0.20
Switch	0.6	2.4	8.1	0.24
Non-Regulated Locomotives (1997 estimates)				
Line-haul	0.5	1.5	13.5	0.34
Switch	1.1	2.4	19.8	0.41
* HC standard is in the form of THC for diesel engines				

Test Cycles. Locomotive emissions are measured over two steady-state test cycles which represent two different types of service including (1) *line-haul* and (2) *switch* locomotives. The duty cycles include different weighting factors for each of the 8 throttle notch modes, which are used to operate locomotive engines at different power levels, as well as for idle and dynamic brake modes. The switch operation involves much time in idle and low power notches, whereas the line-haul operation is characterized by a much higher percentage of time in the high power notches, especially notch 8.

Locomotive certification and compliance programs include several provisions, including production line testing (PLT) program, in-use compliance emissions testing, as well as averaging, banking and trading (ABT) of emissions.

Fuels. To enable catalytic aftertreatment methods at the Tier 4 stage, the EPA regulated (as part of the nonroad Tier 4 rule) the availability of low sulfur diesel fuel for locomotive engines. Sulfur limit of 500 ppm is effective as of June 2007, sulfur limit of 15 ppm from June 2012.

Emissions regulations for locomotives and locomotive engines can be found in the U.S. Code of Federal Regulations, 40 CFR Parts 85, 89 and 92.

Tier 0-2 Standards

Three separate sets of emissions standards have been adopted, termed Tier 0, Tier 1, and Tier 2. The applicability of the standards depends on the date a locomotive is first manufactured, as follows:

- Tier 0 — The first set of standards applies (effective 2000) to locomotives and locomotive engines originally manufactured from 1973 through 2001, any time they are manufactured or remanufactured.
- Tier 1 — These standards apply to locomotives and locomotive engines originally manufactured from 2002 through 2004. These locomotives and locomotive engines are required to meet the Tier 1 standards at the time of the manufacture and each subsequent remanufacture.
- Tier 2 — This set of standards applies to locomotives and locomotive engines originally manufactured in 2005

Table 2. Locomotive Smoke Standards, % opacity (normalized)			
	Steady-state	30-sec peak	3-sec peak
Tier 0	30	40	50
Tier 1	25	40	50
Tier 2 and later	20	40	50

and later. Tier 2 locomotives and locomotive engines are required to meet the applicable standards at the time of original manufacture and each subsequent remanufacture.

Exempted from the emissions standards are electric locomotives, historic steam-powered locomotives, and locomotives originally manufactured before 1973.

The Tier 0-2 emissions standards, as well as typical emissions rates from non-regulated locomotives, are listed in Table 1. A dual cycle approach has been adopted in the regulation, i.e., all locomotives are required to comply with both the line-haul and switch duty cycle standards, regardless of intended usage. Locomotive engines must also meet smoke opacity standards, Table 2.

Tier 3-4 Standards

The 2008 regulation strengthens the Tier 0-2 standards for existing locomotives, and introduces new Tier 3 and Tier 4 emissions standards:

- Tier 0-2 standards — More stringent emissions standards for existing locomotives when they are remanufactured.
- Tier 3 standards — Near-term engine-out emissions standards for newly-built and remanufactured locomotives. Tier 3 standards are to be met using engine technology.
- Tier 4 standards — Longer-term standards for newly built and remanufactured locomotives. Tier 4 standards are expected to require the use of exhaust gas aftertreatment technologies, such as particulate filters for PM control, and urea-SCR for NO_x emissions control.

Table 3. Line-Haul Locomotive Emissions Standards, g/bhp-hr

Tier	MY	Date	HC	CO	NO_x	PM
Tier 0[a]	1973-1992[c]	2010[d]	1.00	5.0	8.0	0.22
Tier 1[a]	1993[c]-2004	2010[d]	0.55	2.2	7.4	0.22
Tier 2[a]	2005-2011	2010[d]	0.30	1.5	5.5	0.10[e]
Tier 3[b]	2012-2014	2012	0.30	1.5	5.5	0.10
Tier 4	2015 or later	2015	0.14[f]	1.5	1.3[f]	0.03

[a] - Tier 0-2 line-haul locomotives must also meet switch standards of the same tier.
[b] - Tier 3 line-haul locomotives must also meet Tier 2 switch standards.
[c] - 1993-2001 locomotive that were not equipped with an intake air coolant system are subject to Tier 0 rather than Tier 1 standards.
[d] - As early as 2008 if approved engine upgrade kits become available.
[e] - 0.20 g/bhp-hr until January 1, 2013 (with some exceptions).
[f] - Manufacturers may elect to meet a combined NOx+HC standard of 1.4 g/bhp-hr.

Table 4. Switch Locomotive Emissions Standards, g/bhp-hr

Tier	MY	Date	HC	CO	NO_x	PM
Tier 0	1973-2001	2010[b]	2.10	8.0	11.8	0.26
Tier 1[a]	2002-2004	2010[b]	1.20	2.5	11.0	0.26
Tier 2[a]	2005-2010	2010[b]	0.60	2.4	8.1	0.13[c]
Tier 3	2011-2014	2011	0.60	2.4	5.0	0.10
Tier 4	2015 or later	2015	0.14[d]	2.4	1.3[d]	0.03

[a] - Tier 1-2 switch locomotives must also meet line-haul standards of the same tier.
[b] - As early as 2008 if approved engine upgrade kits become available.
[c] - 0.24 g/bhp-hr until January 1, 2013 (with some exceptions).
[d] - Manufacturers may elect to meet a combined NO_x+HC standard of 1.3 g/bhp-hr.

The locomotive regulations apply for locomotives originally built in or after 1973 that operate extensively within the United States. Exceptions include (1) historic steam-powered locomotives, (2) electric locomotives, and (3) some existing locomotives owned by small businesses. Furthermore, engines used in locomotive-type vehicles with less than 750 kW total power (used primarily for railway maintenance), engines used only for hotel power (for passenger railcar equipment), and engines that are used in self-propelled passenger-carrying railcars, are excluded from the regulations. The engines used in these smaller locomotive-type vehicles are generally subject to the nonroad engine requirements.

The emissions standards are summarized in Table 3 and Table 4. The Tier 0-2 standards apply to existing locomotives of the indicated manufacture years (MY) at the time they are remanufactured, beginning from the effective date. The Tier 3-4 standards apply to locomotives of the indicated manufacture years at the time they are newly built or remanufactured.

Tier 3-4 locomotives must also meet smoke opacity standards as specified in Table 2.

Manufacturers may certify Tier 0-2 locomotives to an alternate CO emissions standard of 10.0 g/bhp-hr if they also certify those locomotives to alternate PM standards less than or equal to one-half of the otherwise applicable PM standard.

Locomotives may discharge crankcase emissions to the ambient atmosphere if the emissions are added to the exhaust emissions (either physically or mathematically) during all emissions testing.

Useful Life. The emissions standards apply to new and/or remanufactured locomotives for their useful life. The useful life, generally specified as MW-hrs and years, ends when either of the values (MW-hrs or years) is exceeded or the locomotive is remanufactured.

The minimum useful life in terms of MW-hrs is equal to the product of the rated horsepower multiplied by 7.50. The minimum useful life in terms of years is 10 years. For locomotives originally manufactured before January 1, 2000 and not equipped with MW-hr meters, the minimum useful life is equal to 750,000 miles or 10 years, whichever is reached first. The minimum emissions warranty period is one-third of the useful life (with some exceptions).

Emissions Standards: U.S.A.
Marine Diesels

Background

Engine Categories. For the purpose of emissions regulations, marine engines are divided into three categories based on displacement (swept volume) per cylinder, as shown in Table 1. Each of the categories represents a different engine technology. Categories 1 and 2 are further divided into sub-categories, depending on displacement and net power output.

Table 1. Marine Engine Categories

Category	Displacement per Cylinder (D)		Basic Engine Technology
	Tier 1-2	Tier 3-4	
1	D < 5 dm³†	D < 7 dm³	Land-based nonroad diesel
2	5 dm³ ≤ D < 30 dm³	7 dm³ ≤ D < 30 dm³	Locomotive engine
3	D ≥ 30 dm³		Unique marine engine design

† And power ≥ 37 kW

Category 3 marine diesel engines typically range in size from 2,500 to 70,000 kW (3,000 to 100,000 hp). These are very large marine diesel engines used for propulsion power on ocean-going vessels such as container ships, oil tankers, bulk carriers, and cruise ships. Emissions control technologies which can be used on these engines are limited. An important limitation is the residual fuel on which they are operated. This fuel is the by-product of distilling crude oil to produce lighter petroleum products. It possesses high viscosity and density, which affects ignition quality, and it typically has high ash, sulfur and nitrogen content in comparison to marine distillate fuels. Furthermore, residual fuel parameters are highly variable because its content is not regulated. The EPA estimated that residual fuel can increase engine NO_x emissions from 20-50% and PM from 750% to 1250% (sulfate particulates) when compared to distillate fuel.

Category 1 and Category 2 marine diesel engines typically range in size from about 500 to 8,000 kW (700 to 11,000 hp). These engines are used to provide propulsion power on many kinds of vessels including tugboats, pushboats, supply vessels, fishing vessels, and other commercial vessels in and around ports. They are also used as stand-alone generators for auxiliary electrical power on many types of vessels.

Regulatory Acts. Emissions from marine diesel engines (compression ignition engines) have been regulated through a number of rules — the first one issued in 1999 — applicable to different engine categories. Certain overlap also exists with the regulations for mobile, land-based nonroad engines, which may be applicable to some types of engines used on marine vessels. The following are the major regulatory acts which establish emissions standards for marine engines:

- 1999 Marine Engine Rule — On November 23, 1999, the EPA signed the final rule "Control of Emissions of Air Pollution from New CI Marine Engines at or above 37 kW" *[40 CFR Parts 89, 92][64 FR 64 73300-73373, December 29, 1999].* The adopted Tier 2 standards for Category 1 and 2 engines are based on the land-based standard for nonroad engines, while the largest Category 3 engines are expected — but not required by the rule — to comply with IMO MARPOL Annex 6 limits.
- 2002 Recreational Engine Rule — Diesel engines used in recreational vessels are covered in the "Emissions Standards for New Nonroad Engines — Large Industrial Spark-ignition Engines, Recreational Marine Diesel Engines, and Recreational Vehicles" regulation, signed on September 13, 2002 *[40 CFR Part 89 et al.] [67 FR 68241-68447, November 8, 2002].*
- 2003 Category 3 Engine Rule — The decision to leave the largest Category 3 engines unregulated triggered a law suit against the EPA by environmental organizations. A court settlement was reached that required the EPA to develop NO_x emissions limits for Category 3 engines. The final rule "Control of Emissions From New Marine Compression-Ignition Engines at or Above 30 Liters Per Cylinder" *[40 CFR Part 9 and 94][68 FR 9745-9789, February 28, 2003]* — signed by the EPA in January 2003 — establishes Tier 1 emissions standards for marine engines virtually equivalent to the IMO MARPOL Annex 6 limits.
- 2008 Category 1/2 Engine Rule — A regulation signed on March 14, 2008 introduced Tier 3 and Tier 4 emissions standards for marine diesel engines *[73 FR 88 25098-25352, May 6, 2008].* The Tier 4 emissions standards are modeled after the 2007/2010 highway engine program and the Tier 4 nonroad rule, with an emphasis on the use of emissions aftertreatment technology. To enable catalytic aftertreatment methods, the EPA established a sulfur cap in marine fuels (as part of the nonroad Tier 4 rule). Sulfur limit of 500 ppm becomes effective in June 2007, sulfur limit of 15 ppm in June 2012 (the sulfur limits are not applicable to residual fuels).
- 2009 Category 3 Engine Rule — On December 18, 2009, the EPA signed a new emissions rule for Category 3 engines (published April 30, 2010), which introduced Tier 2 and Tier 3 standards in harmonization with the 2008 Amendments to IMO MARPOL Annex 6.

Applicability

1999 Marine Engine Rule. The scope of application of the marine engine rule covers all new marine diesel engines at or above 37 kW (50 hp) (engines below 37 kW must comply with the nonroad standards). Regulated engines include both propulsion and auxiliary marine diesel engines. A propulsion engine is one that moves a vessel through the water or assists in guiding the direction of the vessel (for example, bow thrusters). Auxiliary engines are all other marine engines.

Classification of drilling rigs depends on their propulsion capability. Drilling ships are considered marine vessels, so their engines are subject to the marine rule. Semi-submersible drilling rigs which are moored to the ocean bottom, but have some propulsion capability, are also considered marine vessels. In contrast, permanently anchored drilling platforms are not considered marine vessels, so none of the engines associated with one of these facilities are marine engine.

Consistently with the land-based nonroad regulation, a portable auxiliary engine that is used onboard a marine vessel is not considered to be a marine engine. Instead, a portable auxiliary engine is considered to be a land-based auxiliary engine and is subject to the land-based nonroad requirements. To distinguish a marine auxiliary engine installed on a marine vessel from a land-based portable auxiliary engine used on a marine vessel, EPA specified in that rulemaking that an auxiliary engine is installed on a marine vessel if its fuel, cooling, or exhaust system are an integral part of the vessel or require special mounting hardware. All other auxiliary engines are considered to be portable and therefore land-based.

The following engine categories are exempted from the 1999 marine regulation:

- Engines used in recreational vessels (standards for recreational diesel engines were established by the 2002 rule).
- Emissions certified new land-based engines modified for marine applications (provided certain conditions are met).
- Competition (racing) engines.
- Engines used in military vessels (National Security Exemption).
- Other exemptions (testing, display, export, ...) may also apply to marine engines.

The 1999 rule also included so called Foreign-Trade Exemption which was available (for engines Category 1 and 2 used on ocean vessels with Category 3 propulsion) for U.S. vessels that spend less than 25% of total operating time within 320 kilometers of U.S. territory. The Foreign-Trade Exemption was eliminated for all engine categories by the 2003 (Category 3) regulation.

Under the 1999 rule, the same emissions standards apply to engines fueled by diesel fuel and by other fuels.

2002 Recreational Vessel Rule. This rule applies to new recreational marine diesel engines over 37 kW (50 hp) that are used in yachts, cruisers, and other types of pleasure craft. The 2002 rule does not apply to outboard and personal watercraft spark ignited engines, which are regulated separately.

The same emissions standards apply to recreational engines fueled by diesel fuel and by alternative fuels.

Category 3 Engines, 2003 & 2009 Rules. These standards apply to new marine engines and to new vessels that include marine engines. The rules apply only to vessels flagged or registered in the U.S.A. However, equivalent emissions standards are applicable to foreign ships in U.S. waters under the IMO Annex 6 regulation.

Category 1/2 Engines, 2008 Rule. The regulations introduce two tiers of standards — Tier 3 and Tier 4 — which apply to both newly manufactured and remanufactured marine diesel engines, as follows:

1. *Newly built engines:* Tier 3 standards apply to engines used in commercial, recreational, and auxiliary power applications (including those below 37 kW that were previously covered by nonroad engine standards). Tier 4 standards, based on aftertreatment, apply to engines above 600 kW (800 hp) on commercial vessels.
2. *Remanufactured engines:* The standards apply to commercial marine diesel engines above 600 kW when these engines are remanufactured.

Table 2. Tier 2* Marine Emissions Standards

Cat.	Displacement (D) dm³ per cylinder	CO g/kWh	NO_x+THC g/kWh	PM g/kWh	Date
1	Power ≥ 37 kW D < 0.9	5.0	7.5	0.40	2005
	0.9 ≤ D < 1.2	5.0	7.2	0.30	2004
	1.2 ≤ D < 2.5	5.0	7.2	0.20	2004
	2.5 ≤ D < 5.0	5.0	7.2	0.20	2007[a]
2	5.0 ≤ D < 15	5.0	7.8	0.27	2007[a]
	15 ≤ D < 20 Power < 3300 kW	5.0	8.7	0.50	2007[a]
	15 ≤ D < 20 Power ≥ 3300 kW	5.0	9.8	0.50	2007[a]
	20 ≤ D < 25	5.0	9.8	0.50	2007[a]
	25 ≤ D < 30	5.0	11.0	0.50	2007[a]

* - Tier 1 standards are equivalent to the MARPOL Annex 6 Tier 1 NO_x limits
[a] - Tier 1 certification requirement starts in 2004

Table 3. "Blue Sky Series" Voluntary Emissions Standards

Displacement (D) dm³ per cylinder	NO_x+THC g/kWh	PM g/kWh
Power ≥ 37 kW & D < 0.9	4.0	0.24
0.9 ≤ D < 1.2	4.0	0.18
1.2 ≤ D < 2.5	4.0	0.12
2.5 ≤ D < 5.0	5.0	0.12
5.0 ≤ D < 15	5.0	0.16
15 ≤ D < 20 & Power < 3300 kW	5.2	0.30
15 ≤ D < 20 & Power ≥ 3300 kW	5.9	0.30
20 ≤ D < 25	5.9	0.30
25 ≤ D < 30	6.6	0.30

Table 4. Recreational Marine Diesel Engines Standards

Displacement (D) dm³ per cylinder	CO g/kWh	NO_x+HC g/kWh	PM g/kWh	Date
0.5 ≤ D < 0.9	5.0	7.5	0.40	2007
0.9 ≤ D < 1.2	5.0	7.2	0.30	2006
1.2 ≤ D < 2.5	5.0	7.2	0.20	2006
D ≥ 2.5	5.0	7.2	0.20	2009

The 2008 rule includes exemptions for the following engine categories:

- Test engines, manufacturer-owned engines, display engines.
- Marine diesel engines that are produced by marinizing a certified highway, nonroad, or locomotive engine ("dresser exemption").
- Competition engines.
- Export engines.
- Certain military engines.
- Engines installed on a vessel manufactured by a person for his/her own use (intended to allow hobbyists and fishermen to install a used/rebuilt engine or a reconditioned

vintage engine — not to order a new uncontrolled engine from an engine manufacturer).

Not all exemptions are automatic. Engine or vessel manufacturers, or vessel owners, may need to apply for a specific exemption to the EPA.

Emissions Standards — Category 3

Tier 1 Standards. In the 2003 rule, EPA adopted Tier 1 NO_x emissions standards for Category 3 engines, which are equivalent to the international IMO MARPOL Annex 6 limits. These limits range from 17 to 9.8 g/kWh depending on the engine speed, with higher limits for slower engines.

The EPA Tier 1 limits are in effect for new engines built in 2004 and later. These limits are to be achieved by engine-based controls, without the need for exhaust gas aftertreatment. Emissions other than NO_x are not regulated.

Tier 2-3 Standards. In the 2009 rule, EPA has adopted Tier 2 and Tier 3 emissions standards for newly built Category 3 engines.

- Tier 2 standards apply beginning in 2011. They require the use of engine-based controls, such as engine timing, engine cooling, and advanced electronic controls. The Tier 2 standards result in a 15 to 25% NO_x reduction below the Tier 1 levels.
- Tier 3 standards apply beginning in 2016. They can be met with the use of high efficiency emissions control technology such as selective catalytic reduction (SCR) to achieve NO_x reductions 80% below the Tier 1 levels.

The EPA Tier 2-3 NO_x limits are equivalent to the respective IMO Tier 2-3 standards. Depending on the engine speed, Tier 2 limits range from 14.4 to 7.7 g/kWh, while Tier 3 limits range from 3.4 to 1.96 g/kWh. In addition to the NO_x limits, EPA adopted a HC emissions standard of 2.0 g/kWh and a CO standard of 5.0 g/kWh from new Category 3 engines. No emissions standard was adopted for PM, but manufacturers are required to measure and report PM emissions.

IMO Emissions Control Areas (ECA). The IMO has designated waters along the U.S. and Canadian shorelines as the North American ECA for the emissions of NO_x and SO_x

Table 5. Tier 3 Standards for Marine Diesel Category 1 Commercial Standard Power Density (≤ 35 kW/dm³) Engines

Power (P) kW	Displacement (D) dm³ per cylinder	NO_x+HC† g/kWh	PM g/kWh	Date
P < 19	D < 0.9	7.5	0.40	2009
19 ≤ P < 75	D < 0.9[a]	7.5	0.30	2009
		4.7[b]	0.30[b]	2014
75 ≤ P < 3700	D < 0.9	5.4	0.14	2012
	0.9 ≤ D < 1.2	5.4	0.12	2013
	1.2 ≤ D < 2.5	5.6	0.11[c]	2014
	2.5 ≤ D < 3.5	5.6	0.11[c]	2013
	3.5 ≤ D < 7	5.8	0.11[c]	2012

† Tier 3 NO_x+HC standards do not apply to 2000-3700 kW engines.
[a] - < 75 kW engines ≥ 0.9 dm³/cylinder are subject to the corresponding 75-3700 kW standards.
[b] - Option: 0.20 g/kWh PM & 5.8 g/kWh NO_x+HC in 2014.
[c] - This standard level drops to 0.10 g/kWh in 2018 for < 600 kW engines.

Table 6. Tier 3 Standards for Marine Diesel Category 1 Commercial High Power Density (> 35 kW/dm³) Engines And All Diesel Recreational Engines

Power (P) kW	Displacement (D) dm³ per cylinder	NO_x+HC g/kWh	PM g/kWh	Date
P < 19	D < 0.9	7.5	0.40	2009
19 ≤ P < 75	D < 0.9[a]	7.5	0.30	2009
		4.7[b]	0.30[b]	2014
75 ≤ P < 3700	D < 0.9	5.8	0.15	2012
	0.9 ≤ D < 1.2	5.8	0.14	2013
	1.2 ≤ D < 2.5	5.8	0.12	2014
	2.5 ≤ D < 3.5	5.8	0.12	2013
	3.5 ≤ D < 7	5.8	0.11	2012

[a] - < 75 kW engines ≥ 0.9 dm³/cylinder are subject to the corresponding 75-3700 kW standards.
[b] - Option: 0.20 g/kWh PM & 5.8 g/kWh NO_x+HC in 2014.

Table 7. Tier 3 Standards for Marine Diesel Category 2 Engines‡

Power (P) kW	Displacement (D) dm³ per cylinder	NO_x+HC† g/kWh	PM g/kWh	Date
P < 3700	7 ≤ D < 15	6.2	0.14	2013
	15 ≤ D < 20	7.0	0.27[a]	2014
	20 ≤ D < 25	9.8	0.27	2014
	25 ≤ D < 30	11.0	0.27	2014

‡ Option: Tier 3 PM/NO_x+HC at 0.14/7.8 g/kWh in 2012, and Tier 4 in 2015.
† Tier 3 NO_x+HC standards do not apply to 2000-3700 kW engines.
[a] - 0.34 g/kWh for engines below 3300 kW.

Table 8. Tier 4 Standards for Marine Diesel Category 1/2 Engines

Power (P) kW	NO_x g/kWh	HC g/kWh	PM g/kWh	Date
P ≥ 3700	1.8	0.19	0.12[a]	2014[c]
	1.8	0.19	0.06	2016[b,c]
2000 ≤ P < 3700	1.8	0.19	0.04	2014[c,d]
1400 ≤ P < 2000	1.8	0.19	0.04	2016[c]
600 ≤ P < 1400	1.8	0.19	0.04	2017[d]

[a] - 0.25 g/kWh for engines with 15-30 dm³/cylinder displacement.
[b] - Optional compliance start dates can be used within these model years.
[c] - Option for Cat. 2: Tier 3 PM/NO_x+HC at 0.14/7.8 g/kWh in 2012, and Tier 4 in 2015.
[d] - The Tier 3 PM standards continue to apply for these engines in model years 2014 and 2015 only.

(enforceable from August 2012) and waters surrounding Puerto Rico and the U.S. Virgin Islands as the U.S. Caribbean ECA for NO_x & SO_x (enforceable from 2014).

The ECAs ensure that foreign flagged vessels comply with IMO Tier 3 NO_x limits while in U.S. waters (the IMO Tier 3 standards are only applicable within ECAs). The ECA also triggers low sulfur fuel requirements — by IMO and U.S. EPA — for vessels in U.S. waters.

Emissions Standards — Category 1 and 2

Tier 1-2 Standards. Emissions standards for engines Category 1 and 2 are based on the land-based standard for nonroad and locomotive engines. The emissions standards, referred to as Tier 2 Standards by the EPA, and their implementation dates are listed in table 2. The Tier 1 NO_x standard, equivalent to MARPOL Annex 6, was voluntary under the 1999 rule, but was made mandatory by the 2003 (Category 3) rule for Category 2 and Category 1 engines of above 2.5 liter displacement per cylinder, effective 2004.

The regulated emissions include NO_x+THC, PM, and CO. There are no smoke requirements for marine diesel engines. The regulators believed that the new PM standards will have a sufficient effect on limiting smoke emissions.

In the earlier proposal, the EPA also listed a more stringent Tier 3 standard to be introduced between 2008 and 2010. The Tier 3 standard was not adopted in the final 1999 rule.

Blue Sky Series Program. The 1999 regulation sets a voluntary "Blue Sky Series" program which permits manufacturers to certify their engines to more stringent emissions standards. The qualifying emissions limits are listed in Table 3. The Blue Sky program begins upon the publication of the rule and extends through the year 2010.

Recreational Vessels (2002 Rule). Recreational vessels standards are phased-in beginning in 2006, depending on the size of the engine as listed in Table 4. These standards are similar to the Tier 2 standards for Category 1 commercial vessels.

Recreational engines are also subject to NTE limits. There are no smoke requirements for recreational marine diesel engines. Similarly to commercial vessels, a voluntary "Blue Sky Series" limits exist for recreational vessels, which are based on a 45% emissions reduction beyond the mandatory standards.

Tier 3-4 Standards. The standards and implementation schedules are shown in Table 5 through Table 8. The engine-based Tier 3 standards are phasing in over 2009-2014. The aftertreatment-based Tier 4 standards for commercial marine engines at or above 600 kW are phasing in over 2014-2017. For engines of power levels not included in the Tier 3 and Tier 4 tables, the previous tier of standards — Tier 2 or Tier 3, respectively — continues to apply.

A differentiation is made between *high power density engines* typically used in planing vessels and *standard power density engines,* with a cut point between them at 35 kW/dm^3 (47 hp/dm^3).

In addition to the above NO_x+HC and PM standards, the following CO emissions standards apply for all Category 1/2 engines starting with the applicable Tier 3 model year:

1. 8.0 g/kWh for engines < 8 kW.
2. 6.6 g/kWh for engines ≥ 8 kW and < 19 kW.
3. 5.5 g/kWh for engines ≥ 19 kW and < 37 kW.
4. 5.0 g/kWh for engines ≥ 37 kW.

Emissions Testing

Category 1/2 Engines. Emissions from Category 1 engines are tested using the nonroad (Tier 1-3) test procedures (40 CFR 89), while Category 2 engines are tested using the locomotive test procedures (40 CFR 92), with certain exceptions including different test cycles, certification fuels and NTE testing. Category 1/2 engines are tested on various ISO 8178 test cycles as summarized in Table 9.

Table 9. Test Cycles for Certifying Category 1/2 Marine Diesel Engines

Application	Test Cycle
General Marine Duty Cycle	ISO 8178 E3
Constant-Speed Propulsion Engines	ISO 8178 E2
Variable-Speed Propulsion Engines Used on Nonpropeller Law Vessels and Variable-Speed Auxiliary Engines	ISO 8178 C1
Constant-Speed Auxiliary Engines	ISO 8178 D2
Recreational Marine	ISO 8178 E5

In addition to the test cycle measurement, which is an average from several test modes, the regulations set "not-to-exceed" (NTE) emissions limits, which provide assurance that emissions at any engine operating conditions within an NTE zone are reasonably close to the average level of control. NTE zones are defined as areas on the engine speed-power map. The emissions caps within the NTE zones represent a multiplier (Tier 1/2: between 1.2 and 1.5; Tier 3/4: 1.2-1.9) times the weighted test result used for certification for all of the regulated pollutants (NO_x+THC, CO, and PM).

The test fuel for marine diesel engine testing has a sulfur specification range of 0.03 to 0.80 %wt, which covers the range of sulfur levels observed for most in-use fuels.

Category 3 Engines. Category 3 engines are tested using methods similar to those stipulated by IMO MARPOL Annex 6 (E2 and E3 cycles of the ISO 8178 test). The major differences between the EPA and MARPOL compliance requirements are: (1) EPA liability for in-use compliance rests with the engine manufacturer (it is the vessel operator in MARPOL), (2) EPA requires a durability demonstration (under MARPOL, compliance must be demonstrated only when the engine is installed in the vessel), (3) there are differences in certain test conditions and parameters in EPA and MARPOL testing (air and water temperatures, engine setting, etc.).

Category 3 engines have no NTE emissions limits or test requirements.

Category 3 engines can be tested using distillate fuels, even though vessels with Category 3 marine engines use primar-

Category	Useful Life		Warranty Period	
	hours	years	hours	years
Category 3	10,000	3	10,000	3
Category 2	20,000	10	10,000	5
Category 1	10,000	10	5,000	5
Recreational	1,000	10	500	3

Table 10. Useful Life and Emissions Warranty Periods

ily residual fuels (this allowance is consistent with MARPOL Annex 6).

Other Provisions

Useful life and *warranty* periods for marine engines are listed in Table 10. The periods are specified in operating hours and in years, whichever occurs first. The relatively short useful life period for Category 3 engines is based on the time that engines operate before being rebuilt for the first time.

The periods in the table are the minimum periods specified by the regulations. In certain cases, longer useful life/warranty periods may be required (e.g., in most cases the emissions warranty must not be shorter than the warranty for the engine or its components).

The regulations contain several other provisions, such as emissions Averaging, Banking, and Trading (ABT) program, deterioration factor requirements, production line testing, in-use testing, and requirements for rebuilding of emissions certified engines.

Emissions Standards: U.S.A.

On-Board Diagnostics

Introduction

On-board diagnostic (OBD) systems provide self-diagnostic functionality incorporated into the engine control system, in order to alert the vehicle driver/operator about potential problems that can affect the emissions performance of the vehicle. OBD requirements were first introduced for light-duty vehicles in California in 1991. Today, OBD requirements apply to light-duty vehicles and heavy-duty engines, both in California and under the federal EPA requirements.

The most detailed requirements for OBD systems are provided by the California regulations. Because systems developed for use in California can generally be used for compliance with EPA requirements with only minor differences, it is expected that OBD systems for vehicles and engines sold outside of California will be similar.

California light-duty and heavy-duty regulations define a number of general requirements for the malfunction indicator light (MIL), trouble codes, monitoring, thresholds and standardized communications common to all OBD systems. These requirements — outlined in the following sections — also apply to systems intended to comply with U.S. federal requirements.

MIL and Fault Code Requirements

The Malfunction Indicator Light (MIL) is located on the instrument panel. Except for a functionality check where it illuminates for 15-20 seconds when in the key-on position before engine cranking, it is normally illuminated only when the OBD system has detected and confirmed a malfunction that could increase emissions.

A number of things must happen before the MIL illuminates. When the OBD determines that a malfunction has occurred, it generates and stores a "pending fault code" and a "freeze frame" of engine data. At this point, the MIL does not illuminate. If the malfunction is detected again before the next driving cycle in which the suspected system or component is monitored, the MIL illuminates continuously and a "MIL-on" or "confirmed" fault code is generated and stored as well as a "freeze frame" of engine data. If the malfunction is not detected by the end of the driving cycle, the "pending fault code" is erased.

Except for misfires and fuel system faults, if the malfunction is not detected in the next 3 driving cycles, the MIL can be extinguished but the trouble code is still stored for at least 40 engine warm-up cycles. The MIL can also be extinguished and fault codes erased with a scan tool that technicians use to diagnose malfunctions. Alternate MIL illumination strategies are also possible but subject to approval.

Monitoring

The systems and parameters that require monitoring are outlined in Table 1. While some components can be monitored continuously, this is not always possible. Therefore, manufacturers must define conditions under which important emissions control components and subsystems can be monitored for proper function. The monitoring conditions should meet the following requirements:

- Ensure robust detection of malfunctions by avoiding false passes and false indications of malfunctions.
- Ensure monitoring will occur under conditions that may reasonably be expected to be encountered in normal vehicle operation and use.
- Ensure monitoring will occur during the FTP cycle.

In order to quantify the frequency of monitoring, an in-use monitor performance ratio is defined as:

In-use monitoring performance ratio = Number of monitoring events/Number of driving events.

Each component and subsystem requiring monitoring requires its own ratio. For example, for 2013 and later heavy-duty engines, the minimum acceptable value of this ratio is 0.100 (i.e. monitoring should occur at least during 1 vehicle trip in 10).

Comprehensive Component Monitoring requires the monitoring of any electronic engine component/system not specifically covered by the regulation that provides input to or receives commands from on-board computers and that can affect emissions during any reasonable in-use driving condition or is used as part of the diagnostic strategy for any other

Table 1. Monitoring Requirements of California OBD Systems

System/Component	Parameter Requiring Monitoring
Fuel system	Fuel system pressure control
	Injection quantity
	Injection timing
	Feedback control
Misfire	Detect continuous misfire
	Determine % of misfiring cycles per 1000 engine cycles (2013 and later engines)
EGR	Low flow
	High flow
	Slow response
	EGR cooler operation
	EGR catalyst performance
	Feedback control
Boost pressure	Underboost
	Overboost
	Slow response
	Charge air under cooling
	Feedback control
NMHC catalyst	Conversion efficiency
	Provide DPF heating
	Provide SCR feedgas (e.g., NO_2)
	Provide post DPF NMHC clean-up
	Provide ammonia clean-up
	Catalyst aging
SCR NO_x catalyst	Conversion efficiency
	SCR reductant: • delivery performance, • tank level, • quality, and • injection feedback control
	Catalyst aging
NO_x adsorber	NO_x adsorber capability
	Desorption function fuel delivery
	Feedback control
DPF	Filtering performance
	Frequent regeneration
	NMHC conversion
	Incomplete regeneration
	Missing substrate
	Active regeneration fuel delivery
	Feedback control
Exhaust gas sensors	For air-fuel ratio and NO_x sensors: • performance, • circuit faults, • feedback, and • monitoring capability
	Other exhaust gas sensors
	Sensor heater function
	Sensor heater circuit faults
VVT	Target error
	Slow response
Cooling system	Thermostat
	ECT sensor circuit faults
	ECT sensor circuit out-of-range
	ECT sensor circuit rationality faults
CCV	System integrity
Comprehensive component monitoring	
Cold-start emissions-reduction strategy	
Other emissions control system monitoring	

monitored system or component.

Monitoring is also required for all other emissions control systems that are not specifically identified. Examples include: hydrocarbon traps, HCCI control systems or swirl control valves.

Malfunction Criteria

Malfunction criteria for the various malfunctions listed in Table 1 vary depending on the system or component and individual parameter being monitored. In some cases, such as feedback control systems, sensor rationality checks and checks for circuit faults, a go/no-go criteria is used. In other cases such as the fuel system, EGR, turbocharger physical parameters and aftertreatment system performance, the OBD system must be able to determine when deterioration or other changes cause emissions to exceed a specified threshold.

In order to determine malfunction criteria for many of these faults, manufacturers must correlate component and system performance with exhaust emissions to determine when deterioration will cause emissions to exceed a certain threshold. This may require extensive testing and calibration for each engine model.

In determining the malfunction criteria for diesel engine monitors that are required to indicate a malfunction before emissions exceed an emissions threshold (e.g., 2.0 times any of the applicable standards), the emissions test cycle and standard that would result in higher emissions with the same level malfunction is to be used. Some adjustment is possible for those components experiencing infrequent regeneration.

Manufacturers have the option of simplifying monitoring requirements if failure or deterioration of a parameter will not cause emissions to exceed the threshold limits. For parameters that are controlled, such as temperature, pressure and flow, a malfunction in such a case would only need to be indicated when the commanded setting cannot be achieved. For aftertreatment devices, a malfunction would be indicated when the aftertreatment device has no conversion/filtering capability.

To account for the fact that current technology may not be adequate to detect all malfunctions at the required threshold, some flexibility has been built into the regulations. A manufacturer may request a higher emissions threshold for any monitor if the most reliable monitoring method developed requires a higher threshold. Additionally, the PM filter malfunction criteria may be revised to exclude detection of specific failure modes (e.g., partially melted substrates or small cracks) if the most reliable monitoring method developed is unable to detect such failures.

A number of other exceptions are available including the possibility to disable OBD monitoring at ambient engine start temperatures below 20°F or at elevations above 8000 feet above sea level.

Standardization Requirements

OBD systems have a standardization requirement that makes diagnostics possible with a universal scan tool that is available to anyone — not just manufacturer's repair facilities. The standardization requirements include:

- A standard data link connector.
- A standard protocol for communications with a scan tool. In-use performance ratio tracking and engine run time tracking requirements.
- Engine manufacturers must provide the aftermarket service and repair industry emissions-related service information.
- Standardized functions to allow information to be accessed by a universal scan tool. These functions include:
    - Readiness status: The OBD system indicates "complete" or "not complete" for each of the monitored components and systems.
    - Data stream: A number of specific signals are made available through the standardized data link connector. Some of these include: torque and speed related data, temperatures, pressures, fuel system control parameters, fault codes and associated details, air flow, EGR system data, turbocharger data and aftertreatment data.
    - Freeze frame: The values of many of the important parameters available in the Data Stream are stored when a fault is detected.
    - Fault codes.
    - Test results: Results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems are stored and made available through the data link.
    - Software calibration identification: Software Calibration Verification Number.
    - Vehicle Identification Number (VIN).
    - Erasing emissions-related diagnostic information: The emissions-related diagnostic information can be erased if commanded by a scan tool (generic or enhanced) or if the power to the on-board computer is disconnected.

Emissions Standards: Canada
On-Road Vehicles And Engines

Background

Authority to regulate emissions from internal combustion engines in Canada currently rests with *Environment Canada* and *Transport Canada*. The *Canadian Environmental Protection Act 1999* (CEPA 1999) gave legislative authority to Environment Canada to regulate emissions from engines other than those used in aircraft, railway locomotives and commercial marine vessels. Authority to regulate emissions from aircraft, railway locomotives and commercial marine vessels rests with Transport Canada.

Increasingly, the general approach to setting vehicle emissions standards in Canada is to harmonize them with U.S. EPA federal standards as much as possible. In 1988, on-road vehicle emissions standards were first aligned with the U.S. federal standards. In February 2001, the Minister of the Environment in the *Federal Agenda on Cleaner Vehicles, Engines and Fuels* set out a number of policy measures that would continue the harmonization of on-road emissions standards as well as to expand this harmonization by developing emissions standards for off-road engines and standards for fuels that are aligned with those of the federal U.S. EPA requirements.

On-Road Engines and Vehicles

Canadian federal regulations establishing exhaust emissions limits for on-road vehicles were first promulgated in 1971 under the *Motor Vehicle Safety Act* which is administered by Transport Canada. On March 13, 2000, legislative authority for controlling on-road vehicle emissions was transferred to Environment Canada under the Canadian Environmental Protection Act 1999 (CEPA 1999). Under CEPA 1999, the *On-Road Vehicle and Engine Emissions Regulations* where promulgated on January 1, 2003, and came into effect on January 1, 2004. These regulations replaced the previous regulations adopted under the Motor Vehicle Safety Act. The new regulations adopted under CEPA 1999 continued the past approach of aligning with the federal emissions standards of the U.S. EPA.

MOU. In the interim period between the phase-out of the emissions regulations under the Motor Vehicle Safety Act and the effective date of the On-Road Vehicle and Engine Emissions Regulations, Environment Canada signed a *Memorandum of Understanding* (MOU) with the Canadian Vehicle Manufacturers Association, the Association of International Automobile Manufacturers of Canada, and the member companies of those associations in June 2001. The MOU formalized an industry commitment to market the same low emissions light-duty vehicles and light-duty trucks in Canada as in the U.S. for model years 2001-2003.

On-Road Emissions Regulations. The Regulations align vehicle and engine certification requirements with those of the U.S.

federal EPA requirements beginning January 1, 2004 and including the U.S. Tier 2 program for new light-duty vehicles, light-duty trucks and medium-duty passenger vehicles, and Phase 1 and Phase 2 programs for new heavy-duty vehicles and engines.

The Regulations set out technical standards for vehicles and engines for exhaust, evaporative and crankcase emissions, on-board diagnostic systems and other specifications related to emissions control systems. The intention of the Regulations is to ensure that vehicles and engines meeting more stringent exhaust emissions standards will begin entering the Canadian market in the 2004 model year and will be phased-in over the 2004 to 2010 model year period. The phase-in schedules vary by standard and by vehicle class and can be summarized as follows:

- Tier 2 standards for light-duty vehicles and light light-duty trucks (2004-2007).
- Tier 2 standards for heavy light-duty trucks and medium-duty passenger vehicles (2004-2009).
- Phase 1 (2005) and Phase 2 (2008-2009) standards for complete heavy-duty vehicles.
- Phase 1 (2004-2006) and Phase 2 (2007-2010) standards for heavy-duty engines.

During any phase-in period, every model of vehicle or engine that is certified by the U.S. EPA, and that is sold concurrently in Canada and the United States, is required to meet the same emissions standards in Canada as in the United States. Canadian vehicles will therefore have progressively improved emissions performance without specifying interim phase-in percentages in the Regulations. The final phased-in standards apply to all vehicles and engines sold in Canada, in the model year that they apply, to 100% of a class of vehicles or engines in the United States.

Vehicle Weight Classes. The regulations define the weight classes for vehicles and engines as outlined in Table 1.

Light-Duty Vehicles

The exhaust emissions standards for Light-Duty Vehicles, Light-Duty Trucks and Medium-Duty Passenger Vehicles align with the U.S. Tier 2 emissions standards. Manufacturers certify every vehicle to one of eleven "bins", each of which contains standards for NO_x, non-methane organic gases (NMOG), CO, formaldehyde and PM (see table in U.S. section). The manufacturers' choices of bin within which to certify each vehicle is limited by the obligation to comply with fleet average NO_x emissions standards.

Based on vehicle sales from each "bin", a company calculates a sales-weighted "fleet average NO_x value" for each model year. The emissions bins, fleet average NO_x emissions standards, timing of phase-ins and methods of calculating fleet average NO_x values are consistent with the U.S. Tier 2 emissions program. As in the U.S. program, the Canadian standards have separate fleet average requirements for LDV/LLDTs and HLDT/MDPVs until the end of the 2008 model year. However, there are no separate distinctions between Tier 2 vehicles and interim non-Tier 2 vehicles as in the U.S. program. All Canadian Tier 2 LDV/LLDTs must meet one fleet average requirement and all HLDT/MDPVs another, as outlined in Table 2.

While this results in an upper fleet average LDV/LLDT NO_x limit that is equal to that obtained for the U.S. Tier 2 program, there is a small difference for 2004-2006 HLDT/MDPVs fleet average NO_x limit for Canada. For the U.S. 2004-2006 model year HLDT/MDPVs, a significant proportion of sales do not have to meet Tier 2 or interim non-Tier 2 fleet average NO_x requirements. The only stipulation is that they meet bin 10 requirements if they are HLDTs or bin 11 requirements if they are MDPVs. The Canadian regulations require that all HLDT/MDPVs meet a fleet average NO_x requirement during this period.

As in the U.S. Tier 2 program, by 2009 when the standards are fully phased in, a company's combined fleet of light-duty vehicles, light-duty trucks and medium-duty passenger vehicles will be subject to a single fleet average NO_x emissions standard of 0.07 g/mile, corresponding to the NO_x standard in bin 5. A company can, in any model year, generate NO_x emissions credits by achieving a fleet average NO_x value that is lower than the standard. These credits can be used in a subsequent model year to offset a NO_x emissions deficit (the fleet average NO_x value exceeds the standard). A deficit must be offset no later than the third model year following the year in which it is incurred. NO_x emissions credits may also be transferred to another company.

In order to allow some flexibility in the regulations to account for market differences between Canada and the U.S., the Canadian regulations allow a company to exclude from the fleet average compliance requirement U.S. certified

Table 1. Vehicle Categories

Class	GVWR, kg (lb)
Motorcycle	≤793 (1,749)
Light-Duty Vehicle	≤3,856 (8,500)
Light-Duty Truck	≤3,856 (8,500)
Light Light-Duty Truck	≤2,722 (6,000)
Heavy Light-Duty Truck	>2,722 to 3,856 (6,000 to 8,500)
Medium-Duty Passenger Vehicle	3,856 to <4,536 (8,500 to 10,000)
Complete Heavy-Duty Vehicle (Otto Cycle Only)	3,856 to 6,350 (8,500 to 14,000)
Heavy-Duty Vehicle/Heavy-Duty Engine	>3,856 (8,500)
Light Heavy-Duty Engine	<8,847 (19,500)
Medium Heavy-Duty Engine	8,847 to 14,971 (19,500 to 33,000)
Heavy Heavy-Duty Engine	>14,971 (33,000)

Table 2. Canadian Fleet average NO_x requirements, g/mile

Model Year	LDV/LLDTs	HLDT/MDPV
2004	0.25	0.53
2005	0.19	0.43
2006	0.13	0.33
2007	0.07	0.20
2008	0.07	0.14
2009 & later	0.07	

vehicles that are sold concurrently in Canada and the U.S.A. For vehicle models certified to emissions bins having a NO_x standard higher than the fleet average, this is not allowed if the total number of vehicles of the particular model sold in Canada exceeds the number sold in the U.S.A. If a company chooses this option, they must include all eligible vehicles in that group, they cannot generate emissions credits or transfer credits to another company in that model year and they forfeit any emissions credits obtained in previous model years. In all cases, fleet average emissions must be reported at the end of the year.

Heavy-Duty Engines

Diesel Engines. Phase 1 standards for heavy-duty diesel truck and bus engines apply starting with the 2004 model year. As with the U.S. EPA, there are two options for NO_x+NMHC limits and tighter standards for urban busses (see U.S. table). Phase 2 standards apply starting with the 2007 model year.

In the U.S.A., the Phase 2 NMHC, CO and PM standards apply in 2007 and the NO_x standard is phased in from 2007-2010. In the case of a standard that is set out in the U.S. Code of Federal Regulations (CFR) to be phased in over a period of time, the standard comes into effect in Canada in the model year for which the CFR specifies that the standard applies to 100% of that class, and continues to apply until another standard comes into effect that applies to 100% of that class. This creates a difference in Canadian and U.S. standards during this phase in period. However, because every engine that is covered by an EPA certificate and that is sold concurrently in Canada and the U.S. must conform to the EPA certification and in-use standards, the differences in emissions profiles of engines sold during this period are expected to be small.

There are no emissions averaging, banking and trading options for heavy-duty engines in Canada.

Otto Engines. The standards for heavy-duty Otto cycle engines are outlined in Table 3. Phase 2 standards are the same as those for heavy-duty diesel engines and apply in 2008. As with the heavy-duty diesel engine standards, the NO_x standards in the U.S.A. are phased in and apply to 100% of engines in 2010. Similar comments apply here as those noted above for heavy-duty diesel engines during this phase-in period.

Table 3. Heavy-Duty Otto Engine Emissions Standards, g/bhp-hr

	GVWR kg (lb)	NO_x	NMHC	NO_x + NMHC	CO	PM
Pre-2005	≤ 6,350 (14,000)	4.0	1.1	-	14.4	-
	> 6,350 (14,000)	4.0	1.9	-	37.1	-
Phase 1 (2005)	≤ 6,350 (14,000)	-	-	1.0	14.4	-
	> 6,350 (14,000)	-	-	1.0	37.1	-
Phase 2 (2008 - 2010)	≥ 3,856 (8,500)	0.2	0.14	-	14.4	0.01

Table 4. Complete Heavy-Duty Vehicle Exhaust Emissions Standards, g/mi

	GVWR kg (lb)	NO_x	NMHC	HCHO	CO	PM
Phase 1 (2005)	3,856 - 4,536 (8,500 - 10,000)	0.9	0.28	-	7.3	-
	4,536 - 6,350 (10,000 - 14,000)	1	0.33	-	8.1	-
Phase 2 (2008 - 2009)	3,856 - 4,536 (8,500 - 10,000)	0.2	0.195	0.032	7.3	0.02
	4,536 - 6,350 (10,000 - 14,000)	0.4	0.23	0.04	8.1	0.02

Heavy-Duty Vehicles

Complete Heavy-Duty Vehicles. A complete heavy-duty vehicle is one with a gross vehicle weight rating of 6,350 kg (14,000 lb) or less and that is powered by an Otto-cycle engine and with the load carrying device or container attached after it leaves the control of the manufacturer. As with the U.S. EPA requirements, Phase 1 standards apply starting in the 2005 model year. Because the Phase 2 standards are phased in during 2008 in the U.S.A. and apply to 100% of U.S. vehicles only in 2009, similar comments to those made previously for heavy-duty diesel engines apply. The standards for these vehicles are outlined in Table 4:

Heavy-Duty Vehicles. On-road heavy-duty vehicles other than complete heavy-duty vehicles must meet the heavy-duty engine requirements for the particular engine installed in that vehicle. Alternatively, heavy-duty diesel vehicles of 6,350 kg (14,000 lb) GVWR or less can conform to the standards for complete heavy-duty vehicles.

There are no emissions averaging, banking and trading options for heavy-duty vehicles or complete heavy-duty vehicles in Canada.

Emissions Standards: Canada

Off-Road Vehicles And Engines

Emissions regulations have been adopted for the following categories of off-road engines:

- Off-Road Compression-Ignition Engines, such as those used in construction and agricultural machinery.
- Off-Road Small Spark-Ignition Engines.
- Marine Engines.

The authority for regulating railway locomotive emissions lies with Transport Canada under the Railway Safety Act. Environment Canada monitored locomotive emissions through information provided under a MOU signed by Environment Canada, the Canadian Council of Ministers of the Environment and the Railway Association of Canada in 1995. The MOU set a cap on annual NO_x emissions from railway locomotives operating in Canada of 115,000 tonnes per annum. Since this agreement expired in 2005, locomotive emissions remain unregulated.

Off-Road Compression-Ignition Engines

Prior to the *Canadian Environmental Protection Act 1999* (CEPA 1999), there was no federal authority for regulating emissions from off-road engines such as those typically found in construction, mining, farming and forestry machines. Under the December 2000 Ozone Annex to the 1991 Canada-United States Air Quality Agreement, Canada committed to establishing emissions regulations under CEPA 1999 for new off-road engines that aligned with the U.S. federal EPA requirements. In the period before the regulations were promulgated, Environment Canada signed MOUs with 13 engine manufacturers in 2000. Under the terms of these MOUs, manufacturers agreed to supply off-road diesel engines designed to meet U.S. EPA Tier 1 standards.

The Off-Road Compression-Ignition Engine Emissions Regulations were promulgated on February 23, 2005. These regulations introduced emissions standards for model year 2006 and later diesel engines used in off-road applications such as those typically found in construction, mining, farming and forestry machines. These regulations encompassed the U.S. EPA Tier 2 and Tier 3 standards. In November 2011, the regulations were amended to align with the U.S. EPA Tier 4 standards.

The Off-Road Compression-Ignition Engine Emissions Regulations apply to "reciprocating, internal combustion engines, other than those that operate under characteristics significantly similar to the theoretical Otto combustion cycle and that use a spark plug or other sparking device". This definition is not exactly the same as the definition of a diesel engine used in the On-Road Vehicle and Engine Emissions Regulations where a diesel engine is defined as one "that has operating characteristics significantly similar to those of the theoretical Diesel combustion cycle. The non-use of a throttle during normal operation is indicative of a diesel engine". The off-road regulations focus on the ignition mechanism while the on-road regulations focus on the load control mechanism in distinguishing the engine type.

The regulations specifically exempt engines:

- Designed exclusively for competition.
- Regulated by the On-Road Vehicle and Engine Emissions Regulations.
- Designed to be used exclusively in underground mines.
- With a per-cylinder displacement of less than 50 cm^3.
- For military machines used in combat or combat support.
- Being exported and not sold or used in Canada.
- Designed to be used in a vessel and for which the fuel, cooling and exhaust systems are integral parts of the vessel.

While not specifically exempted by the regulation, Environment Canada does not have legislative authority to regulate emissions from railway locomotive engines.

The Canadian Off-Road Compression-Ignition Engine Emissions Regulations do not include an optional averaging, banking and trading program as do the U.S. EPA regulations.

Tier 2/3 Standards. The Canadian Off-Road Compression-Ignition Engine Emissions Regulations align the engine certification values with those of the U.S. EPA Tier 2 and Tier 3 values, Table 1. The implementations dates, however, were later. In the U.S., compliance with Tier 2 requirements was mandatory as early as model year 2001 and with Tier 3 starting with model year 2006. Compliance in Canada with U.S. EPA Tier 2 requirements was not mandatory until the 2006 model year.

Table 1. Canadian Tier 2/3 Off-Road Compression-Ignition Engine Emissions Standards, g/kWh

Power (P), kW	Tier	Year	NMHC + NO_x	CO	PM
P < 8	Tier 2	2006	7.5	8.0	0.80
8 ≤ P < 19	Tier 2	2006	7.5	6.6	0.80
19 ≤ P < 37	Tier 2	2006	7.5	5.5	0.60
37 ≤ P < 75	Tier 2	2006	7.5	5.0	0.40
	Tier 3	2008	4.7	5.0	0.40
75 ≤ P < 130	Tier 2	2006	6.6	5.0	0.30
	Tier 3	2007	4.0	5.0	0.30
130 ≤ P < 225	Tier 3	2006	4.0	3.5	0.20
225 ≤ P < 450	Tier 3	2006	4.0	3.5	0.20
450 ≤ P < 560	Tier 3	2006	4.0	3.5	0.20
P > 560	Tier 2	2006	6.4	3.5	0.20

Tier 4 Standards. On November 17, 2011, Environment Canada adopted amendments to the Off-Road Compression-Ignition Engine Emissions Regulations which align Canadian emissions standards with the U.S. EPA Tier 4 standards for nonroad engines. The Tier 4 standards come into force on January 16, 2012 and apply to engines of the 2012 and later model years manufactured on and after January 16, 2012.

Table 2. Small Spark-Ignition Engine Emissions Standards, g/kWh						
Class	Engine Type	Displacement (D), cm^3	Date	HC + NO_x[b]	NMHC + NO_x	CO
1-A	Non-handheld	D < 66	2005	50	-	610
1-B		66 ≤ D < 100	2005	40	37	610
1		100 ≤ D < 225	2005[1]	16.1[a]	-	519[a]
			2005[2]	16.1	14.8	610
			2007	16.1	14.8	610
2		D ≥ 225	2005	12.1	11.3	610
3	Handheld	D < 20	2005	50	-	805
4		20 ≤ D < 50	2005	50	-	805
5		D ≥ 50	2005	119	-	603
			2006	96	-	603
			2007	72	-	603

a - Standards apply only when the engine is new
b - Some engine classes include a combined NMHC+NO_x standard that applies only when the engine is fueled by natural gas
1 - For models already in production at coming into force of the Regulations
2 - For models initially produced after coming into force of the Regulations

Alternative less stringent emissions standards, consistent with those available under the CFR, are available:

- For HC+NO_x levels for engines in machines used exclusively in wintertime, such as ice augers and snow-blowers; These engines are subject to the applicable CO standard.
- For replacement engines which are engines manufactured exclusively to replace an existing engine in a machine for which no current model year engine with physical or performance characteristics necessary for the operation of the machine exists.
- For class 3, 4 and 5 when less than 2000 engines of a particular model are sold in total in Canada to accommodate Canada-only niche products.

Mining Engines. Emissions from engines used exclusively in underground mining equipment fall under provincial jurisdiction. While emissions from these engines are not directly regulated, provincial regulations exist for ventilation rates in mines were these engines are used. Canadian Standards Association (CSA) standards have been established that describe the technical requirements and procedures necessary for the design, performance, and testing of new or unused non-rail-bound, diesel-powered, self-propelled machines in underground mines (MMSL02-043). Testing carried out according to these CSA standards establish the minimum ventilation rate required for any engine to keep air quality at an acceptable level. Some provinces base their ventilation requirements on the results of testing according to the CSA standards.

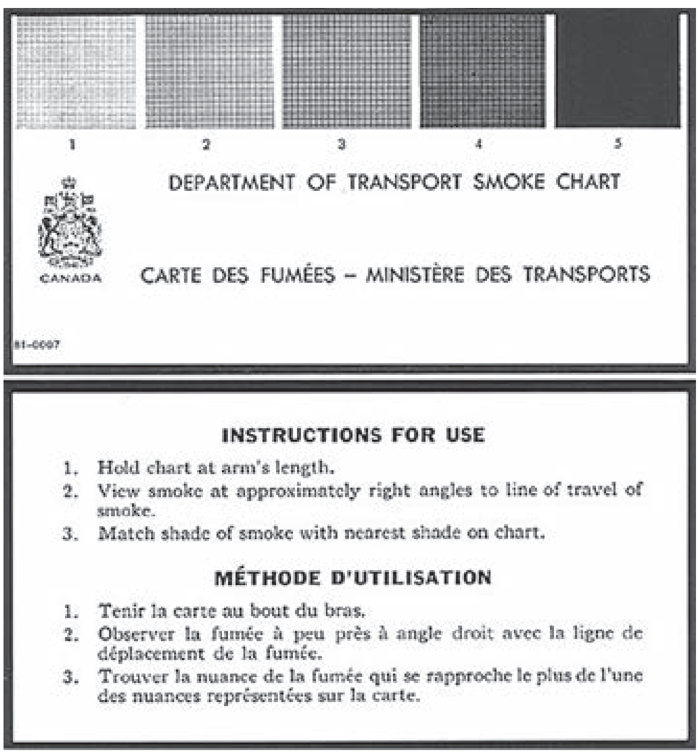
Off-Road Small Spark-Ignition Engines

The Off-Road Small Spark-Ignition Engine Emissions Regulations were promulgated on November 19, 2003. The Regulations apply to off-road engines of model year 2005 and later that use sparkplugs and develop no more than 19 kW (25 hp) of power. The emissions standards are divided into seven classes based on engine displacement and usage in either a handheld or non-handheld application as shown in Table 2.

Engines must meet the emissions standards throughout their useful life (with the exception of pre-2005 Class 1 engines, as indicated in the table). At the time of engine certification, a manufacturer can select one of three specified useful life periods, which range from 50 to 1000 hours depending on the engine class. For example, for a class 1 engine, the useful life can be 125, 250 or 500 hours. The selection of useful life duration must be supported by technical information. Longer useful lives, which entail a higher manufacturing cost, are typically found in commercial equipment while home consumer products are often designed for shorter useful lives.

On February 4, 2011, Environment Canada adopted Marine Spark-Ignition Engine, Vessel and Off-Road Recreational Vehicle Emissions Regulations. These emissions regulations apply to outboard engines, personal watercraft, snowmobiles, off-highway motorcycles and all-terrain vehicles. Most of the regulatory provisions came into force from April 5, 2011. The standards align with corresponding U.S. EPA rules for marine spark-ignition engines and off-road recreational engines

Figure 1. Smoke Density Chart



and vehicles. An earlier MOU with the Canadian Marine Manufacturers Association covered only marine spark ignition engines and under its terms, engine manufacturers voluntarily committed to supply engines designed to meet United States federal emissions standards into Canada starting with the 2001 model year.

Environment Canada plans to propose regulations to address emissions from large spark-ignition engines used in industrial applications such as forklifts and ice re-surfacing machines in the future.

Marine Engines

Authority to regulate emissions from marine propulsion engines smaller than 37 kW falls to Environment Canada. The Off-Road Compression-Ignition Engine Emissions Regulations cover compression ignition marine engines less than 37 kW. Regulations are planned for marine spark-ignition engines.

Transport Canada has authority to regulate emissions from marine propulsion engines larger than 37 kW. Current emissions standards from ships are under the authority of Transport Canada. The Air Pollution Regulations of the Canada Shipping Act regulates the density of black smoke from ships in Canadian waters and within 1 mile of land. Smoke density rating is determined by the Department of Transport Smoke Chart set out in the schedule of the regulations and reproduced below. For vessels with diesel engines a smoke density less than No. 1 is normally required with the exception that a smoke density of No. 2 for an aggregate of not more than 4 minutes in any 30-minute period is allowed (Figure 1).

Pollution Prevention Regulations under the Canada Shipping Act are under development to align with IMO MARPOL 73/78 Annex 6. This agreement sets limits for NO_x emissions from marine engines with power outputs more than 130 kW that have either been installed on a ship constructed on or after January 1, 2000 or have had major conversions on or after January 1, 2000.

Emissions Standards: Mexico
On-Road Vehicles And Engines

Background

Mexican emissions requirements for new vehicles and engines are adopted by the *Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT)*. Emissions compliance is generally required with either the U.S. or European emissions standards.

First emissions standards for both light- and heavy-duty vehicles were established on June 6, 1988 and became effective in model year 1993 [NOM-044-ECOL-1993]. The light-duty standards were later strengthened to be equivalent to the U.S. Tier 1, effective 2001 [NOM-042-ECOL-1999]. A mix of U.S. Tier 1/2 and Euro 3/4 standards is required since 2004 [NOM-042-SEMARNAT-2003].

New emissions requirements for heavy-duty truck and bus engines were adopted on October 12, 2006, which require compliance with U.S. 2004 or Euro 4 equivalent standards effective July 2008 [NOM-044-SEMARNAT-2006].

Light-Duty Vehicle Classification

Light-duty vehicles are defined as vehicles of GVW ≤ 3857 kg. Passenger cars (PC) are defined as vehicles with up to 10 seats, including the driver. Light trucks are classified in four groups — corresponding to the U.S. Light-Duty Truck 1 to 4 — based on the GVW and the test weight (weight of the vehicle with full fuel tank) as follows:

- CL1: GVW ≤ 2722 kg, test weight ≤ 1701 kg.
- CL2: GVW ≤ 2722 kg, test weight 1701 - 2608 kg.
- CL3: GVW 2722 - 3857 kg, test weight ≤ 2608 kg.
- CL4: GVW 2722 - 3857 kg, test weight 2608 - 3857 kg.

Weight ratings based on the European grouping for passenger cars and light commercial vehicles using a vehicle's reference mass (weight of vehicle with full tank of fuel + 100 kg) are also used:

- CL Class 1: reference mass ≤ 1305 kg.
- CL Class 2: reference mass > 1305 kg but ≤ 1760 kg.
- CL Class 3: reference mass > 1760 kg.

Model Year 1993-2003

Emissions standards for light-duty vehicles are summarized in Table 1. The standards were based on the U.S. regulations

Table 1. Emissions Standards for Cars and Light-Duty Trucks, g/km

Year	CO	NMHC*	NO_x		PM†
			Gasoline	Diesel	
Passenger Cars					
1993	2.11	0.25	0.62	0.62	0.07
2001	2.11	0.156	0.25	0.62	0.07
Light Trucks CL1					
1994	8.75	0.63	1.44	1.44	0.07
2001	2.11	0.156	0.25	0.62	0.07
Light Trucks CL2					
1994	8.75	0.63	1.44	1.44	0.07
2001	2.74	0.20	0.44	0.62	0.07
Light Trucks CL3					
1994	8.75	0.63	1.44	1.44	0.07
2001	2.74	0.20	0.44	0.62	0.07
Light Trucks CL4					
1994	8.75	0.63	1.44	1.44	0.10
2001	3.11	0.24	0.68	0.62	0.10

* total hydrocarbons (THC) prior to model-year 2001
† diesel vehicles only

and test methods (FTP-75). The 1993 requirements were based on the U.S. 1981 emissions standards. The 2001 requirements represent the U.S. Tier 1 standards *without OBD 2 provisions*.

The standards apply both to gasoline and diesel vehicles, with the exception of NO_x standards, as specified, and the PM standard that applies only to diesels. Natural gas and LPG vehicles have the same standards as gasoline vehicles.

Gasoline, natural gas, and LPG vehicles of all classes and all model years must also meet an evaporative (SHED) limit of 2 g/test.

Model Year 2004 and Later

The model year 2004 and later standards are based on U.S. Tier 1 and Tier 2 standards and Euro 3 and Euro 4 limits. New vehicles must meet the standards set out in either Table 2 (based on U.S. Tier 1/2 limits) or Table 3 (based on Euro 3/4 limits). Vehicles meeting these standards are also required to be equipped with OBD.

Notes to Table 2 and Table 3:

1. Emissions durability requirements:
   - 80,000 km / 50,000 miles for U.S. EPA option (Table 2), or
   - 100,000 km for European option (Table 3)
2. Gasoline vehicle standards also apply to natural gas and LPG vehicles.
3. Gasoline, natural gas, and LPG vehicles of all classes and all model years must also meet an evaporative (SHED) limit of 2 g/test.

An important factor in the phase-in of these vehicles is the introduction of gasoline with 30 ppm average and 80 ppm maximum sulfur, and diesel fuel with 15 ppm sulfur. The calendar year that these fuels become available nationally is referred to as "Year 1" (Aco 1). It is expected to be 2009, according to Mexican fuel quality regulations [NOM-086-SEMARNAT-SENER-SCFI-2005]. Vehicles meeting the "A" standard in Table 2 are those produced between 2004 to 2009. Vehicles meeting "B" standard in Table 2 and Table 3 are those produced from 2007 to "Year 3"— 2 calendar years after "Year 1". Vehicles meeting "C" standard

Table 2. Light-Duty Vehicle Emissions Limit Option Based on U.S. EPA Standards, g/km

Standard	Class	CO		NMHC		NO_x		PM	
		Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
A	PC	2.11		0.156		0.25	0.62	n/a	0.050
	CL1								
	CL2	2.74		0.200		0.44	0.62		0.062
	CL3								
	CL4	3.11		0.240		0.68	0.95		0.075
B	PC	2.11		0.099		0.249 0.062 0.075		n/a	0.050
	CL1								
	CL2								
	CL3	2.74		0.121					
	CL4								
C	PC	2.11		0.047		0.068 0.062		n/a	0.050
	CL1								
	CL2								
	CL3		0.087		0.124 0.075				
	CL4								

Table 3. Light-Duty Vehicle Emissions Limit Option Based on European Standards, g/km

Standard	Class	CO		NMHC		NO_x		PM	
		Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
B	PC	1.25	0.64	0.125	0.56	0.100	0.50	n/a	0.050
	CL Class 1								
	CL Class 2	2.26	0.80	0.162	0.72	0.125	0.65		0.070
	CL Class 3	2.83	0.95	0.200	0.86	0.137	0.78		0.100
C	PC	1.00	0.50	0.10	0.30	0.08	0.25	n/a	0.050
	CL Class 1								
	CL Class 2	1.81	0.63	0.13	0.39	0.10	0.33		0.040
	CL Class 3	2.27	0.74	0.16	0.46	0.11	0.39		0.060

Table 4. Phase-In Schedule of Light-Duty Vehicles Meeting B Standards

Standard	2007	2008	2009	2010
A	75%	50%	30%	0%
B	25%	50%	70%	100%

Table 5. Phase-In Schedule of Light-Duty Vehicles Meeting C Standards

Standard	Year 1	Year 2	Year 3	Year 4
A+B	75%	50%	30%	0%
C	25%	50%	70%	100%

in in Table 2 and Table 3 are those produced starting in "Year 1". The phase-in schedules for vehicles meeting B and C standards are laid out in Table 4 and Table 5, respectively.

While the standards in Table 2 and Table 3 are based on U.S. EPA limits and European limits, they are not necessarily structured the same way. For example, the NO_x and PM limits defined by the "A" standard in Table 2 are a combination of 50,000 mile and full useful life U.S. EPA Tier 1 limits. For the "B" and "C" standards, the PM limits do not change, (i.e., they stay at the Tier 1 limits) while the NO_x standards decrease to limits based on 50,000 mile U.S. EPA Tier 2 values. The NO_x limit for the "B" standard is U.S. Tier 2 Bin 10 and for the "C" standard is Bin 7 (for lighter vehicles) and Bin 9 (for heavier vehicles). With the exception of "B" standard for gasoline, LPG and natural gas, the standards in Table 3 are equivalent to Euro 3 and 4 limits. Note the different durability requirements for the standards in Table 2 (80,000 km) and Table 3 (100,000 km).

Heavy-Duty Trucks and Buses

Emissions standards for new heavy-duty diesel engines — applicable to vehicles of GVW > 3,857 kg — became first effective in model year 1993. These standards were based on U.S. 1991 and later requirements, including the U.S. EPA test methods (FTP transient test).

Table 6. Emissions Requirements for Diesel Truck and Bus Engines

Date	Requirements	
	US EPA	European
1993	US 1991	
1994	US 1994	
1998	US 1998	
2003.02	US 1998	Euro 3
2008.07†	US 2004	Euro 4

† Through 2011.06; later requirements are not specified.

Since February 2003, engines in Mexico can also meet European standards, as an alternative to the U.S. EPA requirements. The U.S. EPA or European reference standard requirements are summarized in Table 6.

No emissions standards were adopted for gasoline fueled trucks and buses.

Emissions Standards: European Union

Heavy-Duty Truck And Bus Engines

Regulatory Framework

European emissions regulations for new heavy-duty diesel engines are commonly referred to as Euro 1 ... 6. Sometimes Arabic numerals are also used (Euro 1 ... 6). We will use Roman numerals when referencing standards for heavy-duty engines, and reserve Arabic numerals for light-duty vehicle standards.

The emissions standards apply to all motor vehicles with a "technically permissible maximum laden mass" over 3,500 kg, equipped with compression ignition engines or positive ignition natural gas (NG) or LPG engines.

The regulations were originally introduced by the *Directive 88/77/EEC*, followed by a number of amendments. In 2005, the regulations were re-cast and consolidated by the *Directive 05/55/EC*. Beginning with the Euro 6 stage, the legislation became simplified, as "directives"— which need to be transposed into all of the national legislations — were replaced by "regulations" which are directly applicable. The following are some of the most important rulemaking steps in the heavy-duty engine regulations:

- Euro 1 standards were introduced in 1992, followed by the introduction of Euro 2 regulations in 1996. These standards applied to both truck engines and urban buses, the urban bus standards, however, were voluntary.
- In 1999, the EU adopted *Directive 1999/96/EC*, which introduced Euro 3 standards (2000), as well as Euro 4/5 standards (2005/2008). This rule also set voluntary, stricter emissions limits for extra low emissions vehicles, known as "enhanced environmentally friendly vehicles" or EEVs.
- In 2001, the European Commission adopted *Directive 2001/27/EC* which prohibits the use of emissions "defeat devices" and "irrational" emissions control strategies, which would be reducing the efficiency of emissions control systems when vehicles operate under normal driving conditions to levels below those determined during the emissions testing procedure.
- *Directive 2005/55/EC* adopted by the EU Parliament in 2005 introduced durability and OBD requirements, as well as re-stated the emissions limits for Euro 4 and Euro 5 which were originally published in 1999/96/EC. In a "split-level" regulatory approach, the technical requirements pertaining to durability and OBD — including provisions for emis-

Table 1. EU Emissions Standards for HD Diesel Engines, g/kWh (smoke in m^{-1})

Tier	Date	Test	CO	HC	NO_x	PM	Smoke
Euro 1	1992, < 85 kW	ECE R-49	4.5	1.1	8.0	0.612	
	1992, > 85 kW		4.5	1.1	8.0	0.36	
Euro 2	1996.10		4.0	1.1	7.0	0.25	
	1998.10		4.0	1.1	7.0	0.15	
Euro 3	*1999.10, EEVs only*	*ESC & ELR*	*1.5*	*0.25*	*2.0*	*0.02*	*0.15*
	2000.10	ESC & ELR	2.1	0.66	5.0	0.10 0.13[a]	0.8
Euro 4	2005.10		1.5	0.46	3.5	0.02	0.5
Euro 5	2008.10		1.5	0.46	2.0	0.02	0.5
Euro 6	2013.01		1.5	0.13	0.4	0.01	

[a] - for engines of less than 0.75 dm^3 swept volume per cylinder and a rated power speed of more than 3000 min^{-1}

sions systems that use consumable reagents — have been described by the Commission in *Directive 2005/78/EC*.

- Euro 6 emissions standards were introduced by *Regulation 595/2009* published on July 18, 2009 (with a Corrigenda of July 31, 2009). The new emissions limits, comparable in stringency to the U.S. 2010 standards, become effective from 2013 (new type approvals) and 2014 (all registrations). In the "split-level" approach, a number of technical details will be specified in the implementing regulation ('comitology') which should be adopted by the end of 2010.

Emissions Standards

Table 2 contains a summary of the emissions standards and their implementation dates. Dates in the tables refer to new type approvals; the dates for all type approvals are in most cases one year later (EU type approvals are valid longer than one year).

Since the Euro 3 stage (2000), the earlier steady-state engine test ECE R-49 has been replaced by two cycles: the European Stationary Cycle (ESC) and the European Transient Cycle (ETC). Smoke opacity is measured on the European Load Response (ELR) test. The following testing requirements apply:

1. Compression ignition (diesel) engines:
   - Euro 3:
     1. Conventional diesel engines: ESC/ELR test.
     2. Diesel engines with "advanced aftertreatment" (NO_x aftertreatment or DPFs) and EEVs: ESC/ELR + ETC.
   - Euro 4 and later: ESC/ELR + ETC.
2. Positive ignition gas (natural gas, LPG) engines, Euro 3 and later: ETC cycle.

Table 2. Emissions Standards for Diesel and Gas Engines, ETC Test, g/kWh

Tier	Date	Test	CO	NMHC	CH_4[a]	NO_x	PM[b]
Euro 3	*1999.10, EEVs only*	*ETC*	*3.0*	*0.40*	*0.65*	*2.0*	*0.02*
	2000.10	ETC	5.45	0.78	1.6	5.0	0.16 0.21[c]
Euro 4	2005.10		4.0	0.55	1.1	3.5	0.03
Euro 5	2008.10		4.0	0.55	1.1	2.0	0.03
Euro 6	2013.01		4.0	0.16[d]	0.5	0.4	0.01

[a] - for gas engines only (Euro 3-5: NG only; Euro 6: NG + LPG)
[b] - not applicable for gas fueled engines at the Euro 3-4 stages
[c] - for engines with swept volume per cylinder < 0.75 dm^3 and rated power speed > 3000 min^{-1}
[d] - THC for diesel engines

Table 3. Emissions Durability Periods

Vehicle Category†	Period*	
	Euro 4-5	Euro 6
N1 and M2	100 000 km / 5 years	160 000 km / 5 years
N2 N3 ≤ 16 ton M3 Class 1, Class 2, Class A, and Class B ≤ 7.5 ton	200 000 km / 6 years	300 000 km / 6 years
N3 > 16 ton M3 Class 3, and Class B > 7.5 ton	500 000 km / 7 years	700 000 km / 7 years

† Mass designations (in metric tons) are "maximum technically permissible mass"
* km or year period, whichever is the sooner

Emissions standards for diesel engines that are tested on the ETC test cycle, as well as for heavy-duty gas engines, are summarized in Table 2.

Euro 6 Regulation. Additional provisions of the Euro 6 regulation include:

- An ammonia (NH_3) concentration limit of 10 ppm applies to diesel (ESC + ETC) and gas (ETC) engines.
- A particle number limit, in addition to the mass limit, is to be introduced in the implementing regulation. The number limit would prevent the possibility that the Euro 6 PM mass limit is met using technologies (such as "open filters") that would enable a high number of ultra fine particles to pass.
- The world-harmonized test cycles — WHSC and WHTC — will be used for Euro 6 testing. WHSC/WHTC based limit values will be introduced by the implementing regulation based on correlation factors with the current ESC/ETC tests.
- A maximum limit for the NO_2 component of NO_x emissions may be defined in the implementing regulation.

Emissions Durability. Effective October 2005 for new type approvals and October 2006 for all type approvals, manufacturers should demonstrate that engines comply with the emissions limit values for useful life periods which depend on the vehicle category, as shown in Table 3.

Effective October 2005 for new type approvals and October 2006 for all type approvals, type approvals also require confirmation of the correct operation of the emissions control devices during the normal life of the vehicle under normal conditions of use ("conformity of in-service vehicles properly maintained and used").

Early Introduction of Clean Engines. EU Member States are allowed to use tax incentives in order to speed up the marketing of vehicles meeting new standards ahead of the regulatory deadlines. Such incentives have to comply with the following conditions:

- They apply to all new vehicles offered for sale on the market of a Member State which comply in advance with the mandatory limit values set out by the Directive.
- They cease when the new limit values come into effect.
- For each type of vehicle they do not exceed the additional cost of the technical solutions introduced to ensure compliance with the limit values.

Euro 6 type approvals, if requested, must be granted from August 7, 2009, and incentives can be given from the same date. Euro 6 incentives can also be given for scrapping existing vehicles or retrofitting them with emissions controls in order to meet Euro 6 limits.

Early introduction of cleaner engines can be also stimulated by such financial instruments as preferential road toll rates. In Germany, road toll discounts were introduced in 2005 which stimulated early launch of Euro 5 trucks.

Emissions Standards: European Union
Non-Road Diesel Engines

Background

The European emissions standards for new nonroad diesel engines have been structured as gradually more stringent tiers known as Stage 1-4 standards. Additionally, emissions standards have been adopted for small, gasoline fueled nonroad engines. The main regulatory steps were:

- Stage 1/2. The first European legislation to regulate emissions from nonroad (off-road) mobile equipment was promulgated on December 16, 1997 *[Directive 97/68/EC]*. The regulations for nonroad diesels were introduced in two stages: Stage 1 implemented in 1999 and Stage 2 implemented from 2001 to 2004, depending on the engine power output.
  The equipment covered by the standard included industrial drilling rigs, compressors, construction wheel loaders, bulldozers, nonroad trucks, highway excavators, forklift trucks, road maintenance equipment, snow plows, ground support equipment in airports, aerial lifts and mobile cranes. Agricultural and forestry tractors had the same emissions standards but different implementation dates *[Directive 2000/25/EC]*. Engines used in ships, railway locomotives, aircraft, and generating sets were not covered by the Stage 1/2 standards.
- On December 9, 2002, the European Parliament adopted Directive 2002/88/EC, amending the nonroad *Directive 97/68/EC* by adding emissions standards for small, gasoline fueled utility engines below 19 kW. The Directive also extended the applicability of Stage 2 standards on constant speed engines. The utility engine emissions standards are to a large degree aligned with the U.S. emissions standards for small utility engines.
- Stage 3/4. Stage 3/4 emissions standards for nonroad engines were adopted by the European Parliament on April 21, 2004 *[Directive 2004/26/EC]*, and for agricultural and forestry tractors on February 21, 2005 *[Directive 2005/13/EC]*.

Two additional Directives were adopted in 2010: *Directive 2010/26/EU* provides further technical details on the testing and approvals of Stage 3b and Stage 4 engines, and *Directive 2010/22/EU* amends the earlier legislation applicable to agricultural and forestry tractors.

Stage 3 standards — which are further divided into Stages 3a and 3b — are phased-in from 2006 to 2013, Stage 4 enter into force in 2014. The Stage 3/4 standards, in addition to the engine categories regulated at Stage 1/2, also cover railroad locomotive engines and marine engines used for inland waterway vessels. Stage 3/4 legislation applies only to new vehicles and equipment; replacement engines to be used in machinery already in use (except for railcar, locomotive and inland waterway vessel propulsion engines) should comply with the limit values that the engine to be replaced had to meet when originally placed on the market.

EU nonroad emissions standards usually specify two sets of implementation dates:

- *Type approval* dates, after which all newly type approved models must meet the standard, and
- *Market placement* (or first registration) dates, after which all new engines placed on the market must meet the standard.

The dates listed in the following tables are the market placement dates. In most cases, new type approval dates are one year before the respective market placement dates.

Regulatory authorities in the EU, U.S.A., and Japan have been under pressure from engine and equipment manufacturers to harmonize worldwide emissions standards, in order to streamline engine development and emissions type approval/certification for different markets. Stage 1/2 limits were in part harmonized with U.S. regulations. Stage 3/4 limits are harmonized with the U.S. Tier 3/4 standards.

Stage 1/2 Standards

Stage 1 and Stage 2 emissions shall not exceed the amount shown in Table 1. The Stage 1 emissions are engine-out limits and shall be achieved before any exhaust aftertreatment device.

A sell-off period of up to two years is allowed for engines produced prior to the respective market placement date. Since the sell-off period — between zero and two years — is

Table 1. EU Stage 1/2 Emissions Standards for Nonroad Diesel Engines

Cat.	Net Power	Date*	CO	HC	NO_x	PM
	kW		g/kWh			
			Stage 1			
A	130 ≤ P ≤ 560	1999.01	5.0	1.3	9.2	0.54
B	75 ≤ P < 130	1999.01	5.0	1.3	9.2	0.70
C	37 ≤ P < 75	1999.04	6.5	1.3	9.2	0.85
			Stage 2			
E	130 ≤ P ≤ 560	2002.01	3.5	1.0	6.0	0.2
F	75 ≤ P < 130	2003.01	5.0	1.0	6.0	0.3
G	37 ≤ P < 75	2004.01	5.0	1.3	7.0	0.4
D	18 ≤ P < 37	2001.01	5.5	1.5	8.0	0.8

* Stage 2 also applies to constant speed engines effective 2007.01

Table 2. Stage 3a Standards for Nonroad Engines

Cat.	Net Power	Date†	CO	NO_x+HC	PM
	kW		g/kWh		
H	130 ≤ P ≤ 560	2006.01	3.5	4.0	0.2
I	75 ≤ P < 130	2007.01	5.0	4.0	0.3
J	37 ≤ P < 75	2008.01	5.0	4.7	0.4
K	19 ≤ P < 37	2007.01	5.5	7.5	0.6

† dates for constant speed engines are: 2011.01 for categories H, I and K; 2012.01 for category J

determined by each Member State, the exact timeframe of the regulations may be different in different countries.

Emissions are measured on the ISO 8178 C1 8-mode cycle and expressed in g/kWh. Stage 1/2 engines are tested using fuel of 0.1-0.2% (wt.) sulfur content.

Stage 3/4 Standards

Stage 3 standards — which are further divided into two sub-stages: Stage 3a and Stage 3b — and Stage 4 standards for nonroad diesel engines are listed in Table 2, Table 3, and Table 4, respectively. These limit values apply to all nonroad diesel engines of indicated power range for use in applications other than propulsion of locomotives, railcars and inland waterway vessels.

The implementation dates in the following tables (Table 2 through Table 7) refer to the market placement dates. For all engine categories, a sell-off period of two years is allowed for engines produced prior to the respective *market placement* date. The dates for *new type approvals* are, with some exceptions, one year ahead of the respective market placement date.

Stage 3/4 standards also include a limit for ammonia emissions, which must not exceed a mean of 25 ppm over the test cycle.

Stage 3b standards introduce PM limit of 0.025 g/kWh, representing about 90% emissions reduction relative to Stage 2. To meet this limit value, it is anticipated that engines will have to be equipped with particulate filters. Stage 4 also introduces a very stringent NO_x limit of 0.4 g/kWh, which is expected to require NO_x aftertreatment.

To represent emissions during real conditions, a new transient test procedure — the Non-Road Transient Cycle (NRTC) — was developed in cooperation with the U.S. EPA. The NRTC is run twice — with a cold and a hot start. The final emissions results are weighted averages of 10% for the cold start and 90% for the hot start run. The new test will be used in parallel with the prior steady-state schedule, ISO 8178 C1, referred to as the Nonroad Steady Cycle (NRSC).

- The NRSC (steady-state) shall be used for stages 1, 2 and 3a, as well as for constant speed engines at all stages. The NRTC (transient) can be used for Stage 3a testing by the choice of the manufacturer.
- Both NRSC and NRTC cycles shall be used for Stage 3b and 4 testing (gaseous and particulate pollutants).

Inland Water Vessels

Unlike the Stage 1/2 legislation, the Stage 3a standards also cover engines used in inland waterway vessels, Table 5. Engines are divided into categories based on the displacement (swept volume) per cylinder and net power output. The engine categories and the standards are harmonized with the U.S. standards for marine engines. There are no Stage 3b or Stage 4 standards for waterway vessels.

Table 3. Stage 3b Standards for Nonroad Engines

Cat.	Net Power	Date	CO	HC	NO_x	PM
	kW		g/kWh			
L	130 ≤ P ≤ 560	2011.01	3.5	0.19	2.0	0.025
M	75 ≤ P < 130	2012.01	5.0	0.19	3.3	0.025
N	56 ≤ P < 75	2012.01	5.0	0.19	3.3	0.025
P	37 ≤ P < 56	2013.01	5.0	4.7†		0.025

† NO_x+HC

Table 4. Stage 4 Standards for Nonroad Engines

Cat.	Net Power	Date	CO	HC	NO_x	PM
	kW		g/kWh			
Q	130 ≤ P ≤ 560	2014.01	3.5	0.19	0.4	0.025
R	56 ≤ P < 130	2014.10	5.0	0.19	0.4	0.025

Table 5. Stage 3a Standards for Inland Waterway Vessels

Cat.	Displacement (D)	Date	CO	NO_x+HC	PM
	dm³ per cylinder		g/kWh		
V1:1	D ≤ 0.9, P > 37 kW	2007.01	5.0	7.5	0.40
V1:2	0.9 < D ≤ 1.2		5.0	7.2	0.30
V1:3	1.2 < D ≤ 2.5		5.0	7.2	0.20
V1:4	2.5 < D ≤ 5	2009.01	5.0	7.2	0.20
V2:1	5 < D ≤ 15		5.0	7.8	0.27
V2:2	15 < D ≤ 20, P ≤ 3300 kW		5.0	8.7	0.50
V2:3	15 < D ≤ 20, P > 3300 kW		5.0	9.8	0.50
V2:4	20 < D ≤ 25		5.0	9.8	0.50
V2:5	25 < D ≤ 30		5.0	11.0	0.50

Table 6. Stage 3a Standards for Rail Traction Engines

Cat.	Net Power	Date	CO	HC	HC+NO_x	NO_x	PM
	kW		g/kWh				
RC A	130 < P	2006.01	3.5	-	4.0	-	0.2
RL A	130 ≤ P ≤ 560	2007.01	3.5	-	4.0	-	0.2
RH A	P > 560	2009.01	3.5	0.5*	-	6.0*	0.2

* HC = 0.4 g/kWh and NO_x = 7.4 g/kWh for engines of P > 2000 kW and D > 5 liters/cylinder

Table 7. Stage 3b Standards for Rail Traction Engines

Cat.	Net Power	Date	CO	HC	HC+NO_x	NO_x	PM
	kW		g/kWh				
RC B	130 < P	2012.01	3.5	0.19	-	2.0	0.025
R B	130 < P	2012.01	3.5	-	4.0	-	0.025

Rail Traction Engines

Stage 3a and 3b standards have been adopted for engines above 130 kW used for the propulsion of railroad locomotives (categories R, RL, RH) and railcars (RC), Table 6 and Table 7.

Stage 5 Standards

Stage 5 emissions limits for engines in nonroad mobile machinery (category NRE) are shown in Table 8. These standards are applicable to diesel (CI) engines from 0 to 56 kW and to all types of engines above 56 kW. Engines above 560 kW used in generator sets (category NRG) must meet standards shown in Table 9.

Stage 5 regulations introduce a new limit for particle number emissions. The PN limit is designed to ensure that a highly efficient particle control technology — such as wall-flow particulate filters — be used on all affected engine categories. The Stage 5 regulation would also tighten the mass-based PM limit for several engine categories, from 0.025 g/kWh to 0.015 g/kWh.

HC Limits for Gas Engines. For engine categories where an A factor is defined, the HC limit for fully and partially gaseous fueled engines indicated in the table is replaced by the one calculated from the formula:

HC = 0.19 + (1.5 Ч A Ч GER)

where GER is the average gas energy ratio over the appropriate cycle. Where both a steady-state and transient test cycle applies, the GER shall be determined from the hot-start transient test cycle. If the calculated limit for HC exceeds the value of 0.19 + A, the limit for HC should be set to 0.19 + A.

In 2020, due to the COVID-19 pandemic, The European Parliament agreed to delay some Stage V transition deadlines by one year.

Table 8. Stage 5 Emissions Standards for Nonroad Engines

Ca.	Ign.	Net Power	Date	CO	HC	NO_x	PM	PN
		kW		g/kWh				1/kWh
NRE-v/c-1	CI	P < 8	2019	8.00	7.50[a,c]		0.40[b]	-
NRE-v/c-2	CI	8 ≤ P < 19	2019	6.60	7.50[a,c]		0.4	-
NRE-v/c-3	CI	19 ≤ P < 37	2019	5.00	4.70[a,c]		0.015	1×10^{12}
NRE-v/c-4	CI	37 ≤ P < 56	2019	5.00	4.70[a,c]		0.015	1×10^{12}
NRE-v/c-5	All	56 ≤ P < 130	2020	5.00	0.19[c]	0.4	0.015	1×10^{12}
NRE-v/c-6	All	130 ≤ P ≤ 560	2019	3.50	0.19[c]	0.4	0.015	1×10^{12}
NRE-v/c-7	All	P > 560	2019	3.50	0.19[d]	3.5	0.045	-

[a] HC+NO_x
[b] 0.60 for hand-startable, air-cooled direct injection engines
[c] A = 1.10 for gas engines
[d] A = 6.00 for gas engines

Table 9. Stage 5 Emissions Standards for Generator Set Engines Above 560 kW

Cat.	Ign.	Net Power	Date	CO	HC	NO_x	PM	PN
		kW		g/kWh				1/kWh
NRG-v/c-1	All	P > 560	2019	3.50	0.19[a]	0.67	0.035	-

[a] A = 6.00 for gas engines

Emissions Standards: Germany
Stationary Engines — TA Luft

Background

Emissions from stationary engines in Germany are controlled by the TA Luft regulation introduced in 1986 and later by the 44th BImSchV introduced in 2019.

The *Technische Anleitung zur Reinhaltung der Luft*, in short referred to as *TA Luft*, is a regulation covering air quality requirements—including emissions, ambient exposures and their control methods—applicable to a number of pollutants from a range of stationary sources. The TA Luft regulation, based on the “Federal Air Pollution Control Act” (“*Bundes-Immissionsschutzgesetz*”), was introduced and enforced by the German Environment Ministry BMU (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*).

Among other sources, the TA Luft regulation covers emissions of pollutants from stationary internal combustion engines. The TA Luft requirements have been widely applied to stationary gas and diesel engines not only in Germany, but also in several other European markets.

The most recent revision of the TA Luft regulation, known as *TA Luft 2002*, was adopted on July 24, 2002. Compared to the previous requirements, TA Luft 2002 introduced more stringent emission limits for particulate matter, sulfur oxides, and nitrogen oxides from internal combustion engines.

On June 20, 2019, updated emissions standards previously covered by TA Luft 2002 entered into force with the publication of 44. Verordnung zur Durchfьhrung des Bundes-Immissionsschutzgesetzes (Verordnung ьber mittelgroЯe Feuerungs-, Gasturbinen- und Verbrennungsmotoranlagen)—

44th BImSchV. While this incorporated EU Directive 2015/2193 (Medium Combustion Plant Directive, MCPD) into German law, 44th BImSchV included more stringent emission limits as well as limits on pollutants such as CO, NH3 and formaldehyde not included in the EU MCPD. Due to delays in finalization of the legislation, some of the 44th BImSchV requirements apply retroactively. The 44th BImSchV requirements apply to new plants while TA Luft 2002 requirements continue to apply to existing sources until the end of 2024.

Engine Emission Standards

TA Luft 2002 and 44th BImSchV emission limits are given in the following tables [4701][4700]. Different limits exist for compression ignition (CI) and for spark ignited (SI) engines. Gas fueled CI engines (dual fuel with diesel pilot ignition) often enjoy more relaxed limits, especially if fueled by biogas (such as sewage or landfill gas). It should be noted that the concentration values in the tables are at 5% O2 while those for the EU's MCPD are at 15% O2.

Under the 44th BImSCHv, existing installations are those that: (1) were put into service before December 20, 2018 or (2) were approved under the Federal Emission Control Act (Bundes-Immissionsschutzgesetz) and put into service by December 20, 2018. Installations to which the above definition does not apply are regarded as new installations. The 44th BImSchV limits apply to new installations according to the above dates and to exiting installations starting January 2025 unless otherwise noted.

The following apply to engines subject to the 44th BImSchV and used exclusively for emergency operation or operated no more than 300 h/year (peak shaving operation) [4700]:

- For new liquid fueled engines, a DPF is mandatory with particulate emissions limited to 5 mg/m3 unless particulate emissions are less than 50 mg/m3.
- For existing liquid fueled engines, a DPF is not required but particulate emissions must be less than 80 mg/m3.
- CO emissions are not controlled but state of the art measures must be used to limit emissions.
- Only for engines used exclusively only for emergency operation (not engines used < 300 h/y), the formaldehyde limit is 60 mg/m3.
- NOx emissions are not controlled for engines using liquid fuels, biogas, natural gas and LPG but state of the art measures must be used to limit emissions.
- NOx emissions from biogas engines operated < 300 h/y (not those used exclusively for emergency operation), are limited to 0.50 g/m3.
- SOx and total carbon emissions are not limited.

Consistent with the EU's MCPD, the 44th BImSchV has an

Table 1 TA Luft 2002 and 44th BImSchV emission limits for new and existing gaseous fueled engines
TAL = TA Luft 2002; BIm = 44th BImSchV; Values expressed as concentration at 5% O_2

Gaseous Fuel	Engine Type		Power MW_{th}		CO[e] g/Nm³		NOx[e] g/Nm³		SOx[a,e] mg/Nm³		HCHO mg/Nm³		TD[a] mg/Nm³		TC[e] mg/Nm³		NH_3[d] mg/Nm³	
	TAL	BIm	TAL	BIm	TAL	BIm	TAL	BIm	TAL	BIm	TAL	BIm[f]	TAL	BIm	TAL	BIm	TAL	BIm
Natural gas	Lean burn	-		-	0.3	0.25	0.5	New: 0.25 0.1 from 2029 Existing: 0.1 from 2029	9	9	60	New: 30[b] 20 from 2020 Existing: 30[b,c]				New & existing: 1.3 from 2025		30
	Other						0.25									New & existing, λ=1: 0.3 from 2025		
Mine gas	Lean burn				0.65	0.5	0.5	0.5	31	31	60			9		New & existing: 1.3 from 2025		30
	Other						0.25											
Biogas	Pilot injection	-	<3	-	2	0.5	1	New: 0.50[g] 0.1 from 2023 Existing: 0.1 from 2029	310	89	40					New: 1.3 from 2023 Existing: 0.3 from 2029		30
			≥3		0.65		0.5				40							
	Spark ignition		<3		1		0.5				60							
			≥3		0.65		0.5				60							
Sewage gas	Pilot injection	-	<3	-	2	0.5	1	0.5	310	89	60					New & existing: 1.3 from 2025		30
			≥3		0.65		0.5				60							
	Spark ignition		<3		1		0.5				60							
			≥3		0.65		0.25				60							
Landfill gas	Lean burn	-		-	0.65	0.65	0.5		310	New: 31 Existing: 31; 310 for P<1 MW_{th}	60	New: 60[b] 40 from 2025 Existing: 40		9				30
	Other						0.25				60							

[a] - these limit values are specified in the 44th BImSchV with 3% reference oxygen and are converted to 5% in this table
[b] - applies to spark-ignition or lean-burn engines; a limit value of 5 mg/m³ applies to other engines
[c] - if formaldehyde emissions of up to 40 mg/m³ were measured during the last emission measurement before 05.12.2016, the limit values must be complied with from 05.02.2019
[d] - for engines using selective catalytic or selective non-catalytic reduction
[e] - limits do not apply to emergency engines or engines used for peak shaving for less than 300 h/y
[f] - for emergency only engines, a limit of 60 mg/m³ applies
[g] - limit applies to biogas engines operating < 300 h/y

emission monitoring requirement. In most cases, this requires measurements once a year or once every 3 years depending on the fuel used and the particular emission component. However, NOx and NH3 emissions must be continuously monitored. Monitoring of NH3 is not required if an ammonia slip catalyst (ASC) is used.

All of the above engine emission limits are expressed as dry gas concentrations at STP conditions, that have been corrected to a 5% oxygen content using the following formula:

EB = EM Ч (21 - OB)/(21 - OM)

where:

EB - mass concentration of pollutant corrected for the reference O2 concentration,

EM - measured mass concentration of pollutant,

OB - reference O2 concentration, vol. %,

OM - measured O2 concentration, vol. %.

Table 2 TA Luft 2002 and 44th BImSchV emission limits for new and existing liquid fueled engines
TAL = TA Luft 2002; BIm = 44th BImSchV; Values expressed as concentration at 5% O_2

Liquid Fuel	Power		CO[b]		NOx[b]		HCHO		TD		NH_3[d]	
	MW_{th}		g/Nm³		g/Nm³		mg/Nm³		mg/Nm³		mg/Nm³	
	TAL	BIm	TAL	BIm	TAL	BIm	TAL	BIm	TAL	BIm	TAL	BIm
Diesel, light fuel oil, ethanol, methanol, etc.	<3	-	0.3	0.3	1	0.1	60	20/60[c]	20/80[a]	20/50[a]	-	30
	≥3	-			0.5							

[a] - higher value applies to engines used for emergency operation only or peak shaving operation for less than 300 h/y
[b] - limits do not apply to emergency engines or engines used for peak shaving for less than 300 h/y
[c] - higher value applies to engines used for emergency operation only
[d] - for engines using selective catalytic or selective non-catalytic reduction

The TA Luft 2002 limits for diesel engines are rather strict. The NOx limit of 0.5 g/Nm3 typically requires the use of SCR catalysts on large diesel engines.

Sulfur Regulations

According to TA Luft 2002, a liquid fired stationary engine is to burn a light fuel oil according to DIN 51603 Part 1 (March 1998) containing max. 0.2% (wt.) sulfur and with a lower heating value > 42.6 MJ/kg, or to reach an equivalent SO2 limit by installing a flue gas desulfurization unit. The equivalent SO2 limit resulting from the above fuel requirement is about 110 mg/Nm3 @ 15% O2 = approx. 300 mg/Nm3 @ 5% O2. The

TA Luft 2002 sulfur limits no longer apply to either new or existing installations.

Only the following liquid petroleum fuels may be used in stationary diesel engines: heating oils according to DIN 51603 Part 1 (petroleum fuels) or Part 6 (petroleum fuels/renewable fuel blends), March 2017 edition, with a maximum sulfur content of 0.1% mass or diesel fuels according to EN 590 with a maximum sulfur content of 10 mg/kg. Requirements for gaseous fuels are also covered by the regulations [4701][4702].

Emissions Standards: Russia
All Vehicles Categories

Light-Duty Vehicles

Russia adopts European emissions standards, which apply to both manufactured and imported vehicles. Implementation dates are listed in Table 1.

Heavy-Duty Engines

Heavy-duty highway engines are required to meet European emissions standards. The implementation schedule is outlined in Table 2.

Nonroad Engines

Russia adopts European emissions standards for mobile nonroad engines. Current requirements are shown in Table 3.

Fuel Quality

According to the "Technical rules on the Requirements for Automobile and Aviation Fuel, Diesel and Ship Fuel, Fuel for Reactive Engines and Heating Oil" (with amendments delaying the requirements), low sulfur diesel fuels are phased-in based on the following schedule:

- Euro 2 fuel is required from December 31, 2012.
- Euro 3 fuel (equivalent to EN 590:1999 with max 350 ppm sulfur) is required from December 31, 2014.
- Euro 4 fuel (equivalent to EN 590:2004 with max 50 ppm sulfur) is required from December 31, 2015.
- The state may order lower standard fuel for defense purposes. Fuels from the state reserve can be sold for five more years.

Table 1. Emissions Requirements for Light-Duty Vehicles

Date	Requirement
1999.01	Euro 1 (ECE R83.02)
2006.04	Euro 2 (ECE R83.03)
2008.01	Euro 3 (ECE R83.05 Stage 3)
2010.01	Euro 4 (ECE R83.05 Stage 4)
2014.01	Euro 5

Table 2. Emissions Requirements for Heavy-Duty Engines

Date	Requirement
1999.01	Euro 1 / Ecological Class 1 (ECE R49.02)
2006.01	Euro 2 / Ecological Class 2 (ECE R49.02 Stage 2)
2008.01	Euro 3 / Ecological Class 3 (ECE R49.04-A)
2010.01	Euro 4 / Ecological Class 4 (ECE R49.04-B1)
2014.01	Euro 5 / Ecological Class 5 (ECE R49.04-B2 C)

Table 3. Emissions Requirements for Mobile Nonroad Engines

Standard	EU Equivalent
GOST R41 96-99	Stage 1 (Dir 77/537/EC and Dir 97/68/EC, ECE R24 test)

Emissions Standards: Turkey
Non-Road Diesel Engines

Emissions standards for non-road engines are adopted by the Turkish Ministry of Industry and Trade. The standards are fully harmonized with the EU regulations, but implementation dates are different, as outlined in the following table. All the implementation dates are market placement dates.

Table 1. Turkish Emissions Standards for Nonroad Diesel Engines

Stage	Power (P), kW	Date
Mobile Nonroad Engines		
Stage 1 (Phase 1)	$37 \le P \le 560$	2003.04
Stage 2 (Phase 2)	$18 \le P \le 560$	2007
Stage 3a (Phase 3a)	$19 \le P \le 560$	2010
Stage 3b (Phase 3b)	$130 \le P \le 560$	2011
	$56 \le P < 130$	2012
	$37 \le P < 56$	2013
Stage 4 (Phase 4)	$130 \le P \le 560$	2014
	$56 \le P < 130$	2014.10
Inland Waterway Vessels		
Stage 3a (Phase 3a)	$37 \le P$	2010
Rail Engines		
Stage 3a (Phase 3a)	$130 \le P$	2010
Stage 3b (Phase 3b)	$130 \le P$	2012

Emissions Standards: Japan
New Engines And Vehicles

Regulatory Authorities

Japanese emissions standards for engines and vehicles and fuel efficiency targets are jointly developed by a number of government agencies, including:

- Ministry of the Environment (MOE).
- Ministry of Land, Infrastructure and Transport (MLIT).
- Ministry of Economy, Trade and Industry (METI).

In developing engine emissions standards and policies, the Ministry of the Environment relies on recommendations of its advisory body known as the Central Environment Council (CEC).

Engine and vehicle emissions standards are developed under the authority of the "Air Pollution Control Law", while fuel efficiency targets are adopted under the "Law Concerning the Rational Use of Energy" (Energy Conservation Law).

On-Road Engines and Vehicles

Japan introduced fist new engine emissions standards for on-road vehicles in the late 1980's. The Japanese standards, however, remained relaxed through the 1990's. In 2003 the MOE finalized very stringent 2005 emissions standards for both light and heavy vehicles. At the time they came to power, the 2005 heavy-duty emissions standards (NO_x = 2 g/kWh, PM = 0.027 g/kWh) were the most stringent diesel emissions regulation in the world. Effective 2009, these limits are further tightened (NO_x = 0.7 g/kWh, PM = 0.01 g/kWh) to a level in-between the U.S. 2010 and Euro 5 requirements.

Most categories of onroad vehicles, including passenger cars and heavy-duty trucks and buses, are also subject to mandatory fuel efficiency targets. The Japanese fuel efficiency requirements for heavy trucks and buses were the world's first fuel economy regulation for heavy vehicles.

Off-Road Engines

First emissions regulations for new off-road engines and vehicles, known as MOT/MOC standards, were adopted by the former Ministry of Transport (MOT) and Ministry of Construction (MOC).

After the reorganization of Japanese government in 2001, off-road engine emissions fell under the jurisdiction of MOE and MLIT, the same ministries that are responsible for regulating emissions from highway engines. First MOE/MLIT standards for off-road engines were promulgated in 2005.

Marine Engines

In 2003, the MLIT proposed emissions regulations for new and existing ocean-going ships. The regulations, aligned with the 1997 MARPOL 73/78 Annex 6 limits (by International Maritime Organization), require cutting NO_x emissions by about 10% from previous non-regulated levels.

Emissions Standards: Japan
In-Use Vehicle Regulations

Automotive NO_x and PM Law

In 1992, to cope with NO_x pollution from existing vehicle fleets the MOE adopted the Motor Vehicle NO_x Law, which aimed at the elimination of the oldest, most polluting vehicles from in-use fleets in certain geographical areas. In 2001, the regulation has been amended to also include PM emissions requirements, and renamed as Automotive NO_x and PM Law.

Produced in cooperation with: www.DieselNet.com

Tokyo Retrofit Program

The Tokyo government and several neighboring prefectures adopted diesel emissions regulations, which require retrofitting of older in-use diesel vehicles with PM control devices (catalytic converters or particulate filters), or else replacing them with newer, cleaner models. The Tokyo retrofit requirements became effective in October 2003.

Emissions Standards: Japan
On-Road Vehicles And Engines

Emissions standards for new diesel fueled commercial vehicles are summarized in Table 1 for light vehicles (chassis dynamometer test) and in Table 2 for heavy vehicles (engine dynamometer test).

Light-duty trucks and buses are tested on the 10-15 mode cycle, which will be fully replaced by the JC08 mode test by 2011. The test procedure for heavy-duty engines is the JE05 mode cycle (hot start version). Before 2005, heavy-duty engines were tested over the 13-mode cycle and the 6-mode cycle. Vehicles and engines are tested using 50 ppm S fuel for the 2005 standards.

Table 1. Diesel Emissions Standards for Light Commercial Vehicles GVW ≤ 3500 kg (≤ 2500 kg before 2005)

Vehicle Weight*	Date	Test	Unit	CO	HC	NO_x	PM
				mean (max)	mean (max)	mean (max)	mean (max)
≤ 1700 kg	1988	10-15 mode	g/km	2.1 (2.7)	0.40 (0.62)	0.90 (1.26)	
	1993			2.1 (2.7)	0.40 (0.62)	0.60 (0.84)	0.20 (0.34)
	1997			2.1 (2.7)	0.40 (0.62)	0.40 (0.55)	0.08 (0.14)
	2002			0.63	0.12	0.28	0.052
	2005[b]	JC08[c]		0.63	0.024[d]	0.14	0.013
	2009			0.63	0.024[d]	0.08	0.005
> 1700 kg	1988	6 mode	ppm	790 (980)	510 (670)	DI: 380 (500) IDI: 260 (350)	
	1993	10-15 mode	g/km	2.1 (2.7)	0.40 (0.62)	1.30 (1.82)	0.25 (0.43)
	1997[a]			2.1 (2.7)	0.40 (0.62)	0.70 (0.97)	0.09 (0.18)
	2003			0.63	0.12	0.49	0.06
	2005[b]	JC08[c]		0.63	0.024[d]	0.25	0.015
	2009[e]			0.63	0.024[d]	0.15	0.007

* - gross vehicle weight (GVW)
[a] - 1997: manual transmission vehicles; 1998: automatic transmission vehicles
[b] - full implementation by the end of 2005
[c] - full phase-in by 2011
[d] - non-methane hydrocarbons
[e] - 2009.10 for new domestic models; 2010.09 for existing models & imports

Table 2. Diesel Emissions Standards for Heavy Commercial VehiclesGVW > 3500 kg (> 2500 kg before 2005)

Date	Test	Unit	CO	HC	NO_x	PM
			mean (max)	mean (max)	mean (max)	mean (max)
1988/89	6 mode	ppm	790 (980)	510 (670)	DI: 400 (520) IDI: 260 (350)	
1994	13 mode	g/kWh	7.40 (9.20)	2.90 (3.80)	DI: 6.00 (7.80) IDI: 5.00 (6.80)	0.70 (0.96)
1997[a]			7.40 (9.20)	2.90 (3.80)	4.50 (5.80)	0.25 (0.49)
2003[b]			2.22	0.87	3.38	0.18
2005[c]	JE05		2.22	0.17[d]	2.0	0.027
2009			2.22	0.17[d]	0.7	0.01

[a] - 1997: GVW ≤ 3500 kg; 1998: 3500 < GVW ≤ 12000 kg; 1999: GVW > 12000 kg
[b] - 2003: GVW ≤ 12000 kg; 2004: GVW > 12000 kg
[c] - full implementation by the end of 2005
[d] - non-methane hydrocarbons

Produced in cooperation with: **www.DieselNet.com**

Emissions Standards: Japan
Off-Road Engines

Regulatory Background

After the reorganization of Japanese government in 2001, off-road engine emissions standards became the responsibility of MOE and MLIT. The former MOT/MOC emissions regulations were replaced by three groups of emissions standards, applicable to the following categories of equipment:

1. *Special Motor Vehicles* — self-propelled nonroad vehicles and machinery that are registered for operation on public roads (fitted with license plates).
2. *Nonroad Motor Vehicles* — self-propelled and non-registered nonroad vehicles and machinery.
3. *Portable And Transportable Equipment: Recognition System* — recognition of low emissions engines for designation of low emissions construction machinery.

Special/Nonroad Motor Vehicles

These standards apply to nonroad vehicles rated between 19-560 kW with *(Special Motor Vehicles)* or without *(Nonroad Motor Vehicles)* licence plates. The emissions limits for the two vehicle categories are the same, but they are introduced by separate regulatory acts. On June 28, 2005, the MOE promulgated a new set of standards for Special Vehicles, superseding former MOT standards. On March 28, 2006, the same standards were promulgated for Nonroad Vehicles, superseding former MOC standards.

The standards are summarized in Table 1 for compression ignition engines, and in Table 2 for spark ignited engines. Emissions are measured according to JIS B 8001-1 (Japanese version of ISO 8178) 8-mode test for diesel, 7-mode test for SI. Smoke is measured according to JCMAS T-004.

These standards, although similar in stringency to the U.S. Tier 3 (2006-2008) and the EU Stage 3a (2005-2007), are not harmonized with U.S. and EU regulations. The standards do not require the use of exhaust aftertreatment devices, such as diesel particulate filters. The MOE's Central Environmental Council indicated it will consider adopting "aftertreatment-forcing" standards with implementation dates around 2010.

Table 1. Emissions Standards for Diesel Special/Nonroad Vehicles, g/kWh

Power (P)	CO	HC	NO_x	PM	Smoke	Date	
kW	g/kWh				%	New Models	All Models†
19 ≤ P < 37	5.0	1.0	6.0	0.4	40	2007.10	2008.09
37 ≤ P < 56	5.0	0.7	4.0	0.3	35	2008.10	2009.09
56 ≤ P < 75	5.0	0.7	4.0	0.25	30	2008.10	2010.09
75 ≤ P < 130	5.0	0.4	3.6	0.2	25	2007.10	2008.09
130 ≤ P < 560	3.5	0.4	3.6	0.17	25	2006.10	2008.09

† Applies to continuously produced nonroad vehicles (but not special vehicles) and imported special/nonroad vehicles.

Table 2. Emissions Standards for Spark Ignited Special/Nonroad Vehicles, g/kWh

Power (P)	7-mode			Idle		Date	
	CO	HC	NO_x	CO	HC	New Models	All Models†
kW	g/kWh			%	ppm		
19 ≤ P < 560	20.0	0.60	0.60	1	500	2007.10	2008.09

† Applies to continuously produced nonroad vehicles (but not special vehicles) and imported special/nonroad vehicles.

Portable/Transportable Equipment (Recognition System)

Under the recognition system regulations that became effective on March 17, 2006, manufacturers may apply for their engines to be recognized as a *low emissions engine* for use in designated *low emissions construction machinery*. The recognition system applies to portable and transportable (i.e., non-self-propelled) equipment, which is not emissions regulated under the Special/Nonroad Motor Vehicle regulations.

The emissions standards are listed in Table 3. Emissions are measured over the JIS B 8001-1 (ISO 8178) 8-mode test. For generator application, the rated speed is for 60 Hz and the intermediate speed is for 50 Hz.

Table 3. Emissions Limits — Recognition System, g/kWh

Power (P)	CO	HC	NO_x	PM	Smoke
kW	g/kWh				%
8 ≤ P < 19	5.0	7.5*		0.4	40
19 ≤ P < 37	5.0	1.0	6.0	0.4	40
37 ≤ P < 56	5.0	0.7	4.0	0.3	35
56 ≤ P < 75	5.0	0.7	4.0	0.25	30
75 ≤ P < 130	5.0	0.4	3.6	0.2	25
130 ≤ P < 560	3.5	0.4	3.6	0.17	25

* NO_x + HC

Emissions Standards: Japan
Fuel Economy

Heavy-Duty Vehicles: 2015 Targets

The fuel economy standards for heavy vehicles — effective from 2015 — apply to diesel fueled, type-approved commercial vehicles with GVW > 3.5 t, including trucks and buses designed to carry 11 or more passengers. The standards are also applicable to non-type-approved diesel vehicles that are equipped with CO or other emissions control devices. Fuel economy from heavy vehicles fueled by gasoline, LPG or other alternative fuels is not regulated.

When the targets are fully met, the fleet average fuel economy is estimated at:

- For trucks: 7.09 km/L (369.6 g CO_2/km), a 12.2% increase over 2002 performance of 6.32 km/L (414.6 g CO_2/km).
- For buses: 6.30 km/L (416.0 g CO_2/km), a 12.1% increase over 2002 performance of 5.62 km/L (466.3 g CO_2/km).

Table 1. 2015 Fuel Efficiency Targets for Heavy-Duty Transit Buses

Category	GVW, t	FE Target, km/L
1	6 < GVW ≤ 8	6.97
2	8 < GVW ≤ 10	6.30
3	10 < GVW ≤ 12	5.77
4	12 < GVW ≤ 14	5.14
5	14 < GVW	4.23

Table 2. 2015 Fuel Efficiency Targets for Heavy-Duty General (Non-Transit) Buses

Category	GVW, t	FE Target, km/L
1	3.5 < GVW ≤ 6	9.04
2	6 < GVW ≤ 8	6.52
3	8 < GVW ≤ 10	6.37
4	10 < GVW ≤ 12	5.70
5	12 < GVW ≤ 14	5.21
6	14 < GVW ≤ 16	4.06
7	16 < GVW	3.57

The standards for heavy vehicles are summarized in the following tables.

Testing. A computer simulation procedure has been developed that allows to calculate fuel efficiency (in km/L) of heavy-duty trucks and buses based on engine dynamometer testing. The engine testing is performed over the urban JE05 test and over an interurban transient test (speed: 80 km/h, load factor: 50%). A number of vehicle factors, such as vehicle mass, payload, tire size, gear ratios and efficiency, and others are accounted for in the calculation.

Table 3. 2015 Fuel Efficiency Targets for Heavy-Duty Trucks (Excluding Tractors)

Category	GVW, t	Max Load (L), t	FE Target, km/L
1	3.5 < GVW ≤ 7.5	L ≤ 1.5	10.83
2		1.5 < L ≤ 2	10.35
3		2 < L ≤ 3	9.51
4		3 < L	8.12
5	7.5 < GVW ≤ 8		7.24
6	8 < GVW ≤ 10		6.52
7	10 < GVW ≤ 12		6.00
8	12 < GVW ≤ 14		5.69
9	14 < GVW ≤ 16		4.97
10	16 < GVW ≤ 20		4.15
11	20 < GVW		4.04

Table 4. 2015 Fuel Efficiency Targets for Heavy-Duty Tractors

Category	GVW, t	FE Target, km/L
1	GVW ≤ 20	3.09
2	GVW > 20	2.01

Emissions Standards: China
Heavy-Duty On-Road Engines

Implementation Schedule

With a few exceptions, emission standards for new on-road heavy-duty vehicles (HGV) and engines are based on the European standards. Implementation dates for the emission standards are listed in Table 1. China 6a and China 6b standards include the same emission limits, but China 6b includes some more stringent in-use (PEMS) testing and monitoring requirements.

China 3-7 Emission Standards
Emission Limits

The legislation for China 3-5 stages — which were based on Euro 3-5, respectively — was adopted in 2005 *[2881]*. The emission limits are shown in Table 2.

At the China 1/2 stage (not shown in the table), the test was ECE R-49 or the Chinese 9-mode.

Supplemental China 4-5 Requirements

Supplemental requirements were adopted to prevent excess NOx emissions during low-speed, urban driving conditions from some HDVs type approved to China 4 and China 5 standards. These requirements included:

- World Harmonized Transient Cycle (WHTC) limits — applicable in Beijing and nationally, and
- PEMS testing requirements — first applicable in Beijing, then nationally.

The Beijing Municipal Environmental Protection Bureau (EPB) released two local standards in February 2013 and the Ministry of Environmental Protection adopted a national standard in January 2014. These standards are supplemental to China 4 and 5 standards and apply to China 4 and 5 vehicles with GVW > 3,500 kg, registered in Beijing and nationally, respectively.

Table 1. Emission standards implementation dates							
Stage		Beijing	Shanghai	Guangzhou Type Approval	Nationwide		Initially Scheduled
					All Vehicles		
China 1					2000.09	2001.09	
China 2					2003.09	2004.01	
China 3	PI	2010.07	2010.08	2009.07	2009.07	2010.07	2007.07
	CI	2006.01	2007.01	2007.07	2007.01	2008.01	2007.01
China 4	PI	2011.01			2012.07	2013.07	2010.01
	CI	2011.01	2009.11	2010.08	2010.01	2015.01	2010.01
China 5		2013.02[a,c] 2015.06[b]	2014.01[a]	2016.01[a]		2016.04[d,e] 2017.01[e] 2017.07[b]	2012.01
China 6a	Gas					2019.07	
	All					2021.07[f]	
China 6b	Gas					2021.07	
	All					2023.07	

[a] Public buses and municipal service vehicles
[b] All vehicles
[c] Starting 2016.01, DPFs are also required on new public HDDVs (buses and municipal service vehicles)
[d] Beijing, Shanghai, Tianjin, Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong and Guangzhou
[e] Public transportation buses, sanitary and postal vehicles
[f] 2020.07 for urban HDVs

Table 2. China 3-5 emission standards for heavy-duty engines								
Stage	Test Cycle	CO	HC	NMHC	NOx	PM	NH_3	Smoke
		g/kWh					ppm	1/m
China 3	ESC + ELR	2.1	0.66	-	5.0	0.10[a]		0.8
	ETC	5.45	-	0.78	5.0	0.16[a]		-
China 4	ESC + ELR	1.5	0.46	-	3.5	0.02		0.5
	ETC	4.0	-	0.55	3.5	0.03		-
China 5	ESC + ELR	1.5	0.46	-	2.0	0.02	10[b]	0.5
	ETC	4.0	-	0.55	2.0	0.03	10[b]	-

[a] 0.13/0.21 (ESC/ETC) for engines < 0.75 L per cylinder and rated speed > 3000 rpm
[b] Cycle average; 25 ppm maximum

Table 3. Beijing WHTC emission limits for diesel and gas China IV and V engines, g/kWh						
Stage	Date	CO	NMHC	CH_4[a]	NOx	PM[b]
China 4	2013.03	4.0	0.55	1.1	3.7	0.03
China 5	2013.07[c]	4.0	0.55	1.1	2.8	0.03

[a] Only gas engines
[b] Not applicable to gas engines
[c] Buses and sanitary vehicles; other vehicles upon availability of suitable fuel

Table 4. National WHTC emission limits for diesel China IV and V engines, g/kWh					
Stage	Date	CO	NMHC	NOx	PM
China 4	2015.01	4.0	0.55	3.7	0.03
China 5	in line with China 5	4.0	0.55	2.8	0.03

WHTC Limits. One of the Beijing standards *[2895]* implemented March 1, 2013 and the national standard *[2897] [3400]* implemented January 1, 2015, required China 4 and 5 engines to be tested over the WHTC in addition to the ETC (in Europe, testing over the WHTC was not required until the Euro 6 stage). The Beijing standards applied to diesel and gas fueled engines while the national standards applied to only diesel fueled engines. Both cold-start and hot-start tests were required, with results weighted 14% and 86%, respectively. Table 3 and Table 4 provide the WHTC cycle limits for the China 4 and 5 stages. Most of the limit values are equal to the Euro 4/5 ETC values except those for NOx emissions.

PEMS Testing. The second Beijing standard [2896], implemented July 1, 2013, established in-use, complete vehicle Portable Emission Measurement System (PEMS) testing requirements for manufacturers to prove that real-world emissions do not overly exceed the type approval limit values. From October 1, 2017, PEMS testing requirements became effective nationally, applicable to new type approvals of China V heavy-duty diesel- and gas-powered models.

China 6 Emission Standards

The first proposal for Euro 6-based emission standards was published in 2015 by the City of Beijing. These Beijing 6 emission standards were never finalized and have been replaced with the national China 6 program. The final China 6 emission standards were published in 2018, with a phase-in schedule from 2019.07 through 2023.07 (Table 1). The emission limits are shown in Table 5.

Table 5. China 6 emission standards for heavy-duty engines

Stage	Test Cycle	CO	HC	NMHC	CH_4	NOx	PM	PN	NH_3
		mg/kWh						kWh^{-1}	ppm
China 6 CI	WHSC	1500	130	-	-	400	10	8.0×10^{11}	10
	WHTC	4000	160	-	-	460	10	6.0×10^{11}	10
	WNTE	2000	220	-	-	600	16	-	-
China 6 PI	WHTC	4000	-	160	500	460	10	6.0×10^{11}	10
	WNTE	2000	220	-	-	600	16	-	-

Table 6. Emission durability requirements

Category	Useful Life		Aftertreatment Testing	
	China 1-5	China 6	GB 20890-2007	HJ 438-2008
M1 (GVW > 3.5 t) M2	100,000 km/5 yrs	200,000 km/5 yrs	50,000 km	100,000 km
M3 (GVW ≤ 7.5 t) N2 and N3 (GVW ≤ 16 t)	200,000 km/6 yrs	300,000 km/6 yrs	60,000 km	125,000 km
M3 (GVW > 7.5 t) N3 (GVW > 16 t)	500,000 km/7 yrs	700,000 km/7 yrs	80,000 km	167,000 km

The China 6 regulation includes a multi-component compliance program involving agency- and manufacturer-run emission tests during pre-production, production, and in-use stages. It also includes full vehicle PEMS testing requirements based on the European PEMS regulations.

The China 6 standards include two phases, China 6a and China 6b. China 6a is largely equivalent to the Euro 6 standard. China 6b introduces more stringent testing requirements (including a PN limit of 1.2Ч1012 kWh-1 for full-vehicle PEMS tests) and a remote emission monitoring system.

Emission Durability

Emission durability requirements, including the engine useful life and the minimum aftertreatment testing periods, are shown in Table 6. The aftertreatment periods according to HJ 438-2008 are mandatory for type approval and production conformity, while GB 20890-2007 provides a guideline to conduct aftertreatment durability testing during product development.

The GB 20890-2007 standard recommends that aftertreatment testing be conducted on-vehicle, over the China Heavy-Duty Durability Cycle — Vehicle (C-HDD-V). Alternatively, an engine-based durability test can be conducted over the China Heavy-Duty Durability Cycle — Engine (C-HDD-E).

Emission Warranty. China 6 regulations introduced the first mandatory emission warranty program for HDVs. The China 6 minimum emission warranty periods are 80,000 km/5 years for vehicle categories M1, M2 and N1; and 160,000 km/5 years for categories M3, N2, and N3.

OBD Requirements

China 6 regulations include OBD requirements that are based on the Euro 6 OBD program. An OBD system must be installed on all China 6 engines and vehicles to identify, record and communicate types of malfunctions. The OBD threshold limits are listed in Table 7. If emissions exceed an OBD threshold over a certain amount of time, a permanent code must be stored in the computer. An operator inducement system is also required that, when activated, reduces the vehicle torque and/or limits the maximum speed.

Remote OBD. China 6b standards require HDVs to be equipped with an on-board remote emissions monitoring system. Real-time engine data from the ECU, NOx sensor, DPF and other emission-related data are required to be reported remotely to the monitoring center of the regulatory agency.

Table 7. OBD threshold limits, mg/kWh

Engine type	NOx	PM	CO
Compression ignition	1200	25	-
Gas-fueled positive ignition	1200	-	7500

Emissions Standards: China
Non-Road Engines

Regulatory Background

The implementation of China's emission standards for diesel and small spark ignition (SI) mobile nonroad engines is summarized in Table 1. Some of the important regulatory steps include:

Diesel Stage 2/3 standards: The first emission standards for mobile nonroad diesel engines (GB 20891-2007) were adopted in 2007 [2880]. The requirements were based on the European Stage 1/2 nonroad emission standards. However, the Chinese regulation also covered small diesel engines, which were not subject to the European standards. Emission limits for the smallest engines were consistent with US Tier 1/2 nonroad standards.

A Stage 4 implementation date of 2020.01 was proposed and later changed to 2020.12.

Smoke emissions: In September 2018, a test procedure and limits for measuring smoke emissions from non-road equipment and vehicles, GB 36886-2018, was published. The procedure became effective in December 2018.

Table 1. Implementation of National Non-Road Engine Emission Standards

Year	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21+
Diesel	1		1/2	2				2/3	3						4
Small SI; HH					1				2						
Small SI; nHH					1		2								

Table 2. Stage 1/2 Standards for Non-Road Diesel engines, g/kWh

Max Power (P), kW	CO	HC	NOx	HC+NOx	PM
Stage1†					
130 ≤ P ≤ 560	5.0	1.3	9.2	-	0.54
75 ≤ P < 130	5.0	1.3	9.2	-	0.7
37 ≤ P < 75	6.5	1.3	9.2	-	0.85
18 ≤ P < 37	8.4	2.1	10.8	-	1.0
8 ≤ P < 18	8.4	-	-	12.9	-
0 < P < 8	12.3	-	-	18.4	-
Stage 2					
130 ≤ P ≤ 560	3.5	1.0	6.0	-	0.2
75 ≤ P < 130	5.0	1.0	6.0	-	0.3
37 ≤ P < 75	5.0	1.3	7.0	-	0.4
18 ≤ P < 37	5.5	1.5	8.0	-	0.8
8 ≤ P < 18	6.6	-	-	9.5	0.8
0 < P < 8	8.0	-	-	10.5	1.0

† Stage 1 limits shall be achieved before any exhaust aftertreatment device.

Table 3. Stage 3 and Proposed Stage 4 Limits

Stage	Power	CO	HC	NOx	HC+NOx	PM
	kW	g/kWh				
Stage 3	P>560	3.5			6.4	0.20
	130≤P≤560	3.5			4.0	0.20
	75≤P<130	5.0			4.0	0.30
	37≤P<75	5.0			4.7	0.40
	P<37	5.5			7.5	0.60
Proposed Stage 4	P>560	3.5	0.40	3.5, 0.67*		0.10
	130≤P≤560	3.5	0.19	2.0		0.025
	75≤P<130	5.0	0.19	3.3		0.025
	56≤P<75	5.0	0.19	3.3		0.025
	37≤P<56	5.0			4.7	0.025
	P<37	5.5			7.5	0.60

* Applicable to mobile generator sets with Pmax > 900 kW diesel engines

Small SI Stage 1/2 standards: In December 2010, emissions standards for mobile nonroad spark ignition engines < 19 kW were published (GB26133-2010), with limits based on EU and US standards. Stage 1 requirements became effective 2010.03. Stage 2 implementation was different for non-handheld/handheld engines with requirements for new engine types starting 2013.01/2015.01 respectively and all new engines 2014.01/2016.01 respectively.

Diesel Engines

Stage 1/2 Emission Standards

The standards, Table 2, were based on European regulations. The compliance dates were:

- Stage 1 standards: 2007.10
- Stage 2 standards: 2009.10

Emissions were measured over a steady-state test cycle equivalent to the ISO 8178 C1, 8-mode test. Other ISO 8178 test cycles could be used for selected applications.

Stage 3/4 Emission Standards

GB20891-2014 included the Stage 3 limits as well as Stage 4 limits, Table 3. The Stage 3 limits are based on EU Stage 3a standards and the proposed Stage 4 limits on EU Stage 3b standards but with the addition of engines with net power >560 kW and < 37 kW. Limits for engines above 560 kW and under 37 kW are based on US Tier 2 requirements. Stage 3 engines and constant speed Stage 4 engines are measured over the ISO 8178. Variable speed Stage 4 engines were to be tested over the NRTC. Durability requirements are shown in Table 4 .

Stage 4 Emission Standards—2018/19 Revisions

The Stage 4 requirements proposed in GB 20891-2014, Table 3, were further clarified and supplemented with additional requirements through a proposal issued 2018.02. This proposal supplemented the Stage 4 requirements in Table 3 with a DPF-forcing standard — a maximum PN limit of 5Ч1012 #/kWh. Engine manufacturers were also encouraged to instead meet limits based on EU Stage 5 limits, Table 5.

Initially, an implementation date of 2020.01 was proposed; all nonroad engines produced on or after this date would be required to meet the updated Stage 4 requirements. A revision to the proposal published 2019.02 changed the implementation date to 2020.12, pointed to a supplemental document "Technical Requirements for Non-road Diesel Mobile Machinery Pollutant Emission Control" (HJ 1014) for additional compliance guidance and stated that proposed China Stage 5 limits will also be included in the final regulation.

Additional details for Stage 4 include:

- Constant speed diesel engines would be tested over the NRSC and variable speed engines over the NRTC;
- Wider applicable ambient boundary conditions;
- PN limit to apply to 37-560 kW engines (engines to be equipped with a wall-flow DPF);
- There should be no visible smoke during DPF regeneration;
- Average ammonia emissions are not to exceed 25 ppm;
- If the engine is equipped with a vanadium containing SCR catalyst, data demonstrating that vanadium emissions will not occur during the useful life is required and SCR inlet temperatures above 550°C are not allowed;
- PEMS to be used as the primary in-use compliance tool;
- An OBD requirement for NOx and PM controls, covering EGR, DOC, DPF, SCR;
- Global positioning system will be required for all NRMMs equipped with engines of 37-560 kW.

Table 4. Stage 3/4 Durability Requirements

Power, kW	Rated speed, rpm	Effective life, h	Minimum durability test duration, h
P≥37	All	8000	2000
19≤P<37	Variable speed	5000	1250
	Constant speed < 3000		
	Constant speed ≥ 3000	3000	750
P<19	All		

Table 5. Voluntary Emission Limits Proposed in 2018

Power	CO	HC	NOx	HC+NOx	PM	PN
kW	g/kWh					#/kWh
P>560	3.5	0.19	3.5, 0.67*		0.045	
130≤P≤560	3.5	0.19	0.40		0.015	1×1012
56≤P<130	5.0	0.19	0.40		0.015	1×1012
37≤P<56	5.0			4.7	0.015	1×1012
19≤P<37	5.0			4.7	0.015	1×1012
P<19	5.5			7.5	0.40	

* Applicable to mobile generator sets with Pmax > 900 kW diesel engines

Table 6. Exhaust Smoke Limits

Category	Rated net power, P_{max}	Light absorption coefficient[a]	Ringelmann Blackness
	kW	1/m	
Class 1	Pmax < 19	3.00	1
	19 ≤ Pmax < 37	2.00	
	37 ≤ Pmax ≤ 560	1.61	
Class 2	Pmax < 19	2.00	1
	19 ≤ Pmax < 37	1.00	1 (no visible smoke)
	Pmax ≥ 37	0.80	
Class 3	Pmax < 37	0.80	1 (no visible smoke)
	Pmax ≥ 37	0.50	

[a] for engines operating above 1700 m, the limit can be increased by 0.25 1/m
Class 1 limits apply to machinery with Stage 1 and 2 diesel engines (GB 20891-2007) and Class 2 limits to machinery with Stage 3 and subsequent diesel engines (GB 20891-2014). Class 3 limits can be used to limit emissions in low emission zones defined by the government.

In-Use Smoke Emissions

In the September 2018, Limits and measurement methods for exhaust smoke from non-road mobile machinery equipped with diesel engine, GB 36886-2018, was published. This standard specifies the exhaust smoke limit and measurement method for on-site measurements of non-road diesel mobile machinery and vehicles as well as new and imported equipment. Smoke measurements can be carried out with an opacity meter according to GB 3847 or using the Ringelmann method as described in an appendix to GB 36886-2018. The corresponding limits are summarized in Table 6.

On-site smoke measurements are carried out during the normal usage cycle of the equipment. If this is not possible, the free acceleration method (GB 3847) can be used. Opacity meter measurements are carried out with a sampling frequency no less than 1 Hz and the maximum reading is taken as the test result. Ringelmann readings can be taken by video or other similar method with the maximum Ringelmann rating taken as the test result.

Small SI Engines: Stage 1/2 Emission Standards

Stage 1 and 2 emissions requirements for small nonroad spark ignition engines are found in GB26133-2010. This standard applies to spark ignition engines with a net power of no more than 19 kW for use in nonroad mobile machinery such as: lawn mowers, chain saws, generators, water pumps and brush cutters. Engines with a net power greater than 19 kW but a working volume of no more than 1 L may be certified as well. It does not apply to engines for the following purposes: for driving boats; for underground mining or underground mining equipment; for emergency rescue equipment; for recreational vehicles such as sleds, motocross and all-terrain vehicles; engines built for export.

The application dates are as follows:

- Stage 1: New types/all new non-handheld and hand-held engines 2011.03/2012.03, respectively.
- Stage 2:
    - New types/all new non-handheld engines 2013.01/2014.01
    - New types/all new hand-held engines 2015.01/2016.01, respectively.

Testing is in accordance with ISO 8178 (GB/T 8190.4). Emission requirements are based on EU Directive 97/68/EC and its amendments found in 2002/88/EC as well as US EPA Phase 1 and 2 regulations (40 CFR Part 90).

Engines are classified according to displacement volume as shown in Table 7.

Stage 1 limits are shown in Table 8 and Stage 2 limits in Table 9. The durability requirements are shown in Table 10. Two-stroke engines for snowblowers, whether or not they are hand-held, only need to meet the SH1, SH2 or SH3 of the corresponding working volume. For natural gas-fueled engines, NMHC may be used instead of HC.

Table 7. Small SI Engine Classification

	Engine classification	Displacement Volume, cm^3
Handheld	SH1	V<20
	SH2	20≤V<50
	SH3	V≥50
Non-handheld	FSH1	V<66
	FSH2	66≤V<100
	FSH3	100≤V<225
	FSH4	V≥225

Table 8. Small SI Engine Stage 1 Emission Limits, g/kWh

Engine classification	CO	HC	NOx	HC+NOx
SH1	805	295	5.36	
SH2	805	241	5.36	
SH3	603	161	5.36	
FSH1	519			50
FSH2	519			40
FSH3	519			16.1
FSH4	519			13.4

Table 9. Small SI Engine Stage 2 Emission Limits, g/kWh

Engine classification	CO	NOx	HC+NOx
SH1	805	10	50
SH2	805	10	50
SH3	603	10	72
FSH1	610	10	50
FSH2	610	10	40
FSH3	610	10	16.1
FSH4	610	10	13.4

Table 10. Durability Requirements For Small SI Engines, Hrs

Engine classification	Durability class		
	1	2	3
SH1	50	125	300
SH2	50	125	300
SH3	50	125	300
FSH1	50	125	300
FSH2	125	250	500
FSH3	125	250	500
FSH4	250	500	1000

Locomotives

Emission standards for locomotives and other rail traction engines are published by the State Railway Administration. TB/T 2783-2017 specifies the limits for emissions from diesel engines for railway traction. The standard applies to diesel engines for railway traction, new traction equipment for railways or diesel engines reinstalled with existing traction equipment. It does not apply to special-purpose locomotive diesel engines (such as for refinery or mining locomotives) and diesel engines with output power less than 100 kW. Emission standards have been based on UIC and EU NRMM standards. Table 11 lists the emission standards that apply. EPA Tier 2 locomotives are also claimed to be acceptable and development of locomotives capable of meeting EPA Tier 3 and 4 and EU NRMM Stage 3B is being encouraged [4395].

Emissions Standards: India
On-Road Vehicles And Engines

Table 1. Indian Emissions Standards (4-Wheel Vehicles)

Standard	Reference	Date	Region
India 2000	Euro 1	2000	Nationwide
Bharat Stage 2	Euro 2	2001	NCR*, Mumbai, Kolkata, Chennai
		2003.04	NCR*, 11 Cities†
		2005.04	Nationwide
Bharat Stage 3	Euro 3	2005.04	NCR*, 11 Cities†
		2010.04	Nationwide
Bharat Stage 4	Euro 4	2010.04	NCR*, 11 Cities†

* National Capital Region (Delhi)
† Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Secunderabad, Ahmedabad, Pune, Surat, Kanpur and Agra

Table 2. Emissions Standards for Light-Duty Vehicles, g/km

Year	Reference	CO	HC	HC+NO_x	NO_x	PM
Diesel						
1992	-	17.3-32.6	2.7-3.7	-	-	-
1996	-	5.0-9.0	-	2.0-4.0	-	-
2000	Euro 1	2.72-6.90	-	0.97-1.70	-	0.14-0.25
2005†	Euro 2	1.0-1.5	-	0.7-1.2	-	0.08-0.17
2010†	Euro 3	0.64 0.80 0.95	-	0.56 0.72 0.86	0.50 0.65 0.78	0.05 0.07 0.10
2010‡	Euro 4	0.50 0.63 0.74	-	0.30 0.39 0.46	0.25 0.33 0.39	0.025 0.04 0.06
Gasoline						
1991	-	14.3-27.1	2.0-2.9	-	-	-
1996	-	8.68-12.4	-	3.00-4.36	-	-
1998*	-	4.34-6.20	-	1.50-2.18	-	-
2000	Euro 1	2.72-6.90	-	0.97-1.70	-	-
2005†	Euro 2	2.2-5.0	-	0.5-0.7	-	-
2010†	Euro 3	2.3 4.17 5.22	0.20 0.25 0.29	-	0.15 0.18 0.21	-
2010‡	Euro 4	1.0 1.81 2.27	0.1 0.13 0.16	-	0.08 0.10 0.11	-

* for catalytic converter fitted vehicles
† earlier introduction in selected regions, see Table 1
‡ only in selected regions, see Table 1

Table 3. Alternative Emissions Standards for Light-Duty Diesel Engines, g/kWh

Year	Reference	CO	HC	NO_x	PM
1992	-	14.0	3.5	18.0	-
1996	-	11.20	2.40	14.4	-
2000	Euro 1	4.5	1.1	8.0	0.36*
2005†	Euro 2	4.0	1.1	7.0	0.15

* 0.612 for engines below 85 kW
† earlier introduction in selected regions, see Table 1

Background

The first Indian emissions regulations were idle emissions limits which became effective in 1989. These idle emissions regulations were soon replaced by mass emissions limits for both gasoline (1991) and diesel (1992) vehicles, which were gradually tightened during the 1990's. Since the year 2000, India started adopting European emissions and fuel regulations for four-wheeled light-duty and for heavy-duty vehicles. Indian own emissions regulations still apply to two- and three-wheeled vehicles.

On October 6, 2003, the National Auto Fuel Policy has been announced, which envisages a phased program for introducing Euro 2 — 4 emissions and fuel regulations by 2010. The implementation schedule of EU emissions standards in India is summarized in Table 1.

The above standards apply to all new 4-wheel vehicles sold and registered in the respective regions. In addition, the National Auto Fuel Policy introduces certain emissions requirements for interstate buses with routes originating or terminating in Delhi or the other 10 cities.

Light-Duty Vehicles

Emissions standards for light-duty vehicles (GVW ≤ 3,500 kg) are summarized in Table 2. Ranges of emissions limits refer to different categories and classes of vehicles; compare the EU light-duty vehicle emissions standards page for details on the Euro 1 and later standards. The lowest limit in each range applies to passenger cars (GVW ≤ 2,500 kg; up to 6 seats). When three limits are listed, they refer to vehicles category M & N1 Class 1, N1 Class 2, and N1 Class 3, respectively.

The test cycle has been the NEDC for low-powered vehicles (max. speed limited to 90 km/h). Before 2000, emissions were measured over an Indian test cycle.

Gasoline vehicles must also meet an evaporative (SHED) limit of 2 g/test (effective 2000).

Through the BS 2 (Euro 2) stage, engines for use in light-duty vehicles could be alternatively emissions tested using an engine dynamometer. The respective emissions standards are listed in Table 3.

OBD Requirements. OBD 1 is required from April 1, 2010 (except LPG or CNG-fuelled vehicles and those >3500 kg GVW). OBD 2 is required from 1 April 2013 for all categories.

Truck and Bus Engines

Emissions standards for new heavy-duty engines — applicable to vehicles of GVW > 3,500 kg — are listed in Table 4.

Table 4. Emissions Standards for Diesel Truck and Bus Engines, g/kWh

Year	Reference	Test	CO	HC	NO_x	PM
1992	-	ECE R49	17.3-32.6	2.7-3.7	-	-
1996	-	ECE R49	11.20	2.40	14.4	-
2000	Euro 1	ECE R49	4.5	1.1	8.0	0.36*
2005†	Euro 2	ECE R49	4.0	1.1	7.0	0.15
2010†	Euro 3	ESC	2.1	0.66	5.0	0.10
		ETC	5.45	0.78	5.0	0.16
2010‡	Euro 4	ESC	1.5	0.46	3.5	0.02
		ETC	4.0	0.55	3.5	0.03

* 0.612 for engines below 85 kW
† earlier introduction in selected regions, see Table 1
‡ only in selected regions, see Table 1

Emissions Standards: India

Non-Road Diesel Engines

Regulatory Background

Bharat (CEV) Stage 2 - 3 emission standards for diesel construction machinery were adopted on 21 September 2006. The standards were structured into two tiers:

- BS (CEV) 2 - These standards are based on the EU Stage 1 requirements, but also cover smaller engines that were not regulated under the EU Stage 1.
- BS (CEV) 3 - These standards are based on US Tier 2/3 requirements.

First standards for agricultural tractors, Bharat (Trem) Stage 1, became effective in 1999. From the Bharat (Trem) Stage 3a, emission requirements for agricultural tractors became harmonized with those for construction machinery for most engine categories.

On 5 March 2018, India adopted Bharat Stage (CEV/Trem) 4 - 5 emission standards for diesel nonroad engines used in construction and agricultural equipment. The BS (CEV/Trem) 4 emission standards are aligned with EU Stage 4 standards, while the BS (CEV/Trem) 5 standards are aligned with EU Stage 5.

Table 1. Bharat (CEV) Stage 2 - 3 Emission Standards for Diesel Construction Machinery

Engine Power	Date	CO	HC	$HC+NO_x$	NO_x	PM
kW		g/kWh				
Bharat (CEV) Stage 2						
P < 8	2008.10	8.0	1.3	-	9.2	1.00
8 ≤ P < 19	2008.10	6.6	1.3	-	9.2	0.85
19 ≤ P < 37	2007.10	6.5	1.3	-	9.2	0.85
37 ≤ P < 75	2007.10	6.5	1.3	-	9.2	0.85
75 ≤ P < 130	2007.10	5.0	1.3	-	9.2	0.70
130 ≤ P < 560	2007.10	5.0	1.3	-	9.2	0.54
Bharat (CEV) Stage 3						
P < 8	2011.04	8.0	-	7.5	-	0.80
8 ≤ P < 19	2011.04	6.6	-	7.5	-	0.80
19 ≤ P < 37	2011.04	5.5	-	7.5	-	0.60
37 ≤ P < 75	2011.04	5.0	-	4.7	-	0.40
75 ≤ P < 130	2011.04	5.0	-	4.0	-	0.30
130 ≤ P < 560	2011.04	3.5	-	4.0	-	0.20

Table 2. Bharat (CEV) Stage 3 Useful Life Periods		
Power Rating		Useful Life Period
		hours
< 19 kW		3000
19-37 kW	constant speed	3000
	variable speed	5000
> 37 kW		8000

Bharat Stage (CEV/Trem) 1 - 3 Construction Machinery

The standards are summarized in the following table. The limit values apply for both type approval (TA) and conformity of production (COP) testing. Testing is performed on an engine dynamometer over the ISO 8178 C1 (8-mode) and D2 (5-mode) test cycles.

The Bharat Stage 3 standards must be met over the useful life periods shown in Table 2. Alternatively, manufacturers may

Table 3. Bharat (Trem) Stage 1 – 3a Emission Standards for Diesel Agricultural Tractors

Engine Power	Date	CO	HC	HC+NO_x	NO_x	PM
kW		g/kWh				
Bharat (Trem) Stage 1						
All	1999.10	14.0	3.5	-	18.0	-
Bharat (Trem) Stage 2						
All	2003.06	9.0	-	15.0	-	1.00
Bharat (Trem) Stage 3						
All	2005.10	5.5	-	9.5	-	0.80
Bharat (Trem) Stage 3a						
P < 8	2010.04	5.5	-	8.5	-	0.80
8 ≤ P < 19	2010.04	5.5	-	8.5	-	0.80
19 ≤ P < 37	2010.04	5.5	-	7.5	-	0.60
37 ≤ P < 75	2011.04	5.0	-	4.7	-	0.40
75 ≤ P < 130	2011.04	5.0	-	4.0	-	0.30
130 ≤ P < 560	2011.04	3.5	-	4.0	-	0.20

Table 4. Bharat (CEV/Trem) Stage 4 - 5 Emission Standards

Engine Power	Date	CO	HC	NOx	PM	PN	Test Cycle
kW		g/kWh				1/kWh	
Bharat (CEV/Trem) Stage 4							
37 ≤ P < 56	2020.10	5.0	4.7*		0.025	-	NRSC and NRTC
56 ≤ P < 130		5.0	0.19	0.4	0.025	-	
130 ≤ P < 560		3.5	0.19	0.4	0.025	-	
Bharat (CEV/Trem) Stage 5							
P < 8	2024.04	8.0	7.5*		0.4	-	NRSC
8 ≤ P < 19		6.6	7.5*		0.4	-	
19 ≤ P < 37		5.0	4.7*		0.015	1×10^{12}	NRSC and NRTC
37 ≤ P < 56		5.0	4.7*		0.015	1×10^{12}	
56 ≤ P < 130		5.0	0.19	0.4	0.015	1×10^{12}	
130 ≤ P < 560		3.5	0.19	0.4	0.015	1×10^{12}	
P ≥ 560		3.5	0.19	3.5	0.045	-	NRSC

* NOx + HC

six-month grace period when registrations of equipment complying with the previous set of emission standards is allowed. From April 2026, an in-service conformity check is required for all BS 5 approved engines manufactured.

Engines equipped with SCR must meet an ammonia emission limit of 25 ppm for engines ≤ 56 kW and 10 ppm for engines above 56 kW. The limits are defined as a mean value over the NRTC and NRSC cycles.

The standards must be met over the useful life periods shown in Table 5. Alternatively, manufacturers may use fixed emission deterioration factors of 1.3 for CO, 1.3 for HC, 1.15 for NOx, and 1.05 for PM (NRSC and NRTC).

Table 5. Bharat (CEV/Trem) Stage 4 - 5 Useful Life Periods

Power Rating		Useful Life Period hours
≤ 37 kW	constant speed	3000
	variable speed	5000
> 37 kW		8000

Table 6. Proposed locomotive emission standards, g/bhp-hr

Locomotive Type	CO	HC	NOx	PM
Alco type	3.0	1.00	17.0	0.45
EMD (HHP locomotives)	1.4	1.00	9.0	0.35

Locomotives

In March 2017, India's Central Pollution Control Board (CPCB) submitted proposed emission standards for diesel locomotives to the Ministry of Environment and Forests (MoEF).

The proposed limits, outlined in a CPCB Interim Report, are based on emission measurements conducted by CPCB on Indian railways.

There are two sets of limits: for ALCO type locomotives and for high horsepower EMD locomotives. The standards would be applicable through the useful life of the locomotive. The report proposes to define a compliance protocol — including certification, production line testing, and in-use testing — based on the practice followed by US railroads.

Emissions Standards: India

Generator Sets

Emissions from new diesel engines used in generator sets have been regulated by the Ministry of Environment and Forests, Government of India *[GSR 371(E), 17.05.2002]*. The regulations impose type approval certification, production conformity testing and labeling requirements. Certification agencies include: (1) Automotive Research Association of India, (2) Vehicle Research and Development Establishment, and (3) International Centre for Automotive Technology *[GSR 280(E), 11.04.2008]*. The emissions standards are listed below.

Table 1. Emissions Standards for Diesel Engines ≤ 800 kW for Generator Sets

Engine Power (P)	Date	CO	HC	NO_x	PM	Smoke
		g/kWh				1/m
P ≤ 19 kW	2004.01	5.0	1.3	9.2	0.6	0.7
	2005.07	3.5	1.3	9.2	0.3	0.7
19 kW < P ≤ 50 kW	2004.01	5.0	1.3	9.2	0.5	0.7
	2004.07	3.5	1.3	9.2	0.3	0.7
50 kW < P ≤ 176 kW	2004.01	3.5	1.3	9.2	0.3	0.7
176 kW < P ≤ 800 kW	2004.11	3.5	1.3	9.2	0.3	0.7

Engines are tested over the 5-mode ISO 8178 D2 test cycle. Smoke opacity is measured at full load.

Concentrations are corrected to dry exhaust conditions with 15% residual O_2.

Table 2. Emissions Limits for Diesel Engines > 800 kW for Generator Sets

Date	CO mg/Nm³	NMHC mg/Nm³	NO_x ppm(v)	PM mg/Nm³
Until 2003.06	150	150	1100	75
2003.07 - 2005.06	150	100	970	75
2005.07	150	100	710	75

Produced in cooperation with: www.DieselNet.com

DieselNet

Emissions Standards: South Korea
On-Road Vehicles And Engines

Light-Duty Vehicles

South Korean diesel emissions standards for passenger cars (<8 seats, GVW<2,500 kg) are listed in Table 1. Emissions standards for light-duty diesel trucks (GVW<3,000 kg) are listed in Table 2.

Emissions are tested over the U.S. FTP-75 cycle and expressed in g/km.

The South Korean government has proposed that Euro 4 emissions standards will apply to light-duty diesel vehicles effective January 2006 (and California ULEV standards for gasoline vehicles).

Heavy-Duty Vehicles

South Korean emissions standards for heavy-duty diesel trucks (GVW>3,000 kg) are listed in Table 3. Some of the truck engine categories have additional smoke opacity requirements which are not listed in the table.

Since 1996, emissions are tested over the Japanese diesel 13-mode cycle and expressed in g/kWh. The 2003 emissions limits are aligned with Euro 3 requirements.

Table 1. Emissions Standards for Diesel Passenger Cars

Date	CO	HC	NMHC	NO_x	PM	Smoke
-	g/km					%
1993.1.1	2.11	0.25	-	0.62	0.12	
1996.1.1	2.11	0.25	-	0.62	0.08	
1998.1.1	1.50	0.25	-	0.62	0.08	
2000.1.1	1.20	0.25	-	0.62	0.05	20%
2001.1.1	0.5	-	0.01	0.02	0.01	20%
2002.7.1	0.5	-	0.01	0.02	0.01	15%

Table 2. Emissions Standards for Light-Duty Diesel Trucks

Date	CO	HC	NO_x	PM
-	g/km			
1993-1997				
1993.1.1	980†	670†	350† IDI 750† DI	-
1996.1.1	6.21	0.50	1.43	0.31
1998 and later, LW<1,700 kg				
1998.1.1	2.11	0.25	1.40	0.14
2000.1.1	2.11	0.25	1.02	0.11
2004.1.1	1.27	0.21	0.64	0.06
1998 and later, LW>1,700 kg				
1998.1.1	2.11	0.50	1.40	0.25
2000.1.1	2.11	0.50	1.06	0.14
2004.1.1	1.52	0.33	0.71	0.08

LW (loaded weight) = curb weight + 130 kg
† JP 6-mode test, limits expressed in ppm

Table 3. Emissions Standards for Heavy-Duty Diesel Engines

Date	CO	HC	NO_x	PM
-	g/kWh			
1993.1.1	980†	670†	350† IDI 750† DI	-
1996.1.1	4.90	1.20	11.0	0.90
1998.1.1	4.90	1.20	6.0 (9.0)*	0.25 (0.50)*
2000.1.1	4.90	1.20	6.0	0.25 (0.10)*
2002.1.1	4.90	1.20	6.0	0.15 (0.10)*
2003.1.1	2.1	0.66	5.0	0.10

* applies to buses
† JP 6-mode test, limits expressed in ppm

Produced in cooperation with: www.DieselNet.com

Emissions Standards: South Korea
Non-Road Engines

South Korea has proposed emissions standards for mobile nonroad diesel engines used in construction and industrial equipment. The standards would apply to engines between 18 - 560 kW rated power, in such applications as excavators (>1 t), bulldozers, loaders (>2 t), cranes, graders, rollers, and forklift trucks.

The standards would be implemented in two Tier schedules, as shown in Table 1. The South Korean Tier 2 standards are equivalent to the U.S. Tier 2. Emissions are measured over the ISO 8178 C1 test and expressed in g/kWh. There are no smoke opacity requirements.

Diesel fuel specifications are: density 815 - 855 kg/m^3, sulfur < 430 ppm.

Engines (engine families) are to be certified by the South Korean Ministry of Environment or the National Institute of Environmental Research.

Table 1. Proposed Emissions Standards for Nonroad Engines

Power	CO	HC	NO_x+HC	NO_x	PM
kW	g/kWh				
Tier 1: 2004.1.1					
18 - 37	5.5	-	9.5	-	0.8
37 - 75	5.5	1.3	-	9.2	0.6
75 - 130	5.0	1.3	-	9.2	0.6
130 - 225	5.0	1.3	-	9.2	0.54
225 - 560	5.0	1.3	-	9.2	0.54
Tier 2: 2005.1.1					
18 - 37	5.5	-	7.5	-	0.6
37 - 75	5.0	-	7.5	-	0.4
75 - 130	5.0	-	6.6	-	0.3
130 - 225	3.5	-	6.6	-	0.2
225 - 560	3.5	-	6.4	-	0.2

Emissions Standards: Australia
On-Road Vehicles And Engines

Background

Australian emissions standards are based on European regulations for light-duty and heavy-duty (heavy goods) vehicles, with acceptance of selected U.S. and Japanese standards. The long term policy is to fully harmonize Australian regulations with UN ECE standards. The development of emissions standards for highway vehicles and engines is coordinated by the National Transport Commission (NTC) and the regulations — Australian Design Rules (ADR) — are administered by the Department of Infrastructure and Transport.

The emissions standards apply to new vehicles including petrol (gasoline) and diesel cars, light omnibuses, heavy omnibuses, light goods vehicles, medium goods vehicles and heavy goods vehicles, as well as to forward control passenger vehicles and larger motor tricycles. They also cover off-road passenger vehicles (but not off-road engines, such as those used in construction or agricultural machinery).

The evolution of vehicle emissions standards in Australia occurred through a number of regulatory actions. Some of the important steps can be summarized as follows:

- Emissions standards for petrol engined light vehicles commenced in the early 1970s.
- A smoke emissions requirement (ADR30/00) was introduced in 1976 for vehicles with 4 or more wheels powered by a diesel engine. The alternative smoke standards were U.S. EPA '74 or later or British standards "Performance of Diesel Engines for Road Vehicles" BS AU 141a:1971 or ECE R 24/00, 24/01, 24/02 or 24/03 "Diesel and Pollutants" or, in the case of an engine alone, ECE R 24/03.
- The first emissions standards (apart from smoke standards) for heavy diesel fueled vehicles became effective in 1995 for all new models and in 1996 for all existing models. These emissions standards were introduced via ADR70/00 (adopting ECE R49, U.S. & Japanese HDV standards). The requirements of the 1995/96 standards were:
  - Required: Euro 1 for both light-duty and heavy-duty vehicles. Euro 2 and 3 were also accepted though not included in the regulation.
  - Acceptable alternatives: U.S. EPA '91 or '94 (EPA '98 was also accepted though not included in the regulation); 1993 Japanese exhaust emissions standards for "light duty and medium duty vehicles" and 1994 Japanese exhaust emissions standards for "passenger cars and heavy duty vehicles."
- A second round of more stringent emissions standards applied from 2002/2003 model year (for new/existing models). The standards — initially equivalent to Euro 2/3 — have been gradually tightened to adopt Euro 4 for light-duty cars and trucks (diesel and petrol), and Euro 5 for heavy-duty diesel engines.
- A third round of emissions regulations, adopted in 2011, mandates Euro 5/6 emissions standards for light-duty vehicles with an implementation schedule from 2013 to 2018.

Emissions Standards: 2002/03 and Later

The emissions standards were introduced via a series of new ADRs, which apply to vehicles depending on their gross vehicle mass (GVM):

- For light-duty vehicles at or below 3.5 t GVM:
  - Euro 2/4 stage: ADR79/00, ADR79/01, and ADR79/02 (replacing ADR37/01).
  - Euro 5/6 stage: ADR79/03, ADR79/04, and ADR79/05.
- For heavy-duty vehicles above 3.5 t GVM: ADR80/00, ADR80/01, ADR80/02, and ADR80/03 (replacing ADR70/00).

The above ADRs apply to new vehicles fueled with petrol, diesel, as well as with LPG or natural gas. The requirements and the implementation schedules are summarized in Table 1 (the requirements and dates for heavy LPG and NG vehicles are the same as for diesel).

The two year date combinations shown in the table refer to the dates applicable to new model vehicles and all model vehicles, respectively. For example, in the case of 02/03, this means that from January 1, 2002 any new model first produced with a date of manufacture after January 1, 2002 must comply with the ADR, and from January 1, 2003 all new vehicles (regardless of the first production date for that particular model) must comply.

Notes to Table 1

1. The introduction of Euro 2 standards for light-duty petrol and light-duty diesel vehicles is via ADR79/00, which adopts the technical requirements of ECE R83/04.

Table 1. Vehicle Emissions Standards: 2002/03 and Later

ADR Categories			ECE Cat	ADR	02/03	03/04	05/06	06/07	07/08	08/10[a]	10/11	10/11	13/16[b]	17/18[c]
Descr	GVM†	Cat‡			Diesel	Petrol	Petrol	Diesel	Diesel	Petrol	Petrol	Diesel	All	All
Passenger Vehicles														
	≤ 3.5t	MA, MB, MC	M1	ADR 79/..	Euro 2	Euro 2	Euro 3	Euro 4		Euro 4			Euro 5[d]	Euro 6
	> 3.5t			ADR 80/..	Euro 3	US96	US98		Euro 4		Euro 4			
Buses														
Light	≤ 3.5t	MD	M2	ADR 79/..	Euro 2	Euro 2	Euro 3	Euro 4		Euro 4			Euro 5[d]	Euro 6
	3.5 ≤ 5t			ADR 80/..	Euro 3	US96	US98		Euro 4 or US04, JE05		Euro 4 or US08	Euro 5 or US07, JE05		
Heavy	> 5t	ME	M3	ADR 80/..	Euro 3 or US98[e]	US96	US98		Euro 4 or US04, JE05		Euro 4 or US08	Euro 5 or US07, JE05		
Goods Vehicles (Trucks)														
Light	≤ 3.5t	NA	N1	ADR 79/..	Euro 2	Euro 2	Euro 3	Euro 4		Euro 4			Euro 5[d]	Euro 6
Medium	3.5 ≤ 12t	NB	N2	ADR 80/..	Euro 3 or US98[e]	US96	US98		Euro 4 or US04, JE05		Euro 4 or US08	Euro 5 or US07, JE05		
Heavy	> 12t	NC	N3	ADR 80/..	Euro 3 or US98[e]	US96	US98		Euro 4 or US04, JE05		Euro 4 or US08	Euro 5 or US07, JE05		

† Gross vehicle mass

‡ Vehicle categories: MA - passenger cars; MB - forward control vehicles, MC - passenger off-road vehicles

[a] - 1 July 2008/1 July 2010 for new/existing models

[b] - 1 November 2013/1 November 2016 for new/existing models

[c] - 1 July 2017/1 July 2018 for new/existing models

[d] - 'Core' Euro 5 applicable to new models from 1 November 2013, full Euro 5 applicable from 1 November 2016 (see notes below)

[e] - US EPA model year 2000 or later certificate or equivalent testing required (to ensure that no emissions "defeat devices" are used)

2. The introduction of Euro 3 standards for light-duty petrol vehicles, and Euro 4 standards for light-duty diesel vehicles, is via ADR79/01, which adopts the technical requirements of ECE Regulation 83/05. R83/05 embodies the Euro 3 and Euro 4 requirements for light-duty petrol and diesel vehicles, however the ADR only mandates the Euro 3 (pre 2005) provisions of R83/05 for petrol vehicles, but allows petrol vehicles optional compliance with Euro 4 standards.

3. The introduction of Euro 4 standards for light-duty petrol vehicles is via ADR79/02, which adopts the technical requirements of ECE R83/05.

4. The introduction of Euro 3 and Euro 4 standards for medium- and heavy-duty diesel vehicles is via ADR80/00 and ADR80/01, respectively, which adopt the technical requirements of European Directive 99/96/EC amending Directive 88/77/EEC. ADR80/01 has been replaced by ADR80/02 effective 2007/8.

5. The introduction of Euro 4 and Euro 5 standards for medium- and heavy-duty diesel vehicles is via ADR80/02 and ADR80/03, respectively, which adopt the technical requirements of Directive 2005/55/EC as amended by 2005/78/EC and 2006/51/EC.

6. The 'core' Euro 5 (ADR79/03) adopts the technical requirements of ECE R83/06, except that it does not require the new, PMP-based testing methods for PM mass (allowing the old test method with the 0.005 g/km PM limit to be used as an alternative) and has no PN limit. Some other requirements are also relaxed, including the OBD threshold. ADR79/04 applies the full requirements of ECE R83/06 from November 1, 2016.

Other Provisions

Smoke Limits. A smoke emissions ADR30/01 also applies to all categories of diesel vehicles. The smoke standard, which applies from 2002/3, adopts UN ECE R24/03 and allows the U.S. 94 smoke standards as an alternative. This new ADR replaces ADR30/00.

OBD. ADR79/03-05 introduces European OBD requirements for light-duty vehicles. At the 'core' Euro 5 stage (ADR79/03) a relaxed OBD threshold limit for PM mass of 80 mg/km is accepted for M and N category vehicles of reference mass above 1760 kg.

ADR80/02 requires heavy-duty vehicles to have OBD systems meeting the Euro 4 (or Japanese) requirements to warn against "functional failures" (such as an empty urea tank in engines with SCR). ADR80/03 requires vehicles to have OBD systems meeting the Euro 5 requirements to directly monitor emissions levels against set OBD thresholds.

Diesel Fuel. The new emissions requirements were synchronized with new diesel fuel specifications of reduced sulfur content, as follows:

500 ppm sulfur effective December 31, 2002.
50 ppm sulfur effective January 1, 2006.
10 ppm sulfur effective January 1, 2009.

Acknowledgement: *Information for this article contributed in part by Jon Real, Department of Infrastructure and Transport.*

Emissions Standards: Argentina
Heavy-Duty On-Road Engines

Model Year 1994-2005

Emission standards for new, model year 1994-2005 diesel fueled trucks and buses in Argentina are summarized in Table 1 [Decree 779/95].

The standards were based on European heavy-duty engine emission regulations. The standards were also applicable to engines used in light commercial vehicles (LCV), as indicated.

Table 1. Emissions Standards for Diesel Trucks and Buses

Year	Reference Standard	CO	HC	NO_x	PM	Comments
		g/kWh				
1994	Euro 0	11.2	2.45	14.4	-	Urban buses
1995	Euro 1*	4.9	1.23	9.0	-	Urban buses
1996	Euro 1*	4.9	1.23	9.0	0.4[a]	LCV & Trucks
1998	Euro 2	4.0	1.1	7.0	0.4[a]	Urban buses
2000	Euro 2	4.0	1.1	7.0	0.15[a]	LCV & Trucks

* production conformity limit
[a] - multiply by a factor of 1.7 for engines below 85 kW

Table 2. Emissions Standards for Diesel Trucks and Buses: MY 2006 and later			
Reference Standard	Year		Comments
	New models	All models	
Euro III	2006	2007	Resolution 731/2005 [2766]
Euro VI[a]	2009	2011	Resolution 731/2005 [2766]
Euro V	2016	2018	Resolution 35/2009 [2770], 1434/2011 [2769], 1800/2011 [2768], 1448/2012 [2767], 1464/2014 [3201], Directive 2005/55/EC [1569]

[a] - Euro III ceifications are allowed for engines in hevy vehicles (>3500 kg) until 31 December 2015.

Since 2006, Argentina has been adopting EU heavy-duty emission standards by reference. The implementation schedule is summarized in Table 2.

Emissions Standards: Brazil
Heavy-Duty Engines

Regulatory Background

Brazilian emission regulations for heavy-duty engines have been adopted as a series of increasingly more stringent tiers, designated PROCONVE P-1, P-2, P-3, etc. The emission standards are applicable to motor vehicles for the transportation of passengers and/or goods, with maximum gross vehicle weight higher than 3,856 kg or the vehicle curb weight higher than 2,720 kg.

The smoke control or, indirectly, particulate matter control began in 1987 with the adoption of opacity limit (k > 2.5) throughout the maximum torque curve of diesel engines. Noise control began in 1994. Emission standards were adopted in a series of steps:

PROCONVE P-1 voluntary standards were implemented in 1990, followed by P-2 mandatory standards in 1993, P-3 standards in 1994 and P-4 standards in 1998. These standards were also applicable to engines used in light trucks.

PROCONVE P-5, based on Euro III and including transient testing, was phased-in over 2004-2006.

PROCONVE P-6, based on Euro IV, was scheduled to become effective from 2009. However, because low sulfur diesel fuel was not available, the P-5 stage remained in effect until the end of 2011.

PROCONVE P-7, Resolution Conama 403/2008, was adopted in 2008 with implementation from 2012. The standards are based on Euro V.

PROCONVE P-8, based on Euro VI, was adopted in 2018 with implementation from 2022.

1993-2005: P1 Through P4

Emission standards for new MY 1993-2005 diesel fueled trucks and buses are summarized in Table 1. The same standards also applied to light-duty truck engines. All truck and bus engines, including those used in light trucks, were certified on an engine dynamometer (test cycle ECE R-49).

In addition to the P1 to P4 srtandards, new engines have to meet the following free acceleration smoke limits (effective March 94):

0.83/m (30 HSU) for naturally aspirated engines.

1.19/m (40 HSU) for turbocharged engines.

2006-2021: P-5 through P-7

Emission standards applicable to heavy-duty diesel and gas engines since 2006 are summarized in Table 2. Diesel engines are tested over both the ESC and ETC tests, while gas engines are tested over the ETC test only.

Table 1. Emissions Standards for Diesel-fueled Trucks and Buses							
Tier	Year		CO	HC	NO_x	PM	Reference Standard
	City Bus	All	g/kWh				
P-1	1990†		11.2	2.45	14.4	-	Urban buses
P-2	1993		4.9	1.23	9.0	-	Urban buses
P-3	1994	1996	4.9	1.23	9.0	0.4[a]	LCV & Trucks
P-4	1998	2000	4.0	1.1	7.0	0.4[a]	Urban buses

† - voluntary standards
[a] - production conformity limit
[b] - multiply by a factor of 1.7 for engines below 85 kW
[c] - 0.25 g/kWh for engines up to 0.7 liter, rated speed above 3000 rpm

Tier	Year	Test	CO	THC	NMHC	NO_x	PM†	Smoke
			g/kWh					m-1
P-5	2006[1,2,3]	ESC/ELR	2.1	0.66	-	5.0	0.10 or 0.13[5]	0.8
		ETC[4]	5.45	-	0.78	5.0	0.16 or 0.21[5]	-
P-6	2009[6]	ESC/ELR	1.5	0.46	-	3.5	0.02	0.5
		ETC	4.0	-	0.55	3.5	0.03	-
P-7	2012	ESC/ELR	1.5	0.46	-	2.0	0.02	0.5
		ETC	4.0	-	0.55	2.0	0.03	-

Table 2. Emissions Standards for Heavy-duty Diesel and Gas Engines (Durability: 160,000 km/5 years)

† - applicable to diesel engines only
[1] - 2004 for urban buses or 60% of annual production of urban buses (100% by 01/01/2005); in that case, manufacturers must produce at least 60% observing PROCONVE P-5 for the non-urban bus HD annual production
[2] - 2005 for micro-buses
[3] - 2005 40% of production/year of HD (except urban bus and micro-bus) per manufacturer
[4] - diesel vehicles without catalysts or particulate filters can be tested over ESC cycle only
[5] - for engines of less than 0.75 dm^3 swept volume per cylinder and a rated power speed of more than 3000 rpm
[6] - PROCONVE P-6 standards were never enforced (because low sulphur fuel was not available), P-5 standards remained in effect through the end of 2011

2022 and Later: P-8 Standards

The P-8 standards apply to all new on-road passenger and freight vehicles with compression-ignition or spark-ignition engines and weighing at least 3,856 kg. The standards go into effect on 1 January 2022 for new type approvals, and on 1 January 2023 for all new sales and registrations [4257] [4258].

Table 3. PROCONVE P-8 emissions standards for heavy-duty engines

Test	CO	THC[a]	NMHC[b]	CH_4[b]	NOx	NH_3	PM	PN
	mg/kWh					ppm	mg/kWh	kWh^{-1}
WHSC[a]	1500	130	-	-	400	10	10	$8.0x10^{11}$
WHTC[a]	4000	160	-	-	460	10	10	$6.0x10^{11}$
WHTC[b]	4000	-	160	500	460	10	10	-
OCE (WNTE)	2000	220	-	-	600	-	16	-
ISC (PEMS)	6000	240	240	750	690	-	-	-

[a] Applicable to compression-ignition (diesel) engines only
[b] Applicable to spark-ignition (gasoline and natural gas) engines only
[c] Applicable to engines with SCR aftertreatment and to natural gas engines

The P-8 standards are based on Euro VI regulations—they introduce the Euro VI test cycles and testing requirements, off-cycle emission (OCE) and in-service conformity (ISC) testing, as well as particle number (PN) emission limits for diesel engines. The latter are expected to force the use of diesel particulate filters on all heavy-duty diesel engines. P-8 emission limits are summarized in Table 3.

Emissions Standards: Brazil
Non-Road Diesel Engines

In July 2011, CONAMA adopted Resolution 433/2011 [Conama 2011] limiting exhaust emissions and noise from new construction and farm machinery. Referred to as PROCONVE MAR-I, it is the first legislation to regulate emissions from nonroad mobile machinery in Brazil. It sets limits equivalent to USA Tier 3 and EU Stage III A for nonroad diesel engine emissions.

MAR-I emission limits are phased in from 2015 to 2019. The implementation dates depend on the power category and type of machinery (construction or farm), as shown in Table 1. Noise emission limits apply from 2015 for certain types of construction machinery with engines rated below 500 kW.

Emissions are measured in accordance with ISO 8178-1.

Table 1. MAR-I Emissions Standards for Nonroad Engines

Rated Power	Date		CO	NO_x+HC	PM
kW	Construction	Farming	g/kWh		
130 ≤ P ≤ 560	2015.01	2017.01	3.5	4.0	0.2
75 ≤ P < 130	2015.01	2017.01	5.0	4.0	0.3
37 ≤ P < 75	2015.01	2019.01	5.0	4.7	0.4
19 ≤ P < 37	2017.01	2019.01	5.5	7.5	0.6

Produced in cooperation with: www.DieselNet.com

Design Begins Here

EMISSIONS

INCLUDING: **Emissions Technologies, Exhaust System Components, Emissions Controls, Silencers, Mufflers, Catalytic Converters, Acoustical Systems and Materials, Starting Systems (Air, Electric and Hydraulic), Starting Aids, Alternators and Batteries**

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

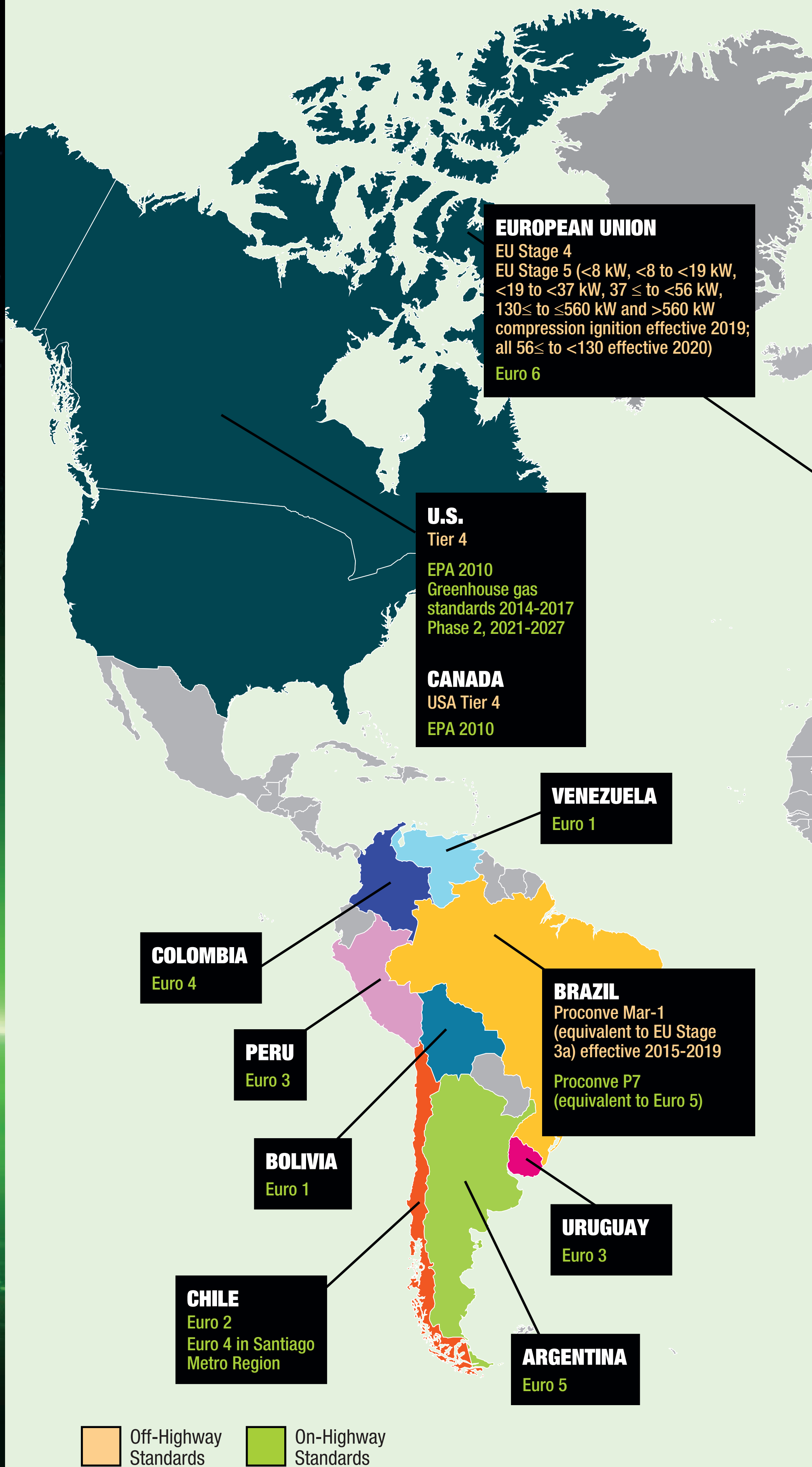
THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

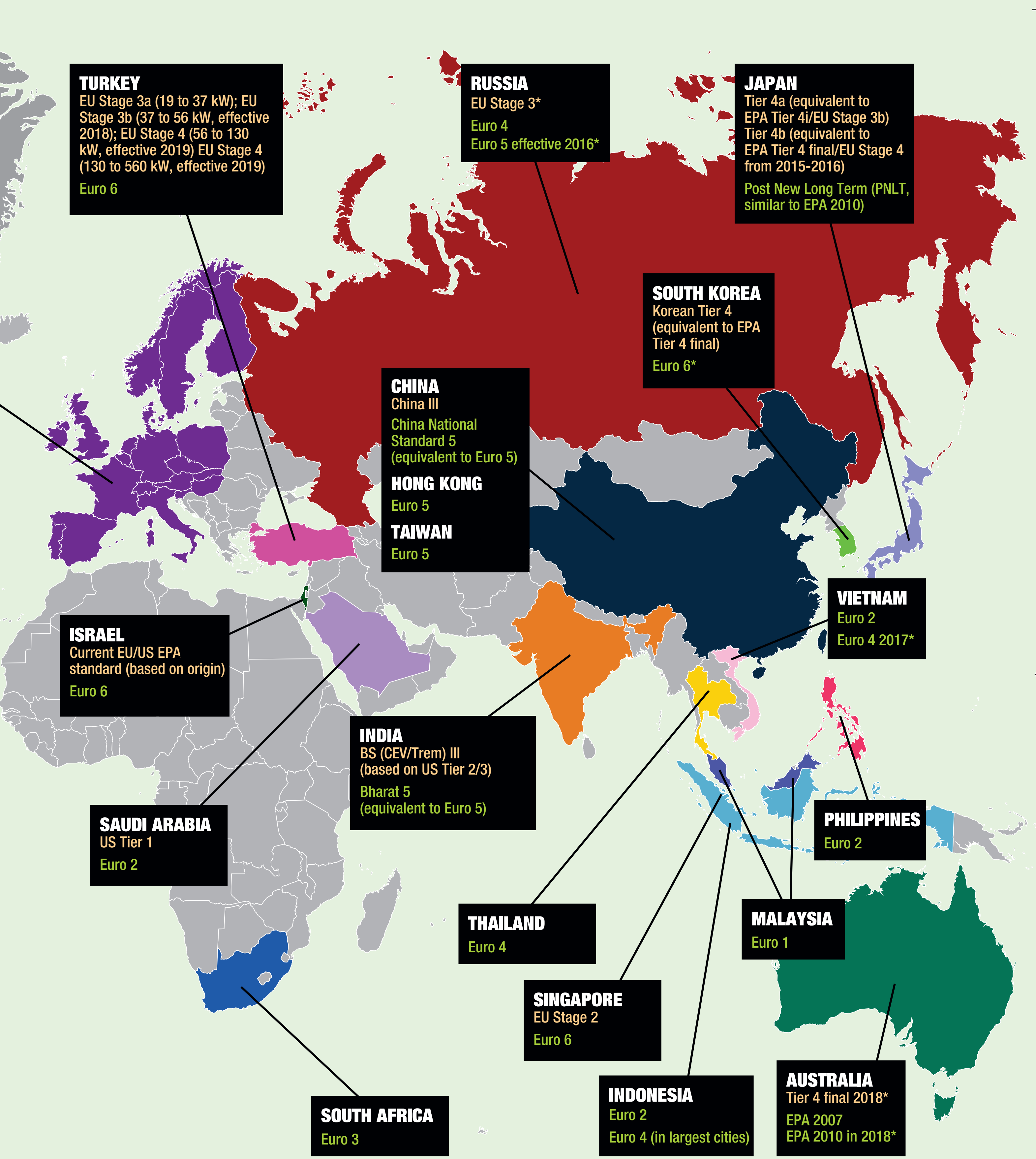
2021-22 GLOBAL DIESEL EMISSIONS REGULATIONS-AT-A-GLANCE

** proposed or under consideration*

For more information on specific emissions levels and the various standards, visit the Emissionsguide.net at Dieselandgasturbineguide.net. For the most current global emissions information, visit DieselNet.com. Emissions information drawn from government and industry sources. Diesel Progress is not responsible for the accuracy of the data as presented.



DIESEL PROGRESS


TURKEY
EU Stage 3a (19 to 37 kW); EU Stage 3b (37 to 56 kW, effective 2018); EU Stage 4 (56 to 130 kW, effective 2019) EU Stage 4 (130 to 560 kW, effective 2019)
Euro 6
RUSSIA
EU Stage 3*
Euro 4
Euro 5 effective 2016*
JAPAN
Tier 4a (equivalent to EPA Tier 4i/EU Stage 3b) Tier 4b (equivalent to EPA Tier 4 final/EU Stage 4 from 2015-2016)
Post New Long Term (PNLT, similar to EPA 2010)
SOUTH KOREA
Korean Tier 4 (equivalent to EPA Tier 4 final)
Euro 6*
CHINA
China III
China National Standard 5 (equivalent to Euro 5)
HONG KONG
Euro 5
TAIWAN
Euro 5
VIETNAM
Euro 2
Euro 4 2017*
ISRAEL
Current EU/US EPA standard (based on origin)
Euro 6
INDIA
BS (CEV/Trem) III (based on US Tier 2/3)
Bharat 5 (equivalent to Euro 5)
SAUDI ARABIA
US Tier 1
Euro 2
PHILIPPINES
Euro 2
THAILAND
Euro 4
MALAYSIA
Euro 1
SINGAPORE
EU Stage 2
Euro 6
INDONESIA
Euro 2
Euro 4 (in largest cities)
AUSTRALIA
Tier 4 final 2018*
EPA 2007
EPA 2010 in 2018*
SOUTH AFRICA
Euro 3


ISUZU
The power behind it all.™
Every Isuzu power unit is built to your exact requirements. There are over 28 million Isuzu engines worldwide. Isuzu has been providing application solutions to wash, light, power, pump, cut, drain, haul and heat with for every environment. We can help you to power your needs today.
We offer products in the 8.8 – 382 kW ranges.
Contact your local Isuzu Distributor or call us direct at 734.582.9470.
www.IsuzuEngines.com
www.IsuzuREDTech.com
4LE2X
Tier 4 Power Unit
4JJ1X
Tier 4 Power Unit
4HV1
Natural Gas / Propane Power Unit
ISUZU
DIESEL
ISUZU
REDTECH™
Reliable | Eco-friendly | Durable | Technologically Advanced

Manufacturer	Page Reference	Engine Model	Rated Power Output (kW)	Speed at Rated Power (r/min)	Maxium Torque (Nm)	Speed at Maximum Torque (r/min)	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Number of Cylinders & Configuration L: In-Line V: Vee-Type H: Horizontal 0: Opposed	Crankshaft Orientation V: Vertical H: Horizontal	Cooling AC: Air-Cooled LC: Liquid-Cooled	Emissions Level (EPA, CARB, EU, etc.)
AMERICAN HONDA MOTOR CO, INC.	*		0.72-16.9	3600-7000	1-48.3	2500-5500	35-88	26-72	0.25-0.39	L, V	H, V	AC	
BRIGGS & STRATTON	*		4-26.5	3600			68-89	56-87	0.21-.0.49	1L, 2V	H, V	AC	EPA, CARB, EU
KAWASAKI HEAVY INDUSTRIES LTD.	*		21.6	7000	60.0	5000	78	78	0.4	1L	H	AC	
			21,6	7000	60.0	5000	78	78	0.4	2V	V	LC	
KOHLER	192	COMMAND PRO EFI ECV850	20.1	3600	63	2400	86	71	0.82	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV860	21.6	3600	64.1	2400	86	71	0.82	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV870	23.1	3600	66.6	2800	86	71	0.82	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV880	24.6	3600	68.1	3200	86	71	0.82	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH940	26.1	3600	75.9	3000	90	78.5	1	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH980	28.3	3600	78.6	3400	90	78.5	1	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV940	26.1	3600	71.8	3200	90	79	1	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH980	28.3	3600	77.2	3400	90	79	1	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH630	14.2	3600	46.4	2200	80	69	0.69	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH650	15.7	3600	46.8	2600	80	69	0.69	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH730	17.2	3600	51.7	2200	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH740	18.6	3600	52.6	2400	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH749	19.8	3600	54.2	2600	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV630	14.2	3600	46.4	2200	80	69	0.69	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV650	15.7	3600	46.8	2600	80	69	0.69	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV730	17.2	3600	51.7	2200	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV740	18.6	3600	52.6	2400	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECV749	19.8	3600	54.2	2600	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH440	10.5	3600	30.8	2800	89	69	0.43	1L	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI ECH440LE	10.5	3600	30.8	2800	89	69	0.43	1L	H	AC	WORLD COMPLIANT
		COMMAND PRO CH940	24.2	3600	71.8	2600	90	78.5	1	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CH980	26	3600	73.6	2400	90	78.5	1	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CH1000	27.5	3600	77.8	3200	90	78.5	1	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CH620	14.2	3600	47.5	2400	80	67	0.67	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH640	15.3	3600	48.4	2400	80	67	0.67	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH682	16.8	3600	52.7	3000	80	69	0.69	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH732	17.5	3600	54.8	2600	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH742	18.6	3600	55.9	2600	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH752	20.1	3600	57.2	3000	83	69	0.75	2V	H	AC	WORLD COMPLIANT
continued		COMMAND PRO CH620	14.2	3600	47.5	2400	80	67	0.67	2V	H	AC	WORLD COMPLIANT

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Engine Model	Rated Power Output (kW)	Speed at Rated Power (r/min)	Maxium Torque (Nm)	Speed at Maximum Torque (r/min)	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Number of Cylinders & Configuration L: In-Line V: Vee-Type H: Horizontal 0: Opposed	Crankshaft Orientation V: Vertical H: Horizontal	Cooling AC: Air-Cooled LC: Liquid-Cooled	Emissions Level (EPA, CARB, EU, etc.)
KOHLER	192	COMMAND PRO CH640	15.3	3600	48.4	2400	80	67	0.67	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH680	16.8	3600	49.9	2800	80	67	0.67	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH730	17.5	3600	52.1	2800	83	67	0.73	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH740	18.6	3600	53.1	3000	83	67	0.73	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CH750	20.1	3600	55.9	3200	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO CV620	14.2	3600	46.1	2400	80	67	0.67	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV640	15.3	3600	47	2400	80	67	0.67	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV682	16.8	3600	52.9	2800	80	69	0.69	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV732	17.5	3600	54.6	2800	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV742	18.6	3600	55.3	3000	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV752	20.1	3600	55.9	3000	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV680	16.8	3600	48.5	2400	80	67	0.67	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV730	17.5	3600	50	2800	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV740	18.6	3600	53.1	2800	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO CV750	20.1	3600	54.6	3000	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI PROPANE PCV850	20.1	3600	61.2	2400	86	71	0.82	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI PROPANE PCV860	21.6	3600	64.7	2400	86	71	0.82	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI PROPANE PCV680	16.4	3600	49.8	2200	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI PROPANE PCV740	17.9	3600	50.6	2400	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI PROPANE PCH680	17.1	3600	51.5	2200	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI PROPANE PCH740	18.6	3600	52.8	2800	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO LP CH730LP	16	3600	46.1	2600	83	67	0.73	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO LP CH740LP	16.4	3600	46	3000	83	67	0.73	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO NG CH740NG	14.5	3600	41.8	3000	83	67	0.73	2V	H	AC	WORLD COMPLIANT
		COMMAND PRO EFI FLEX FUEL FCV740	18.6	3600	54.1	2400	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI FLEX FUEL FCV749	19.8	3600	55.5	3000	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		COMMAND PRO EFI FLEX FUEL FCH749	19.8	3600	54.2	2600	83	69	0.75	2V	H	AC	WORLD COMPLIANT
		AEGIS ELH750	20.1	3600	58.2	2400	83	69	0.75	2V	H	LC	WORLD COMPLIANT
		AEGIS ELH775	22.4	3600	60.5	3400	83	69	0.75	2V	H	LC	WORLD COMPLIANT
		COMMAND PRO CH245	3.3	3600	9.8	2800	68	49	0.18	1L	H	AC	WORLD COMPLIANT
		COMMAND PRO CH255	4	3600	11.2	2800	68	49	0.18	1L	H	AC	WORLD COMPLIANT
		COMMAND PRO CH260	4.5	3600	14.1	3000	70	54	0.21	1L	H	AC	WORLD COMPLIANT
continued		COMMAND PRO CH270	5.2	3600	14.2	3000	70	54	0.21	1L	H	AC	WORLD COMPLIANT

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Engine Model	Rated Power Output (kW)	Speed at Rated Power (r/min)	Maxium Torque (Nm)	Speed at Maximum Torque (r/min)	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Number of Cylinders & Configuration L: In-Line V: Vee-Type H: Horizontal 0: Opposed	Crankshaft Orientation V: Vertical H: Horizontal	Cooling AC: Air-Cooled LC: Liquid-Cooled	Emissions Level (EPA, CARB, EU, etc.)
KOHLER	192	COMMAND PRO CH395	7.1	3600	18.8	2800	78	58	0.28	1L	H	AC	WORLD COMPLIANT
		COMMAND PRO CH440	10.5	3600	30.8	2800	89	69	0.43	1L	H	AC	WORLD COMPLIANT
		COMMAND PRO TRI-FUEL CH270TF	5.2	4000	14.2	3000	70	54	0.21	1L	H	AC	WORLD COMPLIANT
		COMMAND PRO TRI-FUEL CH395TF	7.1	4000	18.8	2800	78	58	0.28	1L	H	AC	WORLD COMPLIANT
		COMMAND PRO TRI-FUEL CH440TF	10.5	3600	30.8	2800	89	69	0.43	1L	H	AC	WORLD COMPLIANT
		CONFIDANT EFI EZT715	14.9	3600	49.9	2400	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		CONFIDANT EFI EZT725	16.4	3600	52.6	2600	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		CONFIDANT EFI EZT740	18.6	3600	55.5	2600	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		CONFIDANT EFI EZT750	20.1	3600	57.5	2800	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		CONFIDANT ZT710	14.2	3600	54.2	2200	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		CONFIDANT ZT720	15.7	3600	55.2	2200	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		CONFIDANT ZT730	17.2	3600	57.1	2400	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		CONFIDANT ZT740	18.6	3600	57.5	2400	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		SH SERIES SH255	4.2	3600	13.6	3000	68	54	0.2	1L	H	AC	WORLD COMPLIANT
		SH SERIES SH265	4.8	3600	13.8	3000	68	54	0.2	1L	H	AC	WORLD COMPLIANT
		HD SERIES HD675			9.2	2800	65	45	0.15	1L	V	AC	WORLD COMPLIANT
		HD SERIES HD775			10.5	2800	70	45	0.17	1L	V	AC	WORLD COMPLIANT
		7500 SERIES EFI EKT740	18.6	3600	52.1	2600	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		7500 SERIES EFI EKT745	19.4	3600	53.5	2600	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		7500 SERIES EFI EKT750	20.1	3600	55.2	2600	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		7000 SERIES KT715	14.9	3600	54.6	2200	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		7000 SERIES KT725	16.2	3600	54.8	2200	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		7000 SERIES KT730	17.2	3600	54.9	2200	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		7000 SERIES KT735	17.9	3600	54.9	2400	83	67	0.73	2V	V	AC	WORLD COMPLIANT
		7000 SERIES KT740	18.6	3600	56	2600	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		7000 SERIES KT745	19.4	3600	57.5	2600	83	69	0.75	2V	V	AC	WORLD COMPLIANT
		6600 SERIES KT600	12.7	3600	46.8	2200	83	61	0.66	2V	V	AC	WORLD COMPLIANT
		6600 SERIES KT610	14.2	3600	46.8	2200	83	61	0.66	2V	V	AC	WORLD COMPLIANT
		6600 SERIES KT620	15.7	3600	48.7	2200	83	61	0.66	2V	V	AC	WORLD COMPLIANT
		5400 SERIES KS530	12.7	3600	40.7	2600	94	78	0.54	1L	V	AC	WORLD COMPLIANT
		5400 SERIES KS540	13.4	3600	40.9	2600	94	78	0.54	1L	V	AC	WORLD COMPLIANT
		5400 SERIES KS590	14.2	3600	41.4	2600	94	78	0.54	1L	V	AC	WORLD COMPLIANT
continued		5400 SERIES KS595	14.5	3600	42	2600	94	78	0.54	1L	V	AC	WORLD COMPLIANT

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Engine Model	Rated Power Output (kW)	Speed at Rated Power (r/min)	Maxium Torque (Nm)	Speed at Maximum Torque (r/min)	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Number of Cylinders & Configuration L: In-Line V: Vee-Type H: Horizontal 0: Opposed	Crankshaft Orientation V: Vertical H: Horizontal	Cooling AC: Air-Cooled LC: Liquid-Cooled	Emissions Level (EPA, CARB, EU, etc.)
KOHLER	192	RH SERIES RH255	4.2	3600	14.2	3000	68	54	0.2	1L	H	AC	WORLD COMPLIANT
		RH SERIES RH265	4.8	3600	14.5	3000	68	54	0.2	1L	H	AC	WORLD COMPLIANT
		XT SERIES XT650			8.8	2800	65	45	0.15	1L	V	AC	WORLD COMPLIANT
		XT SERIES XT675			9.2	2800	65	45	0.15	1L	V	AC	WORLD COMPLIANT
		XT SERIES XT775			10.5	2800	70	45	0.17	1L	V	AC	WORLD COMPLIANT
		XT SERIES XTX650			8.8	2800	65	45	0.15	1L	V	AC	WORLD COMPLIANT
		XT SERIES XTX675			9.2	2800	65	45	0.15	1L	V	AC	WORLD COMPLIANT
		XT SERIES XTX775			10.5	2800	70	45	0.17	1L	V	AC	WORLD COMPLIANT
KUBOTA	158	WG752-G-E3	18.5	3600			68	68	0.74	3L	V	LC	EPA PHASE 3, CARB PHASE 3, EU STAGE 5
		WG752-GL-E3	18.5	3600			68	68	0.74	3L	V	LC	EPA PHASE 3, CARB PHASE 3, EU STAGE 5
		WG972-G-E3	24.2	3600			74.5	73.6	0.962	3L	V	LC	EPA PHASE 3, EU STAGE 5
		WG972-GL-E3	24.2	3600			74.5	73.6	0.962	3L	V	LC	EPA PHASE 3, EU STAGE 5
		WG972-G-E4	24.2	3600			74.5	73.6	0.962	3L	V	LC	EPA PHASE 3, CARB PHASE 4, EU STAGE 5
		WG972-GL-E4	23.2	3600			74.5	73.6	0.962	3L	V	LC	EPA PHASE 3, CARB PHASE 4, EU STAGE 5
		WG1605-G-E3	42.5	3600			79	78.4	1.537	4L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
		WG1605-GL-E3	42.5	3600			79	78.4	1.537	4L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
		WG1605-GLN-E3	42.5	3600			79	78.4	1.537	4L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
		WG1903-G	35	2700			88	102.4	1.868	3L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
		WG1903-GL	35	2700			88	102.4	1.868	3L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
		WG2503-G-E3	45.5	2700			88	102.4	2.491	4L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
		WG2503-GL-E3	45.5	2700			88	102.4	2.491	4L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
		WG3800-G-E3	65	2600			100	120	3.769	4L	V	LC	EPA TIER 2, CARB TIER 3
		WG3800-G-E3	55.4	2600			100	120	3.769	4L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
		WG3800-GL-E3	65	2600			100	120	3.769	4L	V	LC	EPA TIER 2, CARB TIER 3
		WG3800-GL-E3	55.4	2600			100	120	3.769	4L	V	LC	EPA TIER 2, CARB TIER 3, EU STAGE 5
MAHINDRA & MAHINDRA	*		17.5-168	4000-5500	48-380	1500-3500	76-93	82.5-92.25	625-1997	1L-4L		LC	BS4, BS6, EURO 5, EURO 5D
YAMAHA MOTOR CORP.	*		3.5-7.6	3600	10.5-23.9	2400	66-85	50-63	0.17-3.57	1L	H	AC	EPA PHASE 3

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
AGCO POWER	194	D	44 LFTN-A2	108	120	1.1	4L	19	27		2100			76	106	OH	EPA TIER 2
		D	49 LFTN-A2	108	134	1.2	4L	25	35		2100			100	140	OH	EPA TIER 2
		D	66 LFTN-A2	108	120	1.1	6L	20	28		2100			118	165	OH	EPA TIER 2
		D	74 LFTN-A2	108	134	1.2	6L	26	35		1950			158	210	OH	EPA TIER 2
		D	74 LFTN-A2	108	134	1.2	6L	29	35		2100			171	209	OH	EPA TIER 2
		D	84 LFTN-A2	111	145	1.4	6L	37	49		2100			220	292	OH	EPA TIER 2
		D	98 LFTN-A2	111	145	1.4	7L	38	48		1900			265	339	OH	EPA TIER 2
		D	33 LFTN-D4	108	120	1.1	3L	19	30		2100				62	OH	EPA TIER 4F
		D	33 LFTN-D4	108	120	1.1	3L	19	30		2100				69	OH	EPA TIER 4F
		D	33 LFTN-D4	108	120	1.1	3L	19	30		2100				77	OH	EPA TIER 4F
		D	33 LFTN-D4	108	120	1.1	3L	19	30		2100				91	OH	EPA TIER 4F
		D	33 MBTN-D4	108	120	1.1	3L	19	26		2100				58	OH	EPA TIER 4F
		D	33 MBTN-D4	108	120	1.1	3L	19	26		2100				68	OH	EPA TIER 4F
		D	33 MBTN-D4	108	120	1.1	3L	19	26		2100				75	OH	EPA TIER 4F
		D	44 MBTN-D4	108	120	1.1	4L	19	27		2200				86	OH	EPA TIER 4F
		D	44 MBTN-D4	108	120	1.1	4L	19	27		2200				93	OH	EPA TIER 4F
		D	44 MBTN-D4	108	120	1.1	4L	19	27		2200				97	OH	EPA TIER 4F
		D	44 MBTN-D4	108	120	1.1	4L	19	27		2200				101	OH	EPA TIER 4F
		D	44 MBTN-D4	108	120	1.1	4L	19	27		2200				107	OH	EPA TIER 4F
		D	44 LFTN-D4	108	120	1.1	4L	19	29		2100				76	OH	EPA TIER 4F
		D	44 LFTN-D4	108	120	1.1	4L	19	29		2100				81	OH	EPA TIER 4F
		D	44 LFTN-D4	108	120	1.1	4L	19	29		2100				87	OH	EPA TIER 4F
		D	44 LFTN-D4	108	120	1.1	4L	19	29		2100				106	OH	EPA TIER 4F
		D	44 LFTN-D4	108	120	1.1	4L	19	29		2100				115	OH	EPA TIER 4F
		D	49 LFTN-D4	108	134	1.2	4L	25	37		2100				100	OH	EPA TIER 4F
		D	49 LFTN-D4	108	134	1.2	4L	25	37		2100				108	OH	EPA TIER 4F
		D	49 LFTN-D4	108	134	1.2	4L	25	37		2100				118	OH	EPA TIER 4F
		D	49 LFTN-D4	108	134	1.2	4L	25	37		2100				127	OH	EPA TIER 4F
		D	49 LFTN-D4	108	134	1.2	4L	25	37		2100				140	OH	EPA TIER 4F
		D	49 LFTN-D4	108	134	1.2	4L	25	37		2100				148	OH	EPA TIER 4F
		D	66 LFTN-D4	108	120	1.1	6L	20	30		2100				118	OH	EPA TIER 4F
		D	66 LFTN-D4	108	120	1.1	6L	20	30		2100				134	OH	EPA TIER 4F
		D	66 LFTN-D4	108	120	1.1	6L	20	30		2100				150	OH	EPA TIER 4F
		D	66 LFTN-D4	108	120	1.1	6L	20	30		2100				157	OH	EPA TIER 4F
		D	66 LFTN-D4	108	120	1.1	6L	20	30		2100				170	OH	EPA TIER 4F
		D	66 LFTN-D4	108	120	1.1	6L	20	30		2100				179	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		1950				158	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		1950				169	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		1950				183	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		1950				196	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		1950				214	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		2100				150	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		2100				171	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		2100				173	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		2100				188	OH	EPA TIER 4F
continued		D	74 LFTN-D4	108	134	1.2	6L	25	37		2100				200	OH	EPA TIER 4F

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
AGCO POWER	194	D	74 LFTN-D4	108	134	1.2	6L	25	37		2100				220	OH	EPA TIER 4F
		D	74 LFTN-D4	108	134	1.2	6L	25	37		2100				226	OH	EPA TIER 4F
		D	84 LFTN-D4	111	145	1.4	6L	37	50		2100				220	OH	EPA TIER 4F
		D	84 LFTN-D4	111	145	1.4	6L	37	50		2100				232	OH	EPA TIER 4F
		D	84 LFTN-D4	111	145	1.4	6L	37	50		2100				247	OH	EPA TIER 4F
		D	84 LFTN-D4	111	145	1.4	6L	37	50		2100				268	OH	EPA TIER 4F
		D	84 LFTN-D4	111	145	1.4	6L	37	50		2100				278	OH	EPA TIER 4F
		D	84 LFTN-D4	111	145	1.4	6L	37	50		2100				292	OH	EPA TIER 4F
		D	98 LFTN-D4	111	145	1.4	7L	38	48		1900				265	OH	EPA TIER 4F
		D	98 LFTN-D4	111	145	1.4	7L	38	48		1900				339	OH	EPA TIER 4F
		D	33 LFTN-D5	108	120	1.1	3L	19	30		2100				62	OH	EU STAGE 5
		D	33 LFTN-D5	108	120	1.1	3L	19	30		2100				69	OH	EU STAGE 5
		D	33 LFTN-D5	108	120	1.1	3L	19	30		2100				77	OH	EU STAGE 5
		D	33 LFTN-D5	108	120	1.1	3L	19	30		2100				91	OH	EU STAGE 5
		D	33 MBTN-D5	108	120	1.1	3L	19	26		2100				58	OH	EU STAGE 5
		D	33 MBTN-D5	108	120	1.1	3L	19	26		2100				68	OH	EU STAGE 5
		D	33 MBTN-D5	108	120	1.1	3L	19	26		2100				75	OH	EU STAGE 5
		D	44 MBTN-D5	108	120	1.1	4L	19	27		2200				86	OH	EU STAGE 5
		D	44 MBTN-D5	108	120	1.1	4L	19	27		2200				93	OH	EU STAGE 5
		D	44 MBTN-D5	108	120	1.1	4L	19	27		2200				97	OH	EU STAGE 5
		D	44 MBTN-D5	108	120	1.1	4L	19	27		2200				101	OH	EU STAGE 5
		D	44 MBTN-D5	108	120	1.1	4L	19	27		2200				107	OH	EU STAGE 5
		D	44 LFTN-D5	108	120	1.1	4L	19	29		2100				76	OH	EU STAGE 5
		D	44 LFTN-D5	108	120	1.1	4L	19	29		2100				81	OH	EU STAGE 5
		D	44 LFTN-D5	108	120	1.1	4L	19	29		2100				87	OH	EU STAGE 5
		D	44 LFTN-D5	108	120	1.1	4L	19	29		2100				106	OH	EU STAGE 5
		D	44 LFTN-D5	108	120	1.1	4L	19	29		2100				115	OH	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L	25	37		2100				100	OH	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L	25	37		2100				108	OH	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L	25	37		2100				118	OH	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L	25	37		2100				127	OH	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L	25	37		2100				140	OH	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L	25	37		2100				148	OH	EU STAGE 5
		D	66 LFTN-D5	108	120	1.1	6L	20	30		2100				118	OH	EU STAGE 5
		D	66 LFTN-D5	108	120	1.1	6L	20	30		2100				134	OH	EU STAGE 5
		D	66 LFTN-D5	108	120	1.1	6L	20	30		2100				150	OH	EU STAGE 5
		D	66 LFTN-D5	108	120	1.1	6L	20	30		2100				157	OH	EU STAGE 5
		D	66 LFTN-D5	108	120	1.1	6L	20	30		2100				170	OH	EU STAGE 5
		D	66 LFTN-D5	108	120	1.1	6L	20	30		2100				179	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		1950				158	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		1950				169	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		1950				183	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		1950				196	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		1950				214	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		2100				150	OH	EU STAGE 5
continued		D	74 LFTN-D5	108	134	1.2	6L	25	37		2100				171	OH	EU STAGE 5

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
AGCO POWER	194	D	74 LFTN-D5	108	134	1.2	6L	25	37		2100				173	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		2100				188	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		2100				200	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		2100				220	OH	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L	25	37		2100				226	OH	EU STAGE 5
		D	84 LFTN-D5	111	145	1.4	6L	37	50		2100				220	OH	EU STAGE 5
		D	84 LFTN-D5	111	145	1.4	6L	37	50		2100				232	OH	EU STAGE 5
		D	84 LFTN-D5	111	145	1.4	6L	37	50		2100				247	OH	EU STAGE 5
		D	84 LFTN-D5	111	145	1.4	6L	37	50		2100				268	OH	EU STAGE 5
		D	84 LFTN-D5	111	145	1.4	6L	37	50		2100				278	OH	EU STAGE 5
		D	84 LFTN-D5	111	145	1.4	6L	37	50		2100				292	OH	EU STAGE 5
		D	98 LFTN-D5	111	145	1.4	7L	38	48		1900				265	OH	EU STAGE 5
		D	98 LFTN-D5	111	145	1.4	7L	38	48		1900				339	OH	EU STAGE 5
		D	33 DTG	108	120	1.1	3L		20		1500				61	PG	FUEL OPTIMIZED - TIER 2
		D	33 DTP	108	120	1.1	3L		22		1800				67	PG	FUEL OPTIMIZED - TIER 2
		D	49 DTG	108	134	1.2	4L		23		1500				90	PG	FUEL OPTIMIZED - TIER 2
		D	49 DTP	108	134	1.2	4L		28		1800				112	PG	FUEL OPTIMIZED - TIER 2
		D	49 DTAG	108	134	1.2	4L		29		1500				116	PG	FUEL OPTIMIZED - TIER 2
		D	49 DTAP	108	134	1.2	4L		32		1800				128	PG	FUEL OPTIMIZED - TIER 2
		D	74 DTG	108	134	1.2	6L		25		1500				150	PG	FUEL OPTIMIZED - TIER 2
		D	74 DTP	108	134	1.2	6L		26		1800				156	PG	FUEL OPTIMIZED - TIER 2
		D	74 DTAG	108	134	1.2	6L		33		1500				200	PG	FUEL OPTIMIZED - TIER 2
		D	74 DTAP	108	134	1.2	6L		35		1800				212	PG	FUEL OPTIMIZED - TIER 2
		D	84 WIG	111	145	1.4	6L		40		1500				242	PG	FUEL OPTIMIZED - TIER 2
		D	49 LFTN-D5	108	134	1.2	4L		19		1500				95	PG	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L		23		1500				112	PG	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L		21		1500				105	PG	EU STAGE 5
		D	49 LFTN-D5	108	134	1.2	4L		25		1500				123	PG	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L		18		1500				136	PG	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L		22		1500				162	PG	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L		24		1500				179	PG	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L		20		1500				149	PG	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L		24		1500				178	PG	EU STAGE 5
		D	74 LFTN-D5	108	134	1.2	6L		27		1500				197	PG	EU STAGE 5
		D	44 CTIM	108	120	1.1	4L		25		2200				100	M	IMO TIER 2
		D	49 CTIM	108	134	1.2	4L		33		2200				133	M	IMO TIER 2
		D	66 CTIM	108	120	1.1	6L		32		2200				192	M	IMO TIER 2
		D	74 CTIM	108	134	1.2	6L		39		2200				235	M	IMO TIER 2
		D	84 CTIM	111	145	1.4	6L		50		2100				302	M	IMO TIER 2
		D	49 LFTN-BM	108	134	1.2	4L		27		2100				130	M	IMO TIER 3
continued		D	49 LFTN-BM	108	134	1.2	4L		29		2100				141	M	IMO TIER 3

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
AGCO POWER	194	D	49 LFTN-BM	108	134	1.2	4L		27		2100				130	M	STAGE 5 INLAND WATERWAY
		D	49 LFTN-BM	108	134	1.2	4L		29		2100				141	M	STAGE 5 INLAND WATERWAY
		D	74 LFTN-BM	108	134	1.2	6L		21		2100				155	M	IMO TIER 3
		D	74 LFTN-BM	108	134	1.2	6L		24		2100				163	M	IMO TIER 3
		D	74 LFTN-BM	108	134	1.2	6L		26		2100				175	M	IMO TIER 3
		D	74 LFTN-BM	108	134	1.2	6L		28		2100				200	M	IMO TIER 3
		D	74 LFTN-BM	108	134	1.2	6L		30		2100				221	M	IMO TIER 3
		D	74 LFTN-BM	108	134	1.2	6L		21		2100				155	M	STAGE 5 INLAND WATERWAY
		D	74 LFTN-BM	108	134	1.2	6L		24		2100				163	M	STAGE 5 INLAND WATERWAY
		D	74 LFTN-BM	108	134	1.2	6L		26		2100				175	M	STAGE 5 INLAND WATERWAY
		D	74 LFTN-BM	108	134	1.2	6L		28		2100				200	M	STAGE 5 INLAND WATERWAY
		D	74 LFTN-BM	108	134	1.2	6L		30		2100				221	M	STAGE 5 INLAND WATERWAY
ABC - ANGLO BELGIAN CORP.	218	D	6DZC	256	310	15.96	6L		250		1000		18.8		1500	ST-IND, M, PG	EU STAGE 5, IMO TIER 2, IMO TIER 3, EPA TIER 3
		D	8DZC	256	310	15.96	8L		250		1000		18.8		2000	ST-IND, M, PG	EU STAGE 5, IMO TIER 2, IMO TIER 3, EPA TIER 3
		D	12DZC	256	310	15.96	12V		250		1000		18.8		3000	ST-IND, M, PG	EU STAGE 5, IMO TIER 2, IMO TIER 3, EPA TIER 3
		D	16DZC	256	310	15.96	16V		250		1000		18.8		4000	ST-IND, M, PG	EU STAGE 5, IMO TIER 2, IMO TIER 3, EPA TIER 3
		D	6DL36	365	420	43.9	6L		650		750		24		3955	ST-IND, M, PG	IMO TIER 2, IMO TIER 3, EPA TIER 3
		D	8DL36	365	420	43.9	8L		650		750		24		5274	ST-IND, M, PG	IMO TIER 2, IMO TIER 3, EPA TIER 3
		D	12DV36	365	420	43.9	12V		650		750		24		7910	ST-IND, M, PG	IMO TIER 2, IMO TIER 3, EPA TIER 3
		D	16DV36	365	420	43.9	16V		650		750		24		10547	ST-IND, M, PG	IMO TIER 2, IMO TIER 3, EPA TIER 3
		DF	6DZD	256	310	15.96	6L		170		1000		12.5		1000	ST-IND, M, PG	EU STAGE 5, IMO TIER 2, IMO TIER 3
		DF	8DZD	256	310	15.96	8L		170		1000		12.5		1335	ST-IND, M, PG	EU STAGE 5, IMO TIER 2, IMO TIER 3
		DF	12DZD	256	310	15.96	12V		170		1000		12.5		2000	ST-IND, M, PG	EU STAGE 5, IMO TIER 2, IMO TIER 3
		DF	16DZD	256	310	15.96	16V		170		1000		12.5		2670	ST-IND, M, PG	EU STAGE 5, IMO TIER 2, IMO TIER 3
ARROW ENGINE CO.	*	SI		98-191	116-228	0.9-6.5	1L, 1H, 2H, 3L, 4L, 6L	1.5-5.0	4.5-49	900-1000	600-2200		3.7-9.2	1.0-65.2	5.0-97	PG, ST-IND	
BAUDOUIN	205	D	4M06G20/5	89	92	2.3	4L				1500				20	PG	
		D	4M06G25/5	89	92	2.3	4L				1500				25	PG	
		D	4M06G35/5	89	92	2.3	4L				1500				33	PG	
		D	4M06G44/5	89	92	2.3	4L				1500				41	PG	
		D	4M06G50/5	89	92	2.3	4L				1500				48	PG	
		D	4M06G55/5	89	92	2.3	4L				1500				53	PG	
		D	4M06G20/6	89	92	2.3	4L				1800				25	PG	
continued		D	4M06G25/6	89	92	2.3	4L				1800				30	PG	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
BAUDOUIN	205	D	4M06G33/6	89	92	2.3	4L				1800				41	PG	
		D	4M06G41/6	89	92	2.3	4L				1800				47	PG	
		D	4M06G50/6	89	92	2.3	4L				1800				58	PG	
		D	4M06G55/6	89	92	2.3	4L				1800				63	PG	
		D	4M10G70/5	105	118	4.1	4L				1500				66	PG	
		D	4M10G88/5	105	118	4.1	4L				1500				80	PG	
		D	4M10G110/5	105	118	4.1	4L				1500				100	PG	
		D	4M10G83/6	105	118	4.1	4L				1800				95	PG	
		D	4M10G100/6	105	118	4.1	4L				1800				115	PG	
		D	4M11G70/5	105	130	4.5	4L				1500				66	PG	
		D	4M11G90/5	105	130	4.5	4L				1500				81	PG	
		D	4M11G120/5	105	130	4.5	4L				1500				108	PG	
		D	4M11G83/6	105	130	4.5	4L				1800				93	PG	
		D	4M11G106/6	105	130	4.5	4L				1800				118	PG	
		D	6M11G150/5	105	130	6.75	6L				1500				140	PG	
		D	6M11G165/5	105	130	6.75	6L				1500				152	PG	
		D	6M11G110/6	105	130	6.75	6L				1800				132	PG	
		D	6M11G135/6	105	130	6.75	6L				1800				158	PG	
		D	6M11G160/6	105	130	6.75	6L				1800				180	PG	
		D	6M11G176/6	105	130	6.75	6L				1800				200	PG	
		D	6M16G220/5	126	130	9.73	6L				1500				204	PG	
		D	6M16G250/5	126	130	9.73	6L				1500				238	PG	
		D	6M16G275/5	126	130	9.73	6L				1500				264	PG	
		D	6M16G300/5	126	130	9.73	6L				1500				280	PG	
		D	6M16G350/5	126	130	9.73	6L				1500				320	PG	
		D	6M16G350/5CR	126	130	9.73	6L				1500				320	PG	
		D	6M16G200/6	126	130	9.73	6L				1800				238	PG	
		D	6M16G220/6	126	130	9.73	6L				1800				264	PG	
		D	6M16G250/6	126	130	9.73	6L				1800				288	PG	
		D	6M16G308/6	126	130	9.73	6L				1800				360	PG	
		D	6M21G400/5	127	165	12.54	6L				1500				385	PG	
		D	6M21G440/5	127	165	12.54	6L				1500				405	PG	
		D	6M21G500/5	127	165	12.54	6L				1500				450	PG	
		D	6M21G330/6	127	165	12.54	6L				1800				385	PG	
		D	6M21G390/6	127	165	12.54	6L				1800				448	PG	
		D	6M21G400/6	127	165	12.54	6L				1800				460	PG	
		D	6M26G500/5	150	150	15.9	6L				1500				447	PG	
		D	6M26G550/5	150	150	15.9	6L				1500				490	PG	
		D	6M26G450/6	150	150	15.9	6L				1800				506	PG	
		D	6M26G500/6	150	150	15.9	6L				1800				556	PG	
		D	8M21G660/5	127	165	16.72	8V				1500				580	PG	
		D	8M21G520/6	127	165	16.72	8V				1800				580	PG	
		D	6M33G660/5	150	185	19.6	6L				1500				587	PG	
		D	6M33G715/5	150	185	19.6	6L				1500				633	PG	
continued		D	6M33G750/5	150	185	19.6	6L				1500				670	PG	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
BAUDOUIN	205	D	6M33G825/5	150	185	19.6	6L				1500				725	PG	
		D	6M33G575/6	150	185	19.6	6L				1800				633	PG	
		D	6M33G600/6	150	185	19.6	6L				1800				670	PG	
		D	6M33G633/6	150	185	19.6	6L				1800				710	PG	
		D	6M33G660/6	150	185	19.6	6L				1800				740	PG	
		D	12M26G825/5	150	150	31.8	12V				1500				748	PG	
		D	12M26G900/5	150	150	31.8	12V				1500				793	PG	
		D	12M26G1000/5	150	150	31.8	12V				1500				902	PG	
		D	12M26G1100/5	150	150	31.8	12V				1500				973	PG	
		D	12M26G660/6	150	150	31.8	12V				1800				748	PG	
		D	12M26G704/6	150	150	31.8	12V				1800				792	PG	
		D	12M26G800/6	150	150	31.8	12V				1800				902	PG	
		D	12M26G900/6	150	150	31.8	12V				1800				1012	PG	
		D	12M26G1000/6	150	150	31.8	12V				1800				1115	PG	
		D	12M33G1250/5	150	185	39.2	12V				1500				1108	PG	
		D	12M33G1400/5	150	185	39.2	12V				1500				1210	PG	
		D	12M33G1500/5	150	185	39.2	12V				1500				1320	PG	
		D	12M33G1650/5	150	185	39.2	12V				1500				1450	PG	
		D	12M33G1000/6	150	185	39.2	12V				1800				1108	PG	
		D	12M33G1100/6	150	185	39.2	12V				1800				1265	PG	
		D	12M33G1200/6	150	185	39.2	12V				1800				1320	PG	
		D	12M33G1300/6	150	185	39.2	12V				1800				1420	PG	
		D	16M33G1700/5	150	185	52.3	16V				1500				1530	PG	
		D	16M33G1900/5	150	185	52.3	16V				1500				1680	PG	
		D	16M33G2000/5	150	185	52.3	16V				1500				1800	PG	
		D	16M33G1400/6	150	185	52.3	16V				1800				1580	PG	
		D	16M33G1500/6	150	185	52.3	16V				1800				1680	PG	
		D	16M33G1650/6	150	185	52.3	16V				1800				1785	PG	
		D	16M33G1750/6	150	185	52.3	16V				1800				1920	PG	
		D	12M55G2300/5	180	215	65.65	12V				1500				2020	PG	
		D	12M55G2550/5	180	215	65.65	12V				1500				2210	PG	
		D	12M55G2750/5	180	215	65.65	12V				1500				2450	PG	
		D	12M55G2000/6	180	215	65.65	12V				1800				2230	PG	
		D	12M55G2250/6	180	215	65.65	12V				1800				2420	PG	
		D	12M55G2500/6	180	215	65.65	12V				1800				2725	PG	
		SI	4M11G4N0/5	105	130	4.5	4L				1500				77	PG	
		SI	4M11G4N0/6	105	130	4.5	4L				1800				77	PG	
		SI	6M11G4N0/5	105	130	6.75	6L				1500				120	PG	
		SI	6M11G4N0/6	105	130	6.75	6L				1800				132	PG	
		SI	6M16G4N0/5	126	130	9.73	6L				1500				200	PG	
		SI	6M16G4N0/6	126	130	9.73	6L				1800				238	PG	
		SI	6M21G4N0/5	127	156	12.54	6L				1500				288	PG	
		SI	6M21G4N0/6	127	156	12.54	6L				1800				317	PG	
		SI	6M33G6N0/5	150	185	19.6	6L				1500				450	PG	
continued		SI	6M33G6N0/6	150	185	19.6	6L				1800				480	PG	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
BAUDOUIN	205	SI	12M33G10N0/5	150	185	39.2	12V				1500				900	PG	
		SI	12M33G14N0/6	150	185	39.2	12V				1800				960	PG	
		SI	16M33G6N0/5	150	185	52.3	16V				1500				1280	PG	
		SI	16M33G6N0/6	150	185	52.3	16V				1800				1280	PG	
		D	4M06V2D0	89	92	2.3	4L			1500	1800			20	30	ST-IND	
		D	4M06V4D0	89	92	2.3	4L			1500	1800			25	41	ST-IND	
		D	4M06V6D0	89	92	2.3	4L			1500	1800			29	47	ST-IND	
		D	4M06V8D0	89	92	2.3	4L			1500	1800			34	58	ST-IND	
		D	4M11V2D0	105	130	4.5	4L			1500	2200			43	60	ST-IND	
		D	4M11V4D0	105	130	4.5	4L			1500	2200			73	100	ST-IND	
		D	4M11V6D0	105	130	4.5	4L			1500	2200			75	118	ST-IND	
		D	6M11V2D0	105	130	6.75	6L			1500	2200			106	150	ST-IND	
		D	6M11V4D0	105	130	6.75	6L			1500	2200			118	180	ST-IND	
		D	6M16V2D0	126	130	9.73	6L			1500	2200			180	255	ST-IND	
		D	6M21V2D0	127	165	12.54	6L			1500	2200			276	370	ST-IND	
		D	4W105M	105	130	4.5	4L				2100				95	M	
		D	6W105M	105	130	6.75	6L				2100				136	M	IMO 2
		D	6W105M	105	130	6.75	6L				2425				168	M	IMO 2
		D	6M16	126	130	9.7	6L				2100				240	M	IMO 2
		D	6M16	126	130	9.7	6L				2100				264	M	IMO 2
		D	6W126M	126	150	11.6	6L				1800				294	M	IMO 2, CCNR 2, CE97/68 3A
		D	6W126M	126	150	11.6	6L				2100				331	M	IMO 2, CCNR 2, CE97/68 3A
		D	6M19.3	126	155	11.6	6L				1800				331	M	IMO 2, CCNR 2, CE97/68 3A
		D	6M19.3	126	155	11.6	6L				2100				368	M	IMO 2, CCNR 2, CE97/68 3A
		D	6M19.3	126	155	11.6	6L				2100				404	M	IMO 2, CCNR 2, CE97/68 3A
		D	6M19.3	126	155	11.6	6L				2200				425	M	IMO 2, CCNR 2
		D	6F21	127	165	12.5	6L				2300				599	M	IMO 2, EPA Tier 3
		D	6F21	127	165	12.5	6L				2300				662	M	IMO 2, EPA Tier 3
		D	6F21	127	165	12.5	6L				2300				735	M	IMO 2, EPA Tier 3
		D	6M26.2	150	150	15.9	6L				1800				331	M	IMO 2, CCNR 2, CE97/68 3a
		D	6M26.2	150	150	15.9	6L				1800				368	M	IMO 2, CCNR 2, CE97/68 3a
		D	6M26.2	150	150	15.9	6L				1900				404	M	IMO 2, CCNR 2, CE97/68 3a
		D	6M26.2	150	150	15.9	6L				1950				441	M	IMO 2
		D	12M26.2	150	150	31.8	12V				1800				662	M	IMO 2, CCNR 2, CE97/68 3a
		D	12M26.2	150	150	31.8	12V				1800				736	M	IMO 2, CCNR 2, CE97/68 3a
		D	12M26.2	150	150	31.8	12V				1900				809	M	IMO 2, CCNR 2, CE97/68 3a
		D	12M26.2	150	150	31.8	12V				1950				883	M	IMO 2
		D	6M33.2	150	185	19.6	6L				1800				478	M	IMO 2
continued		D	6M33.2	150	185	19.6	6L				1800				515	M	IMO 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

DIESEL, NATURAL GAS & DUAL FUEL ENGINES

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
BAUDOUIN	205	D	6M33.2	150	185	19.6	6L				1800				552	M	IMO 2
		D	12M33.2	150	185	39.2	12V				1800				956	M	IMO 2
		D	12M33.2	150	185	39.2	12V				1800				1029	M	IMO 2
		D	12M33.2	150	185	39.2	12V				1800				1104	M	IMO 2
		D	6M26.3	150	150	15.9	6L				1800				441	M	IMO 2, IMO 3, EPA Tier 3, EPA Tier 4, CCNR 2, CE97/68 3a
		D	6M26.3	150	150	15.9	6L				1800				485	M	IMO 2, CCNR 2, CE97/68 3a
		D	6M26.3	150	150	15.9	6L				2000				515	M	IMO 2, IMO 3, EPA Tier 3, EPA Tier 4, CCNR 2, CE97/68 3a
		D	6M26.3	150	150	15.9	6L				2100				552	M	IMO 2, IMO 3, EPA TIER 3, EPA TIER 4, CCNR 2, CE97/68 3A
		D	6M26.3	150	150	15.9	6L				2100				599	M	IMO 2, IMO 3, EPA TIER 3, EPA TIER 4
		D	12M26.3	150	150	31.8	12V				1800				882	M	IMO 2, IMO 3, EPA TIER 3, EPA TIER 4, CCNR 2, CE97/68 3A
		D	12M26.3	150	150	31.8	12V				1800				972	M	IMO 2, CCNR 2, CE97/68 3A
		D	12M26.3	150	150	31.8	12V				2100				1032	M	IMO 2, IMO 3, EPA TIER 3, EPA TIER 4, CCNR 2, CE97/68 3A
		D	12M26.3	150	150	31.8	12V				2200				1104	M	IMO 2, IMO 3, EPA TIER 3, EPA TIER 4, CCNR 2, CE97/68 3A
		D	12M26.3	150	150	31.8	12V				2300				1215	M	IMO 2, IMO 3, EPA 3, EPA TIER 4
CATERPILLAR INC.	*	D	C0.5	67	72	0.5	2L		5.1		3600		7.5		10.2	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C0.5	67	72	0.5	2L		4.4		3000		5		8.8	OH	EU STAGE 5, EPA TIER 4F
		D	C0.7	67	72	0.7	3L		5.1		3600		7.4		15.3	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C0.7	67	72	0.7	3L		4.43		3600		7.9		13.3	OH	EU STAGE 5, EPA TIER 4F
		D	C1.1	77	81	1.1	3L		6.3		2800		7.9		18.9	OH	EU STAGE 5, EPA TIER 4F
		D	C1.5	84	90	1.5	3L		10		3000		8.8		30	OH	UN ECE R96 Stage 3a or below
		D	C1.5	84	90	1.5	3L		6.13		2100		7.2		18.4	OH	EPA Tier 4f
		D	C1.7	84	100	1.7	3L		6.3		2800		7		18.9	OH	EU Stage 5, EPA Tier 4f
		D	C1.7	84	100	1.7	3L		10		2800		9.2		30	OH	EPA Tier 4f
		D	C1.7	84	100	1.7	3L		12		2800		12.3		36	OH	EU Stage 5, EPA Tier 4f
		D	C2.2	84	100	2.2	4L		11.5		3000		10.8		46	OH	UN ECE R96 Stage 3a or below
		D	C2.2	84	100	2.2	4L		12.25		2800		11.9		49	OH	UN ECE R96 Stage 3a or below
		D	C2.2	84	100	2.2	4L		9		2800		9.4		36	OH	EPA TIER 4F
		D	C2.2	84	100	2.2	4L		11.25		2800		12.7		45	OH	EU STAGE 5, EPA TIER 4F
		D	C2.2	84	100	2.2	4L		13.75		2800		14.3		55	OH	EU STAGE 5, EPA TIER 4F
continued		D	C2.8	90	110	2.8	4L		13.75	2200	2400		17.1		55	OH	EU STAGE 5, TIER 4F OR EU STAGE 3A

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
CATERPILLAR INC.	*	D	C3.6	98	120	3.6	4L		13.75	2200	2400		14.8		55	OH	EU STAGE 5, TIER 4F OR EU STAGE 3A
		D	C3.6	98	120	3.6	4L		22.5	2000	2400		17.5		90	OH	EU STAGE 5, TIER 4F OR EU STAGE 3A
		D	C3.6	98	120	3.6	4L		25	2000	2200		19.2		100	OH	EU STAGE 5, EPA TIER 4F
		D	3054	105	127	4.4	4L		14		2200		7.6		56	OH	UN ECE R96 STAGE 3A OR BELOW
		D	3054	105	127	4.4	4L		20.75		2200		11.9		83	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C4.4	105	127	4.4	4L		26.5		2200		15.9		106	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C4.4	105	127	4.4	4L		35		2200		23.6		140	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C4.4	105	127	4.4	4L		27.5	2000	2200		16		110	OH	EU STAGE 5, EPA TIER 4F
		D	C4.4	105	127	4.4	4L		37.5		2200		23.6		150	OH	EU STAGE 5, EPA TIER 4F
		D	C7.1	105	135	7	6L		18.67		1950		12.1		112	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C7.1	105	135	7	6L		34.17		2200		18.8		205	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C7.1	105	135	7	6L		37.5	1800	2200		23		225	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C7.1	105	135	7	6L		25.17	1800	2200		15.6		151	OH	EU STAGE 5, EPA TIER 4F
		D	C7.1	105	135	7	6L		39.83		2200		22.8		239	OH	EU STAGE 5, EPA TIER 4F
		D	C9.3B	115	149	9.3	6L		56.67	1800	2000		28.2		340	OH	EU STAGE 5, EPA TIER 4F
		D	C9.3B	115	149	9.3	6L		51.67		2000		24.5		310	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C13	130	157	12.5	6L		64.67	1800	2100		22.3		388	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C13	130	157	12.5	6L		64.67	1800	2100		23.9		388	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C13	130	157	12.5	6L		64.17	1800	1800		22.3		385	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C13	130	157	12.5	6L		66.67	1800	2000		23.9		400	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C13B	130	157	12.5	6L		66.67	1800	2100		24.7		400	OH	EU STAGE 5, EPA TIER 4F
		D	C13B	130	157	12.5	6L		71.67	1800	2100		26.5		430	OH	EU STAGE 5, EPA TIER 4F
		D	C15	137	171	15.2	6L		72.17	1800	2100		21.9		433	OH	EU STAGE 5, EPA TIER 4F
		D	C15	137	171	15.2	6L		74	1800	2100		22.8		444	OH	UN ECE R96 STAGE 3A OR BELOW
		D	C18	145	183	18.1	6L		99.5	1800	2100		25.4		597	OH	UN ECE R96 Stage 3a or below
		D	C18	145	183	18.1	6L		99.5	1800	2000		25.9		597	OH	EU Stage 5, EPA Tier 4f
		D	C27	137	152	27	12V		71.5	1800	2100		24		858	OH	UN ECE R96 Stage 3a or below
		D	C27	137	152	27	12V		65.25		1800		21.8		783	OH	EU Stage 5, EPA Tier 4f
		D	C32	145	162	3.1	12V		83.92	1800	2100		24		1007	OH	UN ECE R96 Stage 3a or below
continued		D	C32	145	162	32	12V		69.92		1800		21.6		839	OH	EU Stage 5, EPA Tier 4f

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
CATERPILLAR INC.	*	D	C32	145	162	32	12V		74.58		1800		23		895	OH	EPA Tier 4f
		D	3508	170	190	34.5	8V		93.25		1800		16		746	OH	UN ECE R96 STAGE 3A OR BELOW
		D	3512C	170	215	58.6	12V		93.33		1800		15		1120	OH	UN ECE R96 STAGE 3A OR BELOW
		D	3516C	170	215	78	16V		130.5		1750		17		1566	OH	UN ECE R96 STAGE 3A OR BELOW
		D	3516E	170	215	78	16V		130.5		1650		18		1566	OH	EU STAGE 5, EPA TIER 4F
CUMMINS INC.	Inside Back Cover, 167, 169	D	F2.8	94	100	0.7	4L	24	32.5	2900	3500			96	130	ON	EURO 4
		D	F3.8	102	115	1	4L	28.7	31.2	2600	2600			115	125	ON	EURO 4
		D	B4.5	107	124	1.1	4L	28	39.2	2300	2300			112	157	ON	EURO 4
		D	B6.7	107	124	1.1	6L	27.3	39.8	2300	2300			164	239	ON	EURO 4
		D	L9	114	145	1.5	6L	42.3	49.6	2100	2100			254	298	ON	EURO 4
		SI	L9N	114	145	1.5	6L	34.8	39.8	2200	2200			209	239	ON	EURO 4
		D	X12	132	144	2	6L	44.2	60	1900	1900			265	360	ON	EURO 4
		D	X15	137	169	2.5	6L	49.6	75.2	1800	2000			298	451	ON	EURO 4
		D	B6.7	107	124	1.1	6L	24.2	44.6	2600	2600			145	269	ON	EPA 2021, CARB 2021
		D	L9	114	145	1.5	6L	32.3	56	2100	2200			194	336	ON	EPA 2021, CARB 2021
		D	X12	132	144	2	6L	43.5	62.2	1900	2100			261	373	ON	EPA 2021, CARB 2021
		D	X15	137	169	2.5	6L	49.6	75.2	1700	2100			306	451	ON	EPA 2021, CARB 2021
		SI	B6.7N	102	124	1.1	6L	24.8	29.8	1600	1600			149	179	ON	EPA 2021, CARB 2021
		SI	L9N	114	145	1.5	6L	31	39.8	2200	2200			186	239	ON	EPA 2021, CARB 2021
		SI	ISX12N	130	150	2	6L	39.8	49.6	1700	1800			239	298	ON	EPA 2021, CARB 2021
		D	QSF2.8	94	100	0.7	4L	9.25	13.75	2200	2500			37	55	OH	EPA TIER 4F
		D	F3.8™	102	115	0.95	4L	13.75	43.25	2200	2500			55	129	OH	EPA TIER 4F, EU STAGE 5
		D	B4.5™	107	124	1.1	4L	22.5	37.25	2000	2500			90	149	OH	EPA TIER 4F, EU STAGE 5
		D	B6.7™	107	124	1.2	6L	21.5	81.5	2000	2500			116	243	OH	EPA Tier 4f, EU Stage 5
		D	L9	114	145	1.5	6L	34.8	53.5	1800	2100			209	321	OH	EPA Tier 4f, EU Stage 5
		D	X12	132	144	2	6L	41.7	63.7	1800	2100			250	383	OH	EPA TIER 4F, EU STAGE 5
		D	X15	137	169	2.5	6L	56	83.8	1800	2100			336	503	OH	EPA TIER 4F, EU STAGE 5
		D	QSK19	159	159	3.2	6L	94.5	94.5	1800	2000			567	567	OH	EPA TIER 4F, EU STAGE 5
		D	QSK23	170	170	3.8	6L	94.5	130.5	1800	2100			567	783	OH	EPA TIER 4F, EU STAGE 5
		D	QST30	140	165	2.5	12V	59	74.6	1800	2100			708	895	OH	EPA TIER 4F, EU STAGE 5
		D	QSK38	159	159	3.2	12V	67.5	99.4	1800	1900			810	1193	OH	EPA TIER 4F, EU STAGE 5
		D	QSK50	159	159	3.1	16V	69.9	116.5	1800	1900			1119	1864	OH	EPA TIER 4F, EU STAGE 5
		D	QSK78	170	190	4.3	18V	145	145	1900	1900			2610	2610	OH	EPA TIER 4F
DAIHATSU DIESEL MFG. CO. LTD.	214, 245	D	M5	145	160	2.6	6L	24.5	51.7	1200	1800	6.6	13.9	147	310		
		D	DL-16AE	165	210	4.5	6L	43.3	88.3	900	1200	9.8	19.9	260	530		IMO Tier 2
		D	DE-18	185	280	7.5	6L	66.7	141.7	720	1000	11.8	25.4	400	860		IMO TIER 2
continued		D	DE-20	205	300	9.5	6L	135.2	181.7	720	900	18.2	24.5	811	1090		IMO TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
DAIHATSU DIESEL MFG. CO. LTD.	214, 245	D	DE-23	230	320	13.3	6L	133.3	250.0	720	900	13.2	25.1	800	1516		IMO TIER 2
		D	DEL-23	230	350	14.5	8L	160.0	275.0	750	900	14.7	25.2	1280	2200		IMO TIER 2
		D	DE-28	285	390	24.9	6L	320.2	350.0	720	750	21.5	23.9	1921	2140		IMO TIER 2
		D	DE-33	330	440	37.6	6L	450.0	600.0	720	750	20.0	26.6	2700	3600		IMO TIER 2
		D	DE-33	330	440	37.6	8L	450.0	600.0	720	750	20.0	26.6	3600	4800		IMO Tier 2
		D	DC-32E	320	400	32.0	6L	383.3	500.0	720	750	19.9	25.9	2300	3000		IMO TIER 2
		D	DC-32E	320	400	32.0	8L	343.8	500.0	720	750	16.0	23.3	2750	4000		IMO TIER 2
		D	DC-32E	320	400	32.0	16V	343.8	482.5		720	16.6	23.3	5500	7720		IMO TIER 2
		D	DK-20E	200	300	9.4	6L	96.7	176.7	720	900	13.5	24.6	580	1060		IMO TIER 2
		D	DK-26E	260	380	20.2	6L	200.0	267.0	720	750	14.3	22.0	1200	1850		IMO Tier 2
		D	DK-28E	280	390	24.0	6L	243.3	350.0	720	750	16.9	24.6	1460	2130		IMO Tier 2
		D	DK-28E	280	390	24.0	8L	239.4	350.0	720	750	16.6	24.3	1915	2800		IMO Tier 2
		D	DK-36E	360	480	48.9	6L	491.7	583.3		600	20.1	23.9	2950	3500		IMO Tier 2
		D	DK-36E	360	480	48.9	8L	550.0	562.5		600	21.8	23.0	4400	4650		IMO Tier 2
		D	DK-36E	360	460	46.0	12V	485.8	550.0		600	20.6	23.5	5830	6660		IMO Tier 2
		DF	DE20DF	205	300	9.9	6L		148.3		900		20.0		890		IMO Tier 2
		DF	DE23DF	230	320	13.3	6L		200.0		900		20.1		1200		IMO Tier 2
		DF	DE28DF	280	390	24.0	6L		288.3	720	750		20.0		1730		IMO TIER 2
		DF	DE35DF	350	440	42.3	6L		510.0		720		20.1		3060		IMO TIER 2
		DF	DE35DF	350	440	42.3	8L		510.0		720		20.1		4080		IMO TIER 2
DEUTZ AG	183	D	D 1.2 L3	78.0	82.0	1.2	3 L				2800				17.9	ST-IND	EU STAGE 5, EPA TIER 4
		D	G 2.2 L3	92	110	2.2	3 L				2600				42.0	ST-IND, OH	EU STAGE 5, EPA TIER 2, CARB LSI
		D	D 2.2 L3	92	110	2.2	3 L				2300				18.4	ST-IND, OH	EPA TIER 4
		D	D 2.2 L3	92	110	2.2	3 L				2600				18.4	ST-IND, OH	EU STAGE 5, EPA TIER 4, EU STAGE 3A (EDG)
		D	TD 2.2 L3	92	110	2.2	3 L				2600				44.5	ST-IND, OH, PG	EU STAGE 5, EPA TIER 4, EU STAGE 3A (EDG)
		D	TCD 2.2 L3	92	110	2.2	3 L				2600				55.4	ST-IND, OH	EU STAGE 5, EPA TIER 4, EU STAGE 3A (EDG)
		D	G 2.9 L4	92	110	2.9	4 L				2600				54.0	ST-IND, OH	EU STAGE 5, EPA TIER 2
		D	D 2.9 L4	92	110	2.9	4 L				2600				36.4	ST-IND, OH	EU STAGE 5, EPA TIER 4, CN4
		D	TD 2.9 L4	92	110	2.9	4 L				2600				55.4	ST-IND, OH, PG	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 2.9 L4	92	110	2.9	4 L				2600				55.4	ST-IND, OH, PG	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 2.9 L4 HT	92	110	2.9	4 L				2600				55.4	ST-IND, OH, PG	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 2.9 L4 HP	92	110	2.9	4L				2200				82.0	ST-IND, OH	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 2.9 L4 HP (A)	92	110	2.9	4L				2200				82.0	OH	EU STAGE 5, EPA TIER 4, CN4
		D	TD 3.6 L4	98	120	3.6	4 L				2600				55.4	ST-IND, OH	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 3.6 L4	98	120	3.6	4 L				2300				100.0	ST-IND, OH, PG	EU STAGE 5, EPA TIER 4, CN4
continued		D	TCD 3.6 L4 (A)	98	120	3.6	4 L				2200				105.0	ST-IND, OH	EU STAGE 5, EPA TIER 4, CN4

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
DEUTZ AG	183	D	TCD 3.6 L4 HT	98	120	3.6	4 L				2300				55.4	ST-IND, OH	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 3.6 L4 HP	98	120	3.6	4 L				2300				105.0	ST-IND, OH	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 4.1 L4	101	126	4	4 L				2300				115.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 4.1 L4 (A)	101	126	4	4 L				2100				120.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 5.2 L4	110	136	5.2	4 L				2200				170.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 6.1 L6	101	126	6.1	6 L				2300				180.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 6.1 L6 (A)	101	126	6.1	6 L				2100				174.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TTCD 6.1 L6 (A)	101	126	6.1	6 L				2100				211.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 7.8 L6	110	136	7.8	6 L				2200				260.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TTCD 7.8 L6 (A)	110	136	7.8	6 L				2100				291.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 9.0 L4	135	157	9	4 L				2100				304.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4, EU STAGE 3A
		D	TCD 12.0 L6	130	150	12	6 L				2100				404.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4, EU STAGE 3A
		D	TCD 13.5 L6	135	157	13.5	6 L				2100				454.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4, EU STAGE 3A
		D	TCD 12.0 V6	132	145	11.9	6 V				2100				390.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 16.0 V8	132	145	15.9	8 V				2100				520.0	ST-IND	EU STAGE 5, EPA TIER 4, CN4
		D	TCD 18.0 L6	148	174	18	6 L				1900				623.0	ST-IND	EU STAGE 5, EPA TIER 4
		D	D 2011 L2 O	94	112	1.6	2 L				2800				23.1	ST-IND	EU STAGE 3A, EPA TIER 3
		D	D 2011 L2 I	94	112	1.6	2 L				2800				22.5	ST-IND	EU Stage 3a, EPA Tier 3
		D	D 2011 L3 O	94	112	2.3	3 L				2800				36.4	ST-IND	EU Stage 3a, EPA Tier 3
		D	D 2011 L3 I	94	112	2.3	3 L				2800				36.3	ST-IND	EU Stage 3a, EPA Tier 3
		D	D 2011 L4 W	96	125	3.6	4 L				2600				50.0	ST-IND	EU Stage 3a, EPA Tier 3
		D	D 2011 L4 I	96	125	3.6	4 L				2600				47.5	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TD 2011 L4 I	96	125	3.6	4 L				2600				57.6	ST-IND	EU Stage 3a, EPA Tier 3
		D	TD 2011 L4 W	96	125	3.6	4 L				2600				68.0	ST-IND	EU Stage 3a, EPA Tier 3
		D	TCD 2011 L4 W	96	125	3.6	4 L				2600				79.4	ST-IND	EU STAGE 3A, EPA TIER 3
		D	D 914 L4	102	132	4.3	4 L				2300				58.0	ST-IND	EU Stage 3a, EPA Tier 3
		D	D 914 L6	102	132	6.5	6 L				2300				86.5	ST-IND	EU Stage 3a, EPA Tier 3
		D	TCD 914 L6 ECAGR	102	132	6.5	6 L				2300				129.9	ST-IND	EU Stage 3a, EPA Tier 3
continued		D	D 2.9 L4	92	110	2.9	4 L				2600				36.4	ST-IND, OH	EPA Tier 4, EU Stage 3a (EDG), CN3

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
DEUTZ AG	183	D	TD 2.9 L4	92	110	2.9	4 L				2600				55.4	ST-IND, OH	EPA Tier 4, EU Stage 3a (EDG), CN3
		D	TCD 2.9 L4	92	110	2.9	4 L				2600				55.4	ST-IND, OH	EPA TIER 4, EU STAGE 3A (EDG), CN3
		D	TD 3.6 L4	98	120	3.6	4 L				2600				55.4	ST-IND, OH	EPA TIER 4, EU STAGE 3A (EDG), CN3
		D	TCD 3.6 L4	98	120	3.6	4 L				2300				100.0	ST-IND, OH	EPA TIER 4, EU STAGE 3A (EDG), CN3
		D	TCD 4.1 L4	101	126	4	4 L				2300				115.0	ST-IND	EU Stage 3a, EPA Tier 3
		D	TCD 6.1 L6	101	126	6.1	6 L				2300				160.0	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TCD 7.8 L6	110	136	7.8	6 L				2300				250.0	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TD 2012 L4 2V	101	126	4	4 L				2300				66.0	ST-IND	EU Stage 3a, EPA Tier 3
		D	TCD 2012 L4 2V	101	126	4	4 L				2400				88.0	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TCD 2012 L4 2V	101	126	4	4 L				2400				103.0	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TCD 2012 L6 2V	101	126	6.1	6 L				2400				155.0	ST-IND	EU Stage 3a, EPA Tier 3
		D	TCD 2013 L4 2V	108	130	4.8	4 L				2300				129.0	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TCD 2013 L6 2V	108	130	7.2	6 L				2300				200.2	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TCD 2013 L6 4V	108	130	7.2	6 L				2200				238.0	ST-IND	EU Stage 3a, EPA Tier 3
		D	TCD 2015 V6	132	145	11.9	6 V				2100				360.0	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TCD 2015 V8	132	145	15.9	8 V				2100				500.0	ST-IND	EU STAGE 3A, EPA TIER 3
		D	TCD 12.0 V6	132	145	11.9	6 V				2100				360.0	ST-IND	EU Stage 3a, EPA Tier 3
		D	TCD 16.0 V8	132	145	15.9	8 V				2100				500.0	ST-IND	EU STAGE 3A, EPA TIER 3
		D	F 4 L 912	102	132	4.3	4 L				2500				54.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	F 6 L 912	102	132	6.5	6 L				2500				82.0	ST-IND	EU Stage 2, EPA Tier 2
		D	F 4 L 914	102	132	4.3	4 L				2500				64.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	BF 4 L 914	102	132	4.3	4 L				2500				85.7	ST-IND	EU STAGE 2, EPA TIER 2
		D	F 6 L 914	102	132	6.5	6 L				2500				96.0	ST-IND	EU Stage 2, EPA Tier 2
		D	BF 6 L 914	102	132	6.5	6 L				2500				140.9	ST-IND	EU STAGE 2, EPA TIER 2
		D	BF 6 L 914 C	102	132	6.5	6 L				2500				148.5	ST-IND	EU STAGE 2, EPA TIER 2
		D	F 12 L 513	128	130	20	12 V				2300				235.0	ST-IND	EU Stage 2, EPA Tier 2
		D	BF 8 L 513	125	130	12.8	8 V				2300				243.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	BF12 L 513 C	125	130	19.1	12 V				2300				386.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	BF 4 M 2012	101	126	4	4 L				2500				74.9	ST-IND	EU Stage 2, EPA Tier 2
continued		D	BF 4 M 2012 C	101	126	4	4 L				2500				103.0	ST-IND	EU STAGE 2, EPA TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
DEUTZ AG	183	D	BF 6 M 2012 C	101	126	6	6 L				2500				155.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	BF 4 M 1013 EC	108	130	4.8	4L				2300				118.0	ST-IND	EU Stage 2, EPA Tier 2
		D	BF 6 M 1013 EC	108	130	7.2	4 L				2300				174.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	BF 6 M 1015 C	108	130	11.9	4 L				2100				300.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	BF 6 M 1015 CP	108	130	11.9	6 L				2100				330.0	ST-IND	EU Stage 2, EPA Tier 2
		D	BF 8 M 1015 C	132	145	15.9	6 V				2100				400.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	BF 8 M 1015 CP	132	145	15.9	6 V				2100				440.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	TCD 12.0 V6	132	145	15.9	8 V				2100				400.0	ST-IND	EU STAGE 2, EPA TIER 2
		D	TCD 16.0 V8	132	145	15.9	8 V				2100				440.0	ST-IND	EU Stage 2, EPA Tier 2
DOOSAN INFRACORE CO. LTD. ENGINE & MATERIAL BG	222	D	L AD222TI	128	142	1.8	12V	37.2						446.0	530.0		
		D	L 4V222TI	128	142	1.8	12V	49	73.6			16.9	21	588.0	883.0		
		D	L 4AD222TI	128	142	1.8	12V	40.9	49					491.0	588.0		
		SI	LL GE08TI	111	139	1.4	6L	29.3						176.0	191.0		
		SI	LL GE12TI	123	155	1.9	6L	35.5						213.0	250.0		
		SI	LL GK12	123	155	1.9	6L		35.5		2200		10.5		213.0		
		SI	L GE08TI	111	139	1.4	6L	21.3						128.0	165.0		
		SI	L GE12TI	123	155	1.9	6L	29.2	36.7	1500	1800	12.6	13.2	175.0	220.0		
		SI	L GV158TI	128	142	1.8	8V	28.8						230.0	297.0		
		SI	L GV180TI	128	142	1.8	10V	29	37.4					290.0	374.0		
		SI	L GV222TI	128	142	1.8	12V	29.2						350.0	450.0		
		D	L V158TI	128	142	1.8	8V	44.1						353.0	500.0		
		D	L AD158TI	128	142	1.8	8V	37.8						302.0	353.0		
		D	L 4V158TI	128	142	1.8	8V	48.8				17.3	21	390.0	588.0		
		D	L 4AD158TI	128	142	1.8	8V	54.2	65					325.0	390.0		
		D	L P180LE-1	128	142	1.8	10V	40.3						403.0	498.0		
		D	L P180LE	128	142	1.8	10V	44.3	54					443.0	540.0		
		D	L P180LE-S	128	142	1.8	10V	45.2						452.0	567.0		
		D	L P180FE	128	142	1.8	10V	45.2						452.0	566.0		
		D	L PU180TI	128	142	1.8	10V	44.5						445.0	511.0		
		D	L V180TI	128	142	1.8	10V	44.1						441.0	603.0		
		D	L AD180TI	128	142	1.8	10V	35.7						357.0	441.0		
		D	L P222LE-1	128	142	1.8	12V	51.2			1800			512.0	625.0		
		D	L P222LE	128	142	1.8	12V	44.3						532.0	649.0		
		D	L P222LE-S	128	142	1.8	12V	46	56.8					552.0	682.0		
		D	L P222FE	128	142	1.8	12V	47.4						569.0	711.0		
		D	L PU222TI	128	142	1.8	12V	47	52.1					564.0	625.0		
		D	L V222TI	128	142	1.8	12V	44.2						530.0	736.0		
		D	L MD196TI	123	155	1.9	6L		39.2		2000		12.7		235.0		
		D	L AD196TI	123	155	1.9	6L	28.8			1800	12	12.5	173.0	199.0		
		D	L P126TI	123	155	1.9	6L	40.2						241.0	298.0		
		D	L P126TI-1	123	155	1.9	6L	43.7	48		1800			262.0	288.0		
continued		D	L P126TI-II	123	155	1.9	6L	44.2	57					265.0	342.0		

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type (D: Diesel or Heavy Fuel, DF: Dual Fuel, SI: Spark Ignited)	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders (L: In-Line, V: Vee-Type, H: Horizontal, O: Opposed)	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application (OH - Off-Highway, ON - On-Highway, PG - Power Gen, M - Marine, ST - IND Stationary Ind, R - Rail)	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
DOOSAN INFRACORE CO. LTD. ENGINE & MATERIAL BG	222	D	L PU126TI	123	155	1.9	6L	47.2	49		2100		15.1	283.0	294.0		
		D	L L126TI	123	155	1.9	6L	44.2	49					265.0	294.0		
		D	L AD126TI	123	155	1.9	6L	34.3						206.0	247.0		
		D	DV11	128	142	1.8	6V	40.8						245.0	309.0	ON	EURO 3
		D	DV11	128	142	1.8	6V		40.8		1800				245.0	OH	EPA TIER 3
		D	DV11 S	128	142	1.8	6V	48.8						293.0	328.0	ON	EURO 4
		D	DV11K	128	142	1.8	6V		55		1900				330.0	ON	EURO 5
		D	L DV15T	128	142	1.8	8V		34		2300		9.7		272.0		
		D	L DV15TI	128	142	1.8	8V		38.6		2100		12.1		309.0		
		D	L DV15TIS	128	142	1.8	8V		35.9		2100		11.2		287.0		
		D	L P158LE-2	128	142	1.8	8V	48.8			1800			293.0	375.0		
		D	L P158LE-1	128	142	1.8	8V	40.9						327.0	402.0		
		D	L P158LE	128	142	1.8	8V	45.4						363.0	458.0		
		D	L P158LE-S	128	142	1.8	8V	50.3	60.1	1500	1800	22	22	402.0	481.0		
		D	L P158FE	128	142	1.8	8V	50.3			1800	22	22.5	402.0	492.0		
		D	L PU158TI	128	142	1.8	8V	45.8	51					366.0	408.0		
		D	L L136	111	139	1.4	6L		19.7		2200		7.9		118.0		
		D	L AD136	111	139	1.4	6L	12.8				7.6	7.7	77.0	93.0		
		D	L D1146T	111	139	1.4	6L	17.8				8.6	11.4	107.0	151.0		
		D	L PU086T	111	139	1.4	6L	25.8						155.0	173.0		
		D	L L136T	111	139	1.4	6L	24.5				9.9	10.5	147.0	177.0		
		D	L AD136T	111	139	1.4	6L	17.8						107.0	125.0		
		D	L D1146TI	111	139	1.4	6L	25.2	27			9.7	11.4	151.0	162.0		
		D	L L136TI	111	139	1.4	6L		28.2		2200		11.4		169.0		
		D	L AD136TI	111	139	1.4	6L	19.2	23					115.0	138.0		
		D	L DE08TIS	111	139	1.4	6L	26	29.3					156.0	176.0		
		D	L P086TI-1	111	139	1.4	6L	24.8						149.0	191.0		
		D	L P086TI	111	139	1.4	6L	29.5						177.0	223.0		
		D	L PU086TI	111	139	1.4	6L	35	38					210.0	228.0		
		D	L L086TI	111	139	1.4	6L	35	44.2					210.0	265.0		
		D	L AD086TI	111	139	1.4	6L	25.2	31					151.0	186.0		
		D	DL08	108	139	1.3	6L	30.7						184.0	250.0	ON	EURO 3
		D	DL08	108	139	1.3	6L		35		1900				210.0	ON	EPA TIER 3
		D	DL08 S	108	139	1.3	6L	36.8						221.0	254.0	ON	EURO 4
		D	DL08 K	108	139	1.3	6L		42.3		2200				254.0	ON	EURO 5
		D	DL08 K	108	139	1.3	6L		35.6		1800				213.0	OH	EPA TIER 4I
		D	L DE12	123	155	1.9	6L		28.8		2200		8.5		173.0		
		D	L DE12T	123	155	1.9	6L	31.3						188.0	221.0		
		D	L MD196T	123	155	1.9	6L		34.3		2000		11.1		206.0		
		D	L AD196T	123	155	1.9	6L	25.7						154.0	181.0		
		D	L DE12TI	123	155	1.9	6L	39.7						238.0	250.0		
		D	L DE12TIS	123	155	1.9	6L	35.5			2100	11	13.6	213.0	265.0		
		D	L DB58	102	118	1	6L	9	13.5			6.2	9.7	54.0	81.0		
		D	L PU066	102	118	1	6L		14.2		2800		6.3		85.0		
continued		D	L DB58T	102	118	1	6L		17.3		2500		8.6		104.0		

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
DOOSAN INFRACORE CO. LTD. ENGINE & MATERIAL BG	222	D	L DB58TI	102	118	1	6L	21	21.2		2000	13	13.1	126.0	127.0		
		D	L L066TI	102	118	1	6L		22		2200		12.4		132.0		
		D	L AD066TI	102	118	1	6L	16	18.3				13.2	96.0	110.0		
		D	DL06	100	125	1	6L	21.5						129.0	199.0	ON	EURO 3
		D	DL06	100	125	1	6L				1900				129.0	OH	EPA TIER 3
		D	DL06 S	100	125	1	6L	30.7			2500	15	16.4	184.0	206.0	ON	EURO 4
		D	DL06 K	100	125	1	6L		33.7		2500				202.0	ON	EURO 5
		D	DL06 K	100	125	1	6L		23.1		1900				138.0	OH	EPA TIER 4I
		D	L D1146	111	139	1.4	6L	12.8				7.6	8.6	77.0	134.0		
		D	L PU086	111	139	1.4	6L	17	20.2			7.3	7.9	102.0	121.0		
FAIRBANKS MORSE	*	D, DF		206-510	254-600	11-109	6L, 7L, 8L, 9L, 90, 120, 12V, 14V, 16V, 18V, 20V	113-1150	174-1200	500-900	514-1200	20-25	11.0-27.0	4200-20700	2088-21600	PG	IMO TIER 2
FPT INDUSTRIAL	*	D		88-145	94-170	0.58-2.65	3L, 4L, 6L, 8V		10-101.2		1500-4000				31-607	OH, ON, M, PG	
MOTORENFABRIK HATZ	182	D	1B20	69	65	0.2	1L	2.9	3.1	2700	3350			2.9	3.1	OH	EU STAGE 5
		D	1B20	69	65	0.2	1L	1.5	3.4	1500	3600			1.5	3.4	OH	
		D	1B30	80	69	0.3	1L	3.4	5	2000	3600			3.4	5	OH	EU STAGE 5
		D	1B30	80	69	0.3	1L	2.3	5	1500	3600			2.3	5	OH	
		D	1B30E	80	69	0.3	1L	2.3	4.5	1500	3600			2.3	4.5	OH	EPA TIER 4F, EU STAGE 5
		D	1B40	88	76	0.5	1L	5.6	7.3	2250	3600			5.6	7.3	OH	EU STAGE 5
		D	1B40	88	76	0.5	1L	3.5	7.3	1500	3600			3.5	7.3	OH	
		D	1B50	93	76	0.5	1L	3.9	7.9	1500	3600			3.9	7.9	OH	EU STAGE 5
		D	1B50E	93	76	0.5	1L	3.9	7.9	1500	3600			3.9	7.9	OH	EPA TIER 4F, EU STAGE 5
		D	1D42	90	70	0.4	1H	3.3	6.8	1500	3200			3.3	6.8	OH	EU STAGE 5
		D	1D42	90	70	0.4	1H	3.5	7.3	1500	3600			3.5	7.3	OH	
		D	1D50	97	70	0.5	1L	6.3	7.5	2400	3200			6.3	7.5	OH	EU STAGE 5
		D	1D50	97	70	0.5	1L	3.9	7.7	1500	3600			3.9	7.7	OH	
		D	1D81	100	85	0.7	1L	5.5	10	1500	3000			5.5	10	OH	EU STAGE 5
		D	1D81	100	85	0.7	1L	5.5	10.1	1500	3600			5.5	10.1	OH	
		D	1D81C	100	85	0.7	1L	5.4	9.5	1500	3000			5.4	9.5	OH	EU STAGE 5
		D	1D81C	100	85	0.7	1L	5.4	9.6	1500	3000			5.4	9.6	OH	
		D	1D90	104	85	0.7	1L	6.1	11	1500	3000			6.1	11	OH	EU STAGE 5
		D	1D90	104	85	0.7	1L	6.4	11.2	1500	3000			6.4	11.2	OH	
		D	1D90V	104	85	0.7	1H	6.1	11	1500	3000			6.1	11	OH	EU STAGE 5
		D	1D90V	104	85	0.7	1H	6.4	11.2	1500	3000			6.4	11.2	OH	
		D	1D90E	104	85	0.7	1L	6.1	10.5	1500	3000			6.1	10.5	OH	EU STAGE 5
		D	2G40	92	75	0.5	2L	5.3	8.1	2000	3200			10.5	16.2	OH	EU STAGE 5
		D	2G40	92	75	0.5	2L	3.7	7.8	1500	3600			7.4	15.6	OH	
		D	2L41C	102	105	0.9	2L	9.7	12.2	1850	3000			19.3	24.4	OH	EU STAGE 3A
		D	2L41C	102	105	0.9	2L	6.8	9.5	1500	2300			16.5	18.9	OH	EU STAGE 5
		D	2L41C	102	105	0.9	2L	7.5	12.2	1500	3000			15	24.4	OH	
		D	3L41C	102	105	0.9	3L	7.6	12.2	1500	3000			22.9	36.7	OH	EU STAGE 3A
continued		D	4L41C	102	105	0.9	4L	7.5	9.3	1500	1800			30	36.9	OH	EU STAGE 3A

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

DIESEL, NATURAL GAS & DUAL FUEL ENGINES

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
MOTORENFABRIK HATZ	182	D	4L41C	102	105	0.9	4L	7.5	12.2	1500	3000			30	48.8	OH	
		D	2M41	102	105	0.9	2L	9.8	13.2	1750	3000			19.6	26.3	OH	EU STAGE 3A
		D	2M41	102	105	0.9	2L	6.8	9.5	1500	2300			16.5	18.9	OH	EU STAGE 5
		D	2M41	102	105	0.9	2L	8.2	13.2	1500	3000			16.4	26.3	OH	
		D	3M41	102	105	0.9	3L	8.3	12.3	1500	3000			25	36.8	OH	EU STAGE 3A
		D	3M41	102	105	0.9	3L	8.3	13.3	1500	3000			25	39.8	OH	
		D	4M41	102	105	0.9	4L	8.5	9.2	1500	1800			34	36.8	OH	EU STAGE 3A
		D	4M41	102	105	0.9	4L	8.5	13.1	1500	3000			34	53.1	OH	
		D	3H50T	84	88	0.5	3L	6.1	6.1	1500	2800			18.4	18.4	OH	EPA TIER 4F, EU STAGE 5
		D	3H50TI	84	88	0.5	3L	13	15.3	2600	2800			38.9	46	OH	EU STAGE 2
		D	3H50TI	84	88	0.5	3L	7.5	9.6	1500	1800			22.5	28.8	PG	EU STAGE 3A
		D	3H50TI	84	88	0.5	3L	7.5	12.1	1500	2800			22.5	36.4	OH	EU STAGE 3A
		D	3H50TIC	84	88	0.5	3L	7.5	14	1500	2800			22.5	42	OH	EPA TIER 4F, EU STAGE 3B
		D	3H50TICD	84	88	0.5	3L	7.5	14.6	1500	2800			22.6	43.7	OH	EPA TIER 4F, EU STAGE 5
		D	4H50TI	84	88	0.5	4L	11.5	13.8	2300	2800			45.9	62	OH	EU STAGE 2
		D	4H50TI	84	88	0.5	4L	7.2	9.1	1500	1800			28.7	36.4	PG	EU STAGE 3A
		D	4H50TI	84	88	0.5	4L	6.6	6.6	2200	2600			36.4	36.4	OH	EU STAGE 3A
		D	4H50TIC	84	88	0.5	4L	7.2	13.8	1500	2800			28.7	55	OH	EPA TIER 4F, EU STAGE 3B
		D	4H50TICD	84	88	0.5	4L	7.8	13.8	1500	3000			31	55	OH	EPA TIER 4F, EU STAGE 5
IHI POWER SYSTEMS CO., LTD.	*	D	6M26ATE	260	460	24.4	6L		152		400		18.6		912		
		D	6M28BT	280	480	30	6L		177		390		18.4		1062		
		D	6M28NT	280	480	30	6L		202		390		21		1214		
		D	6M31BT	310	530	40	6L		228		360		19		1368		
		D	6M31NT	310	600	45.3	6L		226		290		20.6		1353		
		D	6M34BT	340	620	56.3	6L		278		310		19.1		1669		
		D	6M34NT	340	620	56.3	6L		316		310		21.7		1897		
		D	6M34RT	340	630	57.2	6L		245		280		18.3		1471		
		D	NSD	160	210	4.2	6L		83		1450		16.2		496		
		D	NSDL	160	235	4.7	6L		95		1400		17.2		570		
		D	17HX	165	215	4.6	6L		127		1650		20		761		
		D	20FX	205	220	7.3	16V		250		1650		25		4000		
		D	19HX	190	260	7.4	6L		127		1000		20.6		761		
		D	22HX	220	280	10.6	6L		177		1000		19.9		1062		
		D	25HX	250	350	17.2	6L		228		750		21.2		1368		
		D	26HLX	260	350	18.6	6L		253		750		21.7		1518		
		D	28HX	280	370	22.8	6L,8L		303		750		21.3		2427		
		D	28HLX	280	400	24.6	6L,8L,12V,16V,18V		379		750		24.6		6825		
		D	28AHX	280	390	24	6L,8L,9L,12V,16V,18V		370		800		23.1		6660		
		D	34HX	340	450	40.9	6,8L		455		620		22.2		3640		
		D	41HX	410	560	73.9	6L		759		520		23.6		4552		
		SI	28AGS	295	400	27.3	6L,8L,12V,16V,18V		344		750		20.1		6186		
		DF	28AHX-DF	280	390	24	6,8,9L		320		800		19.9		2880		

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

DIESEL, NATURAL GAS & DUAL FUEL ENGINES

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
INNIO - JENBACHER GAS ENGINES	211	SI	J208 GS	135	145	2.1	8L	17.5	43.6	1500	1800	6.6	16.5	134	335	ST-IND	TA-LUFT
		SI	J312 GS	135	170	2.4	12V	21.9	54.8	1500	1800	7.2	18	254	635	ST-IND	TA-LUFT
		SI	J316 GS	135	170	2.4	16V	21.9	54.8	1500	1800	7.2	18	340.4	851	ST-IND	TA-LUFT
		SI	J320 GS	135	170	2.4	20V	21.9	54.8	1500	1800	7.2	18	426.8	1067	ST-IND	TA-LUFT
		SI	J412 GS	145	185	3.1	12V	32	80	1500	1800	8.4	21	374	935	ST-IND	TA-LUFT
		SI	J416 GS	145	185	3.1	16V	32	80	1500	1800	8.4	21	498	1245	ST-IND	TA-LUFT
		SI	J420 GS	145	185	3.1	20V	32	80	1500	1800	8.4	21	624	1560	ST-IND	TA-LUFT
		SI	J612 GS	190	220	6.2	12V	86	172	1500	1500	11	22	1002	2004	ST-IND	TA-LUFT
		SI	J616 GS	190	220	6.2	16V	85.8	171.6	1500	1500	11	22	1339.5	2679	ST-IND	TA-LUFT
		SI	J620 GS	190	220	6.2	20V	85.8	171.6	1500	1500	11	22	1680	3360	ST-IND	TA-LUFT
		SI	J624 GS	190	220	6.2	24V	96.3	192.6	1500	1500	12.4	24.7	2249	4498	ST-IND	TA-LUFT
		SI	J920 GS	310	350	26	20V	211.3	528.4	900	1000	9.6	24	4152	10380	ST-IND	TA-LUFT
INNIO - WAUKESHA GAS ENGINES	211	SI	275GL+/16V	275	300	17.81	16V	175	233	750	1000		16	2796	3729	ST-IND, PG	
		SI	275GL+/12V	275	300	17.83	12V	175	233	750	1000		16	2097	2796	ST-IND, PG	
		SI	VHP/P9394S5	238	216	9.62	16V	87	117	900	1200		12	1398	1864	ST-IND, PG	
		SI	VHP/L7044 S5	238	216	9.62	12V	89	118	900	1200		12	1063	1417	ST-IND, PG	
		SI	VHP/L7044	238	216	9.62	12V	70	104	800	1200		11	835	1253	ST-IND, PG	EPA MOBILE / STATIONARY
		SI	VHP/L7042 S5	238	216	9.62	12V	70	93	900	1200		10	839	1119	ST-IND, PG	
		SI	VHP/L7042 S4	238	216	9.62	12V	61	92	800	1200		10	736	1104	ST-IND, PG	
		SI	VHP/L5794	216	216	7.92	12V	57	86	800	1200		11	686	1029	ST-IND, PG	EPA MOBILE / STATIONARY
		SI	VHP/L5774	216	216	7.92	12V	38	80	1000	1200		10	458	954	ST-IND, PG	
		SI	VHP/F3524	238	216	9.58	6L	70	104	800	1200		11	418	626	ST-IND, PG	
		SI	VHP/F3514	238	216	9.58	6L	61	92	800	1200		10	368	552	ST-IND, PG	
		SI	VGF/P48	152	165	3.00	16V	33	55	1100	1800		12	530	880	ST-IND, PG	
		SI	VGF/L36	152	165	3.00	12V	38	55	1400	1800		12	460	660	ST-IND, PG	
		SI	VGF/H24	152	165	3.00	8L	20	55	1200	1800		12	160	440	ST-IND, PG	EPA MOBILE / STATIONARY
		SI	VGF/F18	152	165	3.00	6L	20	55	1400	1800		12	119	330	ST-IND, PG	EPA MOBILE / STATIONARY
ISOTTA FRASCHINI MOTORI SPA A FINCANTIERI COMPANY	209	D	L1306C2 MSD	130	142	1.9	6L		98.3		2600		24.1		590	M	EPA TIER 2, MARPOL TIER 2
		D	V1312C2 MSD	130	126	1.7	12V		91.7		2800		23.5		1100	M	EPA TIER 2, MARPOL TIER 2
		D	V1708C2 MLL	170	170	3.9	8V		101.9		1935		16.4		815	M	MARPOL TIER 2
		D	V1712C2 MLL	170	170	3.9	12V		128.3		2000		20		1540	M	MARPOL TIER 2
		D	V1712C2 MLH	170	170	3.9	12V		112.5		1800		19.4		1350	M	MARPOL TIER 2
		D	VL1716C2 MSD	170	185	4.2	16V		171.8		2100		23.4		2200	M	MARPOL TIER 2
		D	VL1716C2 MSD	170	185	4.2	16V		150		2000		21.4		2000	M	MARPOL TIER 2
		D	VL1716C2MLH	170	185	4.2	16V		112.5		1800		17.9		1800	M	MARPOL TIER 2
		D	L1306C2 ME	130	142	1.9	6L		53.3		1500		22.5		320	PG	EPA Tier 2, MARPOL Tier 2
		D	L1306C2 ME	130	142	1.9	6L		62.5		1800		21.9		375	PG	EPA Tier 2, MARPOL Tier 2
		D	V1312C2 ME	130	126	1.7	12V		44.6		1500		23.5		535	PG	EPA TIER 2, MARPOL TIER 2
		D	V1312C2 ME	130	126	1.7	12V		53.3		1800		20.9		640	PG	EPA TIER 2, MARPOL TIER 2
continued		D	V1708C2 ME	170	170	3.9	8V		91.3		1500		18.7		730	PG	MARPOL TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
ISOTTA FRASCHINI MOTORI SPA A FINCANTIERI COMPANY	209	D	V1708C2 ME	170	170	3.9	8V		107.5		1800		18.4		860	PG	MARPOL TIER 2
		D	V1712C2 ME	170	170	3.9	12V		88.8		1500		18.2		1065	PG	MARPOL TIER 2
		D	V1712C2 ME	170	170	3.9	12V		106.7		1800		18.2		1280	PG	MARPOL TIER 2
		D	VL1716C2 ME	170	185	4.2	16V		104.4		1200		24.9		1670	PG	MARPOL TIER 2
		D	VL1716C2 ME	170	185	4.2	16V		117.5		1500		22.4		1880	PG	MARPOL TIER 2
		D	VL1716C2 ME	170	185	4.2	16V		136.9		1800		21.7		2190	PG	MARPOL TIER 2
ISUZU MOTORS	Engines Tab, 154	D	3CJ SERIES	74	77	0.3	3L		4.7		3000				14.2	OH, PG, ST-IND	EPA TIER 4F, STAGE 5
		D	3CE SERIES	88	90	0.5	3L		5.2		1800				15.7	PG, ST-IND	EPA TIER 4F
		D	3CH SERIES	80	84	0.4	3L		6		3000				17.8	OH, PG, ST-IND	EPA TIER 4F, STAGE 5
		D	4LE SERIES	85	96	0.55	4L		11.5		2400		12.3		46	OH, PG, ST-IND	EPA TIER 4F
		D	4JJ SERIES	95.4	104.9	0.75	4L		21.4		2200		15.7		85.7	OH, PG, ST-IND	EPA TIER 4F
		D	4H SERIES	115	125	1.3	4L		35		2000		16.3		140	OH, PG, ST-IND	EPA TIER 4F
		D	6H SERIES	115	125	1.3	6L		35		1900		17.4		210	OH, PG, ST-IND	EPA TIER 4F
		D	6UZ SERIES	120	145	1.63	6L		45		2000		18.4		270	OH, PG, ST-IND	EPA TIER 4F
		D	6W SERIES	147	154	2.62	6L		63.7		1800		17.6		382	OH, PG, ST-IND	EPA TIER 4F
		SI	4HV SERIES (GAS ENGINE)	115	110	1.14	4L		15.4		2200		9.5		61.5	OH, PG, ST-IND	EPA-CERTIFIED
JCB POWER SYSTEMS LTD.	Back Cover, 200	D	DIESELMAX 430 TCAE	92	112	0.8	4L	13.8	13.8	850	2200	10.1	10.1	55	55	OH, ST-IND	EU STAGE 5
		D	DIESELMAX 448 TCAE	106	135	1.2	4L	20.3	20.3	850	2200	14.7	14.7	81	81	OH, ST-IND	EU STAGE 5
		D	DIESELMAX 448 TCAE	106	135	1.2	4L	24.2	24.3	850	2200	15.2	15.2	97	97	OH, ST-IND	EU STAGE 5
		D	DIESELMAX 448 TCAE	106	135	1.2	4L	28	28	850	2200	14.8	14.8	112.0	112.0	OH, ST-IND	EU STAGE 5
		D	DIESELMAX 448 TCAE	106	135	1.2	4L	32.3	32.3	850	2200	18.2	18.2	129.0	129.0	OH, ST-IND	EU STAGE 5
		D	ECOMAX 430 TCAE	92	112	0.8	4L	13.8	13.8	850	2200	10.1	10.1	55	55	OH, ST-IND	EPA TIER 4
		D	ECOMAX 444 TCAE	103	132	1.1	4L	13.8	23.3	850	2200	11.4	15.7	68	68	OH, ST-IND	EPA TIER 4
		D	ECOMAX 444 TCAE	103	132	1.1	4L	13.8	23.3	850	2200	11.4	15.7	68	93	OH, ST-IND	EPA TIER 4
		D	ECOMAX 448 TCAE	106	135	1.2	4L	27	27	850	2200	14.8	14.8	108.0	108.0	OH, ST-IND	EPA TIER 4
		D	ECOMAX 448 TCAE	106	135	1.2	4L	32.3	32.3	850	2050	18.2	18.2	129.0	129.0	OH, ST-IND	EPA TIER 4
		D	DIESELMAX 444 TC	103	132	1.1	4L		13.8	900	2200				55	OH, ST-IND	UN 3 (FORMERLY STAGE 3A)
		D	DIESELMAX 444 TC	103	132	1.1	4L		13.8	900	2200				63	OH, ST-IND	UN 3 (FORMERLY STAGE 3A)
		D	DIESELMAX 444 TC	103	132	1.1	4L	13.8	17.2	900	2200	9.34	11.7	55	68.6	OH, ST-IND	UN 3 (FORMERLY STAGE 3A)
		D	DIESELMAX 444 TCA	103	132	1.1	4L		18.5	900	2200				74	OH, ST-IND	UN 3 (Formerly Stage 3a)
		D	DIESELMAX 444 TCA	103	132	1.1	4L	18.6	21.3	900	2200	12.6	12.6	74.2	85	OH, ST-IND	UN 3 (Formerly Stage 3a)
		D	DIESELMAX 444 TCAE	103	132	1.1	4L		24.3	850	2200				97	OH, ST-IND	UN 3 (Formerly Stage 3a)
		D	DIESELMAX 444 TCAE	103	132	1.1	4L		27	850	2200				108.0	OH, ST-IND	UN 3 (FORMERLY STAGE 3A)
		D	DIESELMAX 444 TCAE	103	132	1.1	4L	24.3	30	850	2200	15.2	18.7	97	120	OH, ST-IND	UN 3 (Formerly Stage 3a)
		D	DIESELMAX 444 NA	103	132	1.1	4L	13.8	15.8	800	2200	6.86	9.14	55	63	OH, ST-IND	UN 2 (Formerly Stage 2)
continued		D	DIESELMAX 444 TC	103	132	1.1	4L	18.6	18.5	800	2200	12.14	12.14	74.2	74	OH, ST-IND	UN 2 (Formerly Stage 2)

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
JCB POWER SYSTEMS LTD.	Back Cover, 200	D	DIESELMAX 444 TCA	103	132	1.1	4L	23.3	23.3	800	2200	15	15	93	93	OH, ST-IND	UN 2 (FORMERLY STAGE 2)
		D	DIESELMAX 672 TCAE	106	135	1.2	6L		23.3	850	2000				140	OH, ST-IND	UN 2 (FORMERLY STAGE 2)
		D	DIESELMAX 672 TCAE	106	135	1.2	6L		27.5	850	2000				165	OH, ST-IND	UN 2 (FORMERLY STAGE 2)
		D	DIESELMAX 672 TCAE	106	135	1.2	6L		31.7	850	2000				190	OH, ST-IND	UN 2 (Formerly Stage 2)
		D	DIESELMAX 672 TCAE	106	135	1.2	6L	23.3	35.3	850	2000	11.8	20.2	140.0	212.0	OH, ST-IND	UN 2 (FORMERLY STAGE 2)
		D	DIESELMAX 430 TCAE	92	112	0.8	4L	13.8	13.8	850	2200	10.1	10.1	55	55	IND	UN 2
		D	DIESELMAX 448 TCAE	106	135	1.2	4L	20.3	20	850	2200	14.7	14.7	81	81	IND	UN 2
		D	DIESELMAX 448 TCAE	106	135	1.2	4L	24.2	24.2	850	2200	15.2	15.2	97	97	IND	UN 2
		D	DIESELMAX 448 TCAE	106	135	1.2	4L	28	28	850	2200	14.8	14.8	112.0	112.0	IND	UN 2
		D	DIESELMAX 448 TCAE	106	135	1.2	4L	32.3	32.3	850	2200	18.2	18.2	129.0	129.0	IND	UN 2
		D	DIESELMAX 430 TCAE	92	112	0.8	4L	13.8	13.8	850	2200	16.75	10	55	55	IND	UN 2
		D	ECOMAX 444 TCAE SERIES	103	132	1.1	4L	13.8	23.3	850	2200	11.4	15.7	68	93	IND	UN 2
		D	ECOMAX 448 TCAE	106	135	1.2	4L	27	27	850	2200	14.8	14.8	108.0	108.0	IND	UN 2
		D	ECOMAX 448 TCAE	106	135	1.2	4L	32.3	32.3	850	2050	18.2	18.2	129.0	129.0	IND	UN 2
		D	DIESELMAX 444 TC	103	132	1.1	4L	13.8	13.8	850	2200	9.34	9.34	55	55	IND	UN 2
		D	ECOMAX 444 TCAE SERIES	103	132	1.1	4L	13.8	23.3	850	2200	11.4	15.7	68	93	IND	UN 2
		D	ECOMAX 448 TCAE	106	135	1.2	4L	27	27	850	2200	14.8	14.8	108.0	108.0	IND	UN 2
		D	ECOMAX 448 TCAE	106	135	1.2	4L	32.3	32.3	850	2050	18.2	18.2	129.0	129.0	IND	UN 2
		D	DIESELMAX 444 TC SERIES	103	132	1.1	4L	13.8	17.2	900	2200	9.34	11.7	55	68.6	IND	UN 2
		D	DIESELMAX 444 TCA SERIES	103	132	1.1	4L	18.6	21.3	900	2200	12.6	12.6	74.2	85	IND	UN 2
		D	DIESELMAX 444 TCAE SERIES	103	132	1.1	4L	24.3	30	850	2200	15.2	18.7	97	120	IND	UN 2
		D	DIESELMAX 444 NA SERIES	103	132	1.1	4L	13.8	15.8	800	2200	6.86	9.14	55	63	IND	UN 2
		D	DIESELMAX 444 TC	103	132	1.1	4L	18.6	18.6	800	2200	12.14	12.14	74.2	74.2	IND	UN 2
		D	DIESELMAX 444 TCA	103	132	1.1	4L	23.3	23.3	800	2200	15	15	93	93	IND	UN 2
		D	DIESELMAX 444 NA G-DRIVE	103	132	1.1	4L	11.8	12.9		1500			47	51.7	PG	UN 2 (Formerly Stage 2)
		D	DIESELMAX 444 TC G-DRIVE	103	132	1.1	4L	14	15.5		1500			56	62	PG	Non Certified
		D	DIESELMAX 444 TC G-DRIVE	103	132	1.1	4L	14	20.4		1500			56	81.6	PG	UN 2 (Formerly Stage 2)
		D	DIESELMAX 444 TCA G-DRIVE	103	132	1.1	4L	25	27.5		1500			100	110	PG	UN 2 (Formerly Stage 2)
		D	DIESELMAX 444 TCA G-DRIVE	103	132	1.1	4L	25	32		1500			100	128	PG	UN 2 (FORMERLY STAGE 2)
		D	DIESELMAX 448 TC G-DRIVE	106	135	1.2	4L	27.5	16.5		1500			110	66	PG	UN 3 (FORMERLY STAGE 3A)
		D	DIESELMAX 448 TC G-DRIVE	106	135	1.2	4L	27.5	19.9		1500			110	79.6	PG	UN 3 (FORMERLY STAGE 3A)
continued		D	DIESELMAX 448 TCA G-DRIVE	106	135	1.2	4L	27.5	25.3		1500			110	101.2	PG	UN 3 (FORMERLY STAGE 3A)

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
JCB POWER SYSTEMS LTD.	Back Cover, 200	D	DIESELMAX 448 TCAE G-DRIVE	106	135	1.2	4L	27.5	28		1500			110	112	PG	UN 3 (FORMERLY STAGE 3A)
		D	DIESELMAX 448 TCAE G-DRIVE	106	135	1.2	4L	23.5	31.3		1500			94	133	PG	UN 3 (FORMERLY STAGE 3A)
		D	DIESELMAX 444 NA G-DRIVE	103	132	1.1	4L	11.8	14		1800			47	56	PG	NON CERTIFIED
		D	DIESELMAX 444 TC G-DRIVE	103	132	1.1	4L	14	22.5		1800			56	90	PG	NON CERTIFIED
		D	DIESELMAX 444 TCA G-DRIVE	103	132	1.1	4L	25	26.3		1800			100	105	PG	NON CERTIFIED
		D	DIESELMAX 448 TCAE G-DRIVE	106	135	1.2	4L	25	28		1800			100	112	PG	UN 3 (FORMERLY STAGE 3A)
		D	DIESELMAX 448 TCA G-DRIVE	106	135	1.2	4L		33		1800				132	PG	NON CERTIFIED
		D	DIESELMAX 448 TCAE G-DRIVE	106	135	1.2	4L		33.3		1800				133	PG	UN 3 (FORMERLY STAGE 3A)
		D	ECOMAX 444 TCAE G-DRIVE	103	132	1.1	4L	14	13.5		1800			56	54	PG	EPA TIER 4
		D	ECOMAX 444 TCAE G-DRIVE	103	132	1.1	4L	25	20.3		1800			100	81	PG	EPA TIER 4
		D	ECOMAX 448 TCAE G-DRIVE	106	135	1.2	4L	25	31.8		1800			100	127	PG	EPA TIER 4
JOHN DEERE POWER SYSTEMS	178	D	EWX 2.9L, 3029HI530	106	110	2.9	3L	36	55	2200	2400				18	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	M 4.5L, 4045TF280	106	127	4.5	4L	56	74	2200	2400				19	OH, ST-IND	EPA TIER 3, EU STAGE 3A
		D	E 4.5L, 4045TF285	106	127	4.5	4L	63	104	2200	2400				26	OH, ST-IND	EPA TIER 3, EU STAGE 3A
		D	PLUS 4.5L, 4045HF485	106	127	4.5	4L	111	129	2000	2400				32	OH, ST-IND	EPA TIER 3, EU STAGE 3A
		D	EWX 4.5L, 4045TI530	106	127	4.5	4L	55	55	2200	2400				14	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	EWS 4.5L, 4045HI551	106	127	4.5	4L	86	104	N/A	2100				26	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	PWL 4.5L, 4045HFC04	106	127	4.5	4L	63	104	2200	2400				26	OH, ST-IND	EPA TIER 4F
		D	PSL 4.5L, 4045HFC06	106	127	4.5	4L	93	129	2200	2400				32	OH, ST-IND	EPA TIER 4F
		D	PWS 4.5L, 4045HI550	106	127	4.5	4L	74	104	2200	2400				26	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	PSS 4.5L LOW PROFILE, 4045CI551	106	127	4.5	4L	116	129	2200	2400				32	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	PSS 4.5L HIGH PROFILE, 4045CI550	106	127	4.5	4L	93	129	2200	2200				32	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	E 6.8L, 6068HF285	106	127	6.8	6L	104	149	2200	2400				25	OH, ST-IND	EPA TIER 3, EU STAGE 3A
		D	PLUS 6.8L, 6068HF485	106	127	6.8	6L	134	205	2000	2400				34	OH, ST-IND	EPA TIER 3, EU STAGE 3A
		D	PVS 6.8L, 6068HI550	106	127	6.8	6L	104	187	2000	2400				31	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	PSS 6.8L, 6068CI550	106	127	6.8	6L	168	224	2200	2400				37	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	PLUS 9.0L, 6090HF485	118	136	9	6L	168	298	2000	2200				50	OH, ST-IND	EPA TIER 3, EU STAGE 3A
		D	PSS 9.0L, 6090CI550	118	136	9	6L	187	317	2000	2200				53	OH, ST-IND	EPA TIER 4F, EU STAGE 5
continued		D	PLUS 13.5L, 6135HF485	132	165	13.5	6L	261	448	1900	2100				75	OH, ST-IND	EPA TIER 3, EU STAGE 3A

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
JOHN DEERE POWER SYSTEMS	178	D	PWL 13.6L, 6136HI440	132	165	13.6	6L	300	410	N/A	2100				68	OH, ST-IND	EPA TIER 4F
		D	PSL 13.6L, 6136CI440	132	165	13.6	6L	391	510	N/A	2100				85	OH, ST-IND	EPA TIER 4F
		D	PWS 13.6L, 6136HI550	132	165	13.6	6L	300	410	N/A	2100				68	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	PSS 13.6L, 6136CI550	132	165	13.6	6L	391	510	N/A	2100				85	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	18.0L			18	6L	560	676	560	1900				112	OH, ST-IND	EPA TIER 4F, EU STAGE 5
		D	POWERTECH PWL 4.5L, 4045HFG04			4.5	4L	68	99	1500	1800			68	99	PG	EPA TIER 4F
		D	POWERTECH PSL 4.5L, 4045HFG06			4.5	4L	112	128	1500	1800			112	128	PG	EPA TIER 4F
		D	POWERTECH PVL 6.8L, 6068HFG05			6.8	6L	160	192	1500	1800			160	192	PG	EPA TIER 4F
		D	POWERTECH PSL 6.8L, 6068HFG06			6.8	6L	197	240	1500	1800			197	240	PG	EPA TIER 4F
		D	POWERTECH PSL 9.0L, 6090HFG06			9	6L	273	345	1500	1800			273	345	PG	EPA TIER 4F
		D	POWERTECH PSL 13.6L, 6136CG440			13.6	6L	430	473	1500	1800			430	473	PG	EPA TIER 4F
		D	POWERTECH EWX 2.9L, 3029HG530, 3029HP530			2.9	3L	36	55	1500	1800			36	55	PG	EPA TIER 4F, EU STAGE 5
		D	POWERTECH EWS 4.5L, 4045HG551, 4045HP551			4.5	4L	83	106	1500	1800			83	106	PG	EPA TIER 4F, EU STAGE 5
		D	POWERTECH PVS 6.8L, 6068HG550, 6068HP550			6.8	6L	165	180	1500	1800			165	180	PG	EPA TIER 4F, EU STAGE 5
		D	POWERTECH PSS 6.8L, 6068CG550, 6068CP550			6.8	6L	202	241	1500	1800			202	241	PG	EPA TIER 4F, EU STAGE 5
		D	POWERTECH PSS 9.0L, 6090CG550, 6090CP550			9	6L	273	326	1500	1800			273	326	PG	EPA TIER 4F, EU STAGE 5
		D	POWERTECH PSS 13.6L, 6136CG550			13.6	6L	505	505	1500	1800			505	505	PG	EPA TIER 4F, EU STAGE 5
		D	POWERTECH M 2.9L, 3029TFG89, 3029HFU89, 3029TFU89, 3029HFU89			2.9	3L	31	46	1500	1800			31	46	PG	EPA TIER 3, EU STAGE 3A
		D	POWERTECH M 4.5L, 4045HFG81, 4045HFU81			4.5	4L	61	65	1500	1800			61	65	PG	EPA TIER 3, EU STAGE 3A
		D	POWERTECH E 4.5L, 4045HFG82, 4045HFU82			4.5	4L	83	126	1500	1800			83	126	PG	EPA TIER 3, EU STAGE 3A
		D	POWERTECH E 6.8L, 6068HFG82, 6068HFU82			6.8	6L	153	212	1500	1800			153	212	PG	EPA TIER 3, EU STAGE 3A
		D	POWERTECH E 9.0L, 6090HFG84, 6090HFU84			9	6L	253	315	1500	1800			253	315	PG	EPA TIER 3, EU STAGE 3A
		D	POWERTECH M 2.9L, 3029TFG89, 3029HFG89			2.9	3L	35	46		1800			35	46	PG	EPA TIER 3, NSPS
continued		D	POWERTECH M 4.5L, 4045TF290, 4045TF280, 4045HF280			4.5	4L	55	74		1800			55	74	PG	EPA TIER 3, NSPS

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
JOHN DEERE POWER SYSTEMS	178	D	POWERTECH E 4.5L, 4045TF285, 4045HF285			4.5	4L	74	118		1800			74	118	PG	EPA TIER 3, NSPS
		D	POWERTECH PLUS 4.5L, 4045HFG85			4.5	4L	147	147		1800			147	147	PG	EPA TIER 3, NSPS
		D	POWERTECH E 6.8L, 6068HF285, 6068HFG82			6.8	6L	147	212		1800			147	212	PG	EPA TIER 3, NSPS
		D	POWERTECH PLUS 6.8L, 6068HFG85			6.8	6L	235	235		1800			235	235	PG	EPA TIER 3, NSPS
		D	POWERTECH E 9.0L, 6090HFG84, 6090HF484, 6090HFG86			9	6L	258	345		1800			258	345	PG	EPA TIER 3, NSPS
		D	POWERTECH PLUS 9.0L, 6090HFG85			9	6L	315	315		1800			315	315	PG	EPA TIER 3, NSPS
		D	POWERTECH E 13.5L, 6135HFG84, 6135HFG75			13.5	6L	401	563		1800			401	563	PG	EPA TIER 3, NSPS
		D	POWERTECH PLUS 13.5L, 6135HF485			13.5	6L	401	460		1800			401	460	PG	EPA TIER 3, NSPS
		D	POWERTECH M 2.9L, 3029TFG20, 3029TFU20, 3029HFG20, 3029HFU20			2.9	3L	31	70	1500	1800			31	70	PG	NON-EMISSIONS CERTIFIED 50 HZ 60 HZ
		D	POWERTECH M 4.5L, 4045HFG20, 4045HFU20			4.5	4L	85	133	1500	1800			85	133	PG	NON-EMISSIONS CERTIFIED 50 HZ 60 HZ
		D	POWERTECH M 6.8L, 6068HFG20, 6068HFU20			6.8	6L	157	210	1500	1800			157	210	PG	NON-EMISSIONS CERTIFIED 50 HZ 60 HZ
		D	POWERTECH E 6.8L, 6068HFG25, 6068HFG55, 6068HFU55			6.8	6L	225	236	1500	1800			225	236	PG	NON-EMISSIONS CERTIFIED 50 HZ 60 HZ
JSC ZVEZDA	*	D	16/17	160	170	3.50					2200		1.5		7355		
		D	18/20	180	200	5.20	6H, 6L, 12V				1600		13.5		1100		
KAWASAKI HEAVY INDUSTRIES LTD.	*	SI, D, DF		300-900	480-3720		5L, 6L, 7L, 8L, 9L, 10L, 11L, 12L, 18	390-4520	417-6870	58-148	72-720	15.8-16.8	20-21.5	1560-22600	2670-82440	M	IMO TIER 2, IMO TIER 3
KEM EQUIPMENT INC.	*	SI	GKEMB02.4LSI	79	81.5	0.6	4L		13		3000				52	OH	CURRENT EPA
		SI	GKEMB03.0CS1	102	91	0.75	4L		15		2700				60	ST-IND	CURRENT EPA
		SI	GKEMB03.0CS1	102	91	0.75	4L		14.75		2800				59	ST-IND	CURRENT EPA
		SI	GKEMB03.0ULE	101.6	91.44	0.75	4L		16		3000				64	OH	CURRENT EPA
		SI	GKEMB04.3CS1	102	88	0.72	6V		13.83		2650				83	ST-IND	CURRENT EPA
		SI	GKEMB04.3CS1	102	88	0.72	6V		12.5		2650				75	ST-IND	CURRENT EPA
		SI	GKEMB04.3CS2	102	88	0.72	6V		14.67		2650				88	PG, ST-IND	CURRENT EPA
		SI	GKEMB04.3CS2	102	88	0.72	6V		13.17		2650				79	PG, ST-IND	CURRENT EPA
		SI	GKEMB04.3ULE	102	88	0.72	6V		12.17		3000				73	OH	CURRENT EPA
		SI	GKEMB04.3WHG	102	88	0.72	6V		7.333		2200				44	PG, ST-IND	PENDING
		SI	GKEMB05.7ULE	102	88.39	0.72	8V		14.125		2650				113	OH	CURRENT EPA
		SI	GKEMB05.7ULE	101.6	88.39	0.72	8V		12.25		2650				98	OH	CURRENT EPA
		SI	GKEMB05.7CS1	102	88	0.72	8V		13.875		2650				111	ST-IND	CURRENT EPA
		SI	GKEMB05.7CS1	102	88	0.72	8V		12.625		2650				101	ST-IND	CURRENT EPA
		SI	GKEMB05.7EPO	102	88	0.72	8V		11.875		2800				95	ST-IND	CURRENT EPA
continued		SI	GKEMB05.7CS2	102	88	0.72	8V		10.375		2650				83	PG, ST-IND	CURRENT EPA

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
KEM EQUIPMENT INC.	*	SI	GKEMB05.7CS2	102	88	0.72	8V		12.25		2650				98	PG, ST-IND	CURRENT EPA
		SI	GKEMB05.7WHG	102	88	0.72	8V		8		2200				64	PG, ST-IND	CURRENT EPA
		SI	GKEMB08.0CS1	108	108	1	8V		18.25		2400				146	PG, ST-IND	CURRENT EPA
		SI	GKEMB08.0CS1	108	108	1	8V		15.625		2400				125	PG, ST-IND	CURRENT EPA
		SI	GKEMB08.0WHG	108	108	1	8V		15.625		2200				125	PG, ST-IND	CURRENT EPA
		SI	GKEMB08.1ULE	107.95	111	1.01	8V		16.875		2650				135	OH	CURRENT EPA
		SI	GKEM10.3WHG	109	121	1.14	8V		18.875		2200				151	PG, ST-IND	CURRENT EPA
		SI	GKEM10.3WHG	117	121	1.29	8V		20.375		2200				163	PG, ST-IND	CURRENT EPA
		SI	GKEM10.3CS1	116.8	120.66	1.29	8V		21.875		2400				175	PG, ST-IND	CURRENT EPA
		SI	GKEM10.3CS1	116.8	121	1.29	8V		19.75		2400				158	PG, ST-IND	CURRENT EPA
KOHLER ENGINES	192	D	KDW 1003	75	77.6	0.3	3L		6.5		3600				19.5	OH, PG, ST/IND	EU STAGE 3A
		D	KDW 1003	75	77.6	0.3	3L		6.5		3600				18.5	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5, CHINA 4 READY
		D	KDW 1404	75	77.6	0.3	4L		6.5		3000				18.5	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5, CHINA 4 READY
		D	KDW 1603	88	90.4	0.6	3L		10		3000				30	OH, PG, ST/IND	EU STAGE 3A, EU STAGE 5
		D	KDW 2204	88	90.4	0.6	4L		9.5		3000				38	OH, PG, ST/IND	EU STAGE 3A
		D	KDW 2204T	88	90.4	0.6	4L		12		3000				48	OH, PG, ST/IND	EU Stage 3a
		D	KD 350D	78	66	0.3	1L		5		3600				5	OH, PG, ST/IND	
		D	KD 440	86	76	0.4	1L		7.7		3600				7.7	OH, PG, ST/IND	
		D	KD 425-2	85	75	0.4	2L		7		3600				14	OH, PG, ST/IND	EPA Tier4F, EU Stage 5
		D	KD 477-2	90	75	0.5	2L		8.1		3000				16.2	OH, PG, ST/IND	
		D	KD 625-2	95	88	0.6	2L		9.4		3000				18.8	OH, PG, ST/IND	
		D	KD 625-3	95	88	0.6	3L		9.2		3000				27.5	OH, PG, ST/IND	
		D	KDW 702	75	77.6	0.3	2L		6.3		3600				12.5	OH, PG, ST/IND	EPA Tier 4f, EU Stage 5, China 4 ready
		D	KDI 1903M	88	102	1.9	3		10.3		2800				31	OH, PG, ST/IND	EU Stage 3a
		D	KDI 2504M	88	102	2.5	4		9.1		2800				36.4	OH, PG, ST/IND	EU STAGE 3A
		D	KDI 2504TM	88	102	2.5	4		13.85		2600				55.4	OH, PG, ST/IND	
		D	KDI 1903TCR	88	102	1.9	3		14		2600				42	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5, CHINA 4 READY
		D	KDI 2504TCR	88	102	2.5	4		13.85		2600				55.4	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5, CHINA 4 READY
		D	KDI 3404TCR	96	116	3.4	4		13.85		2200				55.4	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5
		D	KDI 3404TCR	96	116	3.4	4		13.85		2200				100	OH, PG, ST/IND	EU STAGE 5, CHINA 4 READY
		D	KDI 3404TCR-SCR	96	116	3.4	4		25		2200				100	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 4
		D	KD15-440	86	76	0.4	1		7.3		3600				7.3	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5
		D	KD15-440S	86	76	0.4	1		8		3600				8	OH, PG, ST/IND	
		D	KD15-350	82	66	0.3	1		14.7		3600				14.7	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5
		D	KD15-350S	82	66	0.3	1		5.5		3600				5.5	OH, PG, ST/IND	
continued		D	15 LD 500	87	85	0.5	1		8.8		3600				8.8	OH, PG, ST/IND	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
KOHLER ENGINES	192	D	25 LD 330/2	80	65	0.3	2		6		3600				12	OH, PG, ST/IND	
		D	25 LD 425/2	85	75	0.4	2		7		3600				14	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5
		D	12 LD 477/2	90	75	0.5	2		8.4		3600				16.8	OH, PG, ST/IND	
		D	9 LD 625/2	95	88	0.6	2		10.5		3000				21	OH, PG, ST/IND	
		D	11 LD 626/3	95	88	0.6	3		10.3		3000				30.9	OH, PG, ST/IND	
		D	LDW 502	72	62	0.3	2		2		3600				4	OH, PG, ST/IND	
		D	LDW 702	75	77.6	0.3	2		6.3		3600				12.5	OH, PG, ST/IND	EPA TIER 4F, EU STAGE 5, CHINA 4 READY
		D	LDW 1003	75	77.6	0.3	3		6.7		3600				20	OH, PG, ST/IND	
		D	LDW 1404	75	77.6	0.3	4		6.5		3600				26	OH, PG, ST/IND	
		D	LDW 1603	88	90.4	0.6	3		9.8		3000				29.5	OH, PG, ST/IND	
		D	LDW 2204	88	90.4	0.6	4		9.4		3000				37.5	OH, PG, ST/IND	
		D	LDW2204T	88	90.4	0.6	4		11.8		3000				47	OH, PG, ST/IND	
		D	15 LD 225S	69	60	0.2	1		2.7		3000				2.7	OH, PG, ST/IND	
		D	15 LD 225	69	60	0.2	1		3.5		3600				3.5	OH, PG, ST/IND	
KUBOTA CORPORATION	158	SI	WG752-G-E3	68	68	0.74	3L		0		3600				18.5	ST-IND	EPA PHASE 3, CARB PHASE 3, EU STAGE5
		SI	WG752-GL-E3	68	68	0.74	3L		5.9		3600				17.7	ST-IND	EPA PHASE 3, CARB PHASE 3, EU STAGE 5
		SI	WG972-G-E3	74.5	73.6	0.96	3L		8.07		3600				24.2	ST-IND	EPA PHASE 3, EU STAGE5
		SI	WG972-GL-E3	74.5	73.6	0.96	3L		7.7		3600				23.1	ST-IND	EPA PHASE 3, EU STAGE 5
		SI	WG972-G-E4	74.5	73.6	0.962	3L		8.07		3600				24.2	ST-IND	EPA PHASE 3, CARB PHASE 4, EU STAGE5
		SI	WG972-GL-E4	74.5	73.6	0.96	3L		7.33		3600				22	ST-IND	EPA PHASE 3, CARB PHASE 4, EU STAGE 5
		SI	WG972-L-E4	74.5	73.6	0.96	3L		7.33		3600				22	ST-IND	EPA PHASE 3, CARB PHASE 4, EU STAGE 5
		SI	WG972-N-E4	74.5	73.6	0.96	3L		6.8		3600				20.4	ST-IND	EPA PHASE 3, CARB PHASE 4, EU STAGE 5
		SI	WG1605-G-E3	79	78.4	1.537	4L		10.63		3600				42.5	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE5
		SI	WG1605-GL-E3	79	78.4	1.54	4L		10.25		3600				41	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG1605-GLN-E3	79	78.4	1.54	4L		10.25		3600				41	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG1605-GLN-E3	79	78.4	1.54	4L		9.6		3600				38.4	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG1605-L-E3	79	78.4	1.54	4L		10.25		3600				41	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG1605-LN-E3	79	78.4	1.54	4L		10.25		3600				41	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG1605-LN-E3	79	78.4	1.54	4L		9.6		3600				38.4	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG1605-N-E3	79	78.4	1.54	4L		9.6		3600				38.4	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG1903-G	88	102.4	1.868	3L		11.67		2700				35.0	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE5
		SI	WG1903-GL	88	102.4	1.87	3L		11.67		2700				35	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
continued		SI	WG1903-L-LM	88	102.4	1.87	3L		10.87		2400				32.6	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
KUBOTA CORPORATION	158	SI	WG1903-N	88	102.4	1.87	3L		10.83		2700				32.5	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG2503-G-E3	88	102.4	2.491	4L		11.38		2700				45.5	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE5
		SI	WG2503-GL-E3	88	102.4	2.49	4L		11.5		2700				46	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG2503-L-E3	88	102.4	2.49	4L		11.5		2700				46	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG2503-N-E3	88	102.4	2.49	4L		10.6		2700				42.4	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG3800-G-E3	100	120	3.769	4L		16.25		2600				65.0	ST-IND	EPA TIER 2, CARB TIER 3
		SI	WG3800-GL-E3	100	120	3.77	4L		17		2600				68	ST-IND	EPA TIER 2, CARB TIER 3
		SI	WG3800-GL-E3	100	120	3.77	4L		13.85		2600				55.4	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG3800-L-E3	100	120	3.77	4L		17.5		2600				70	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5 READY
		SI	WG3800-L-E3	100	120	3.77	4L		13.85		2600				55.4	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		SI	WG3800-N-E3	100	120	3.77	4L		16.25		2600				65	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5 READY
		SI	WG3800-N-E3	100	120	3.77	4L		13.85		2600				55.4	ST-IND	EPA TIER 2, CARB TIER 3, EU STAGE 5
		D	V3800DI-T-E3B	100	120	3.77	4L		18.5		2600				74	ST-IND	EPA TIER 3, EU STAGE 3A
		D	V3800-CR-T-E4B (2600 RPM)	100	120	3.77	4L		18.63		2600				74.5	ST-IND	EPA TIER 4I, EU STAGE 3B LEVEL
		D	V3800-CR-T-E4B (2200 RPM)	100	120	3.77	4L		13.85		2200				55.4	ST-IND	EPA TIER 4, EU STAGE 3B
		D	V3800-CR-TI-E4B	100	120	3.77	4L		21.2		2600				84.8	ST-IND	EPA TIER 4I, EU STAGE 3B LEVEL
		D	V3800-TIE4B	100	120	3.77	4L		13.85		2200				55.4	ST-IND	EPA TIER 4, EU STAGE 3B
		D	V3800-CR-T (2200RPM)	100	120	3.77	4L		13.85		2200				55.4	ST-IND	EU STAGE 5
		D	V3800-TIEF4	100	120	3.77	4L		21.6		2600				86.4	ST-IND	EPA TIER 4F, EU STAGE 4, EU STAGE 5 READY
		D	V3800-CR-TIEF4H	100	120	3.77	4L		24.1		2400				96.4	ST-IND	EU STAGE 5 READY
		D	V2607-DI-E3B	87	110	2.62	4L		9.13		2700				36.5	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	V2607-DI-T-E3B	87	110	2.62	4L		12.3		2700				49.2	ST-IND	EPA INTERIM TIER 4 , EU STAGE 3A
		D	V2607-CR-T-E4B	87	110	2.62	4L		13.25		2700				53	ST-IND	EPA TIER 4, EU STAGE 3B
		D	V2607-CR-TI-E4B	87	110	2.62	4L		13.25		2700				53	ST-IND	EPA TIER 4, EU STAGE 3B
		D	V2607-CR-E5	87	110	2.62	4L		10.5		2700				42	ST-IND	EPA TIER4, EU STAGE 5
		D	V2607-CR-T-E5	87	110	2.62	4L		13.25		2700				53	ST-IND	EPA TIER4, EU STAGE 5
		D	V2607-CR-TI-E5	87	110	2.62	4L		13.85		2700				55.4	ST-IND	EPA TIER4, EU STAGE 5
		D	V3307-DI-T-E3B	94	120	3.33	4L		13.85		2600				55.4	ST-IND	EPA INTERIM TIER 4, EU STAGE 3A
continued		D	V3307-CR-T-E4B	94	120	3.33	4L		13.85		2600				55.4	ST-IND	EPA TIER 4, EU STAGE 3B

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

DIESEL, NATURAL GAS & DUAL FUEL ENGINES

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
KUBOTA CORPORATION	158	D	V3307-CR-TI-E4B	94	120	3.33	4L		13.85		2600				55.4	ST-IND	EPA TIER 4, EU STAGE 3B
		D	V3307-CR-T-E5	94	120	3.33	4L		13.85		2600				55.4	ST-IND	EPA TIER4, EU STAGE 5
		D	V3307-CR-TI-E5	94	120	3.33	4L		13.85		2600				55.4	ST-IND	EPA TIER4, EU STAGE 5
		D	D1503-M-E3B	83	92.4	1.5	3L		7.93		2800				23.8	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	D1703-M-E3B	87	92.4	1.65	3L		8.7		2800				26.1	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	D1703-M-DI-E4B	87	92.4	1.65	3L		6.17		2200				18.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE), EU STAGE 5
		D	D1803-M-E3B	87	102.4	1.83	3L		9.3		2700				27.9	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	D1803-M-DI-E3B	87	102.4	1.83	3L		9.3		2700				27.9	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	D1803-CR-E4B	87	102.4	1.83	3L		9.33		2700				28	ST-IND	EPA TIER 4, EU STAGE 3A
		D	D1803-CR-T-E4B	87	102.4	1.83	3L		12.33		2700				37	ST-IND	EPA TIER 4, EU STAGE 3B
		D	D1803-CR-TI-E4B	87	102.4	1.83	3L		12.33		2700				37	ST-IND	EPA TIER 4, EU STAGE 3B
		D	D1803-CR-E5B	87	102.4	1.83	3L		9.33		2700				28	ST-IND	EPA TIER4, EU STAGE 5
		D	D1803-CR-T-E5	87	102.4	1.83	3L		12.33		2700				37	ST-IND	EPA TIER4, EU STAGE 5
		D	D1803-CR-TI-E5	87	102.4	1.83	3L		14		2700				42	ST-IND	EPA TIER4, EU STAGE 5
		D	V2003-M-E3B	83	92.4	2	4L		8.15		2800				32.6	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	V2203-M-E3B	87	92.4	2.2	4L		8.98		2800				35.9	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	V2403-M-DI-E3B	87	102.4	2.43	4L		9.13		2700				36.5	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	V2403-M-DI-T-E3B	87	102.4	2.43	4L		9.13		2200				36.5	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	V2403-CR-E4B	87	102.4	2.43	4L		9.35		2700				37.4	ST-IND	EPA TIER 4, EU STAGE 3B
		D	V2403-CR-T-E4B	87	102.4	2.43	4L		12.15		2700				48.6	ST-IND	EPA TIER 4, EU STAGE 3B
		D	V2403-CR-TI-E4B	87	102.4	2.43	4L		12.15		2700				48.6	ST-IND	EPA TIER 4, EU STAGE 3B
		D	V2403-CR-E5	87	102.4	2.43	4L		9.35		2700				37.4	ST-IND	EPA TIER4, EU STAGE 5
		D	V2403-CR-T-E5	87	102.4	2.43	4L		12.5		2700				50	ST-IND	EPA TIER4, EU STAGE 5
		D	V2403-CR-TI-E5	87	102.4	2.43	4L		13.85		2700				55.4	ST-IND	EPA TIER4, EU STAGE 5
		D	D1005-E4B(3200RPM)	76	73.6	1	3L		6.17		3200				18.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE)
		D	D1005-E4B(3000RPM)	76	73.6	1	3L		5.83		3000				17.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE)
		D	D1105-E3B (3600 RPM)	78	78.4	1.12	3L		7.23		3600				21.7	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	D1105-E3B (3000 RPM)	78	78.4	1.12	3L		6.17		3000				18.5	ST-IND	EPA TIER 4 LEVEL
continued		D	D1105-E4B	78	78.4	1.12	3L		6.17		3000				18.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE)

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
KUBOTA CORPORATION	158	D	D1105-T-E3B	78	78.4	1.12	3L		8.17		3000				24.5	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	D1305-E3B	78	88	1.26	3L		7.23		3000				21.7	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	D1305-E4B	78	88	1.26	3L		6.17		2600				18.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE)
		D	V1505-E3B (3600 RPM)	78	78.4	1.5	4L		7.25		3600				29	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	V1505-E3B (3000 RPM)	78	78.4	1.5	4L		6.63		3000				26.5	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	V1505-E4B	78	78.4	1.5	4L		4.63		2300				18.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE)
		D	V1505-T-E3B	78	78.4	1.5	4L		8.25		3000				33	ST-IND	EPA TIER 4I, EU STAGE 3A
		D	V1505-CR-TE5	78	78.4	1.5	4L		8.25		3000				33	ST-IND	EPA/CARB TIER4 FINAL, EU STAGE 5
		D	SUPER MINI Z482-E4B	67	68	0.48	2L		4.95		3600				9.9	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE), EU STAGE 5
		D	SUPER MINI Z602-E4B	72	73.6	0.6	2L		6.25		3600				12.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE), EU STAGE 5
		D	SUPER MINI D722-E4B	67	68	0.72	3L		4.97		3600				14.9	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE), EU STAGE 5
		D	SUPER MINI D902-E4B	72	73.6	0.9	3L		6.17		3600				18.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE), EU STAGE 5
		D	SUPER MINI D902-T	72	73.6	0.9	3L		6.17		3600				18.5	ST-IND	EPA/CARB TIER 4, EU STAGE5
		D	SUPER MINI D902-K	72	73.6	0.9	3L		6.17		3600				18.5	ST-IND	EPA/CARB TIER 4, EU STAGE5+ CHINA NR READY
		D	OC60-E4	72	68	0.28	1L		4.5		3600				4.5	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE), EU STAGE 5
		D	OC95-E4	83	77	0.42	1L		7		3600				7	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE), EU STAGE 5
		D	EA330-E4	77	70	0.33	1L		5.15		3000				5.15	ST-IND	EPA TIER 4 (NRTC, NTE TEST MODE), EU STAGE 5
		D	Z482-E2 (3600 RPM)	67	68	0.48	2L		4.45		1800				8.9	PG	EPA/CARB TIER 2 LEVEL
		D	Z482-E3 (3600 RPM)	67	68	0.48	2L		4.45		3000				8.9	PG	EPA/CARB TIER 4 LEVEL
		D	Z482-E4 (3600 RPM)	67	68	0.48	2L		4.45		3000				8.9	PG	EPA/CARB TIER 4 (NRTC/NTE TEST MODE), EU STAGE 5
		D	D722-E2 (3600 RPM)	67	68	0.72	3L		4.43		1500				13.3	PG	EPA/CARB TIER 2 LEVEL
		D	D722-E3 (3600 RPM)	67	68	0.72	3L		4.43		1800				13.3	PG	EPA/CARB TIER 4 LEVEL
		D	D722-E4	67	68	0.72	3L		4.43		1800				13.3	PG	EPA/CARB TIER 4 (NRTC/NTE TEST MODE), EU STAGE 5
		D	Z482 (1800 RPM)	67	68	0.479	2L		2.2		3600				4.4	PG	-
		D	Z482-E4 (1800 RPM)	67	68	0.479	2L		2.1		3600				4.2	PG	EPA/CARB TIER 4 (NRTC/NTE TEST MODE), EU STAGE 5
continued		D	D1005-E2-BG	76	73.6	1.001	3L		3.27		3600				9.8	PG	EPA/CARB TIER 2 LEVEL

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
KUBOTA CORPORATION	158	D	D1005-E3-BG	76	73.6	1.001	3L		3.27		3600				9.8	PG	EPA/CARB TIER 4 LEVEL
		D	D1005-E4-BG	76	73.6	1.001	3L		3.27		3600				9.8	PG	EPA/CARB TIER 4 (NRTC/NTE TEST MODE)
		D	D1105-E2-BG	78	78.4	1.123	3L		3.83		1800				11.5	PG	EPA/CARB TIER 2 LEVEL
		D	D1105-E3-BG	78	78.4	1.123	3L		3.83		1800				11.5	PG	EPA/CARB TIER 4 LEVEL
		D	D1105-E4-BG	78	78.4	1.123	3L		3.83		1800				11.5	PG	EPA/CARB TIER 4 (NRTC/NTE TEST MODE), EU STAGE 5
		D	D1305-E3-BG	78	88	1.261	3L		4.37		1800				13.1	PG	EPA/CARB TIER 4 LEVEL
		D	D1305-E4-BG	78	88	1.261	3L		4.37		1800				13.1	PG	EPA/CARB TIER 4 (NRTC/NTE TEST MODE)
		D	V1505-E2-BG	78	78.4	1.498	4L		3.78		1800				15.1	PG	EPA/CARB TIER 2 LEVEL
		D	V1505-E3-BG	78	78.4	1.498	4L		3.78		1800				15.1	PG	EPA/CARB TIER 4 LEVEL
		D	V1505-E4-BG	78	78.4	1.498	4L		3.78		1800				15.1	PG	EPA/CARB TIER 4 (NRTC/NTE TEST MODE), EU STAGE 5
		D	D1503-M-E4-BG	83	92.4	1.499	3L		5.4		1800				16.2	PG	EPA/CARB TIER 4 (NRTC/NTE TEST MODE)
		D	D1703-E2-BG	87	92.4	1.647	3L		6.03		1800				18.1	PG	EPA/CARB TIER 2 LEVEL
		D	D1703-M-E3-BG	87	92.4	1.647	3L		6.03		1800				18.1	PG	EPA/CARB INTERIM TIER 4 LEVEL
		D	D1803-CR-TI-E4-BG	87	102.4	1.826	3L		8.07		1800				24.2	PG	EPA/CARB TIER 4
		D	V2003-T-E2-BG	83	92.4	1.999	4L		6.78		1800				27.1	PG	EPA/CARB TIER 2 LEVEL
		D	V2003-M-E3-BG	83	92.4	1.999	4L		5.45		1800				21.8	PG	EPA/CARB INTERIM TIER 4 LEVEL
		D	V2003-M-T-E3-BG	83	92.4	1.999	4L		6.78		1800				27.1	PG	EPA/CARB INTERIM TIER 4 LEVEL
		D	V2203-E2-BG	87	92.4	2.197	4L		6.05		800				24.2	PG	EPA/CARB TIER 2 LEVEL
		D	V2203-M-E3-BG	87	92.4	2.197	4L		6.05		1800				24.2	PG	EPA/CARB INTERIM TIER 4 LEVEL
		D	V2403-M-E3-BG	87	102.4	2.434	4L		6.63		1800				26.5	PG	EPA/CARB INTERIM TIER 4 LEVEL
		D	V2403-CR-TI-E4-BG	87	102.4	2.434	4L		8.4		1800				33.6	PG	EPA/CARB TIER 4
		D	V2403-CR-TI-E4-BG	87	102.4	2.434	4L		8.4		1800				33.6	PG	EPA/CARB TIER 4
		D	V3300-E2-BG	98	110	3.318	4L		8.83		1800				35.3	PG	EPA/CARB TIER 2 LEVEL
		D	V3300-E3-BG	98	110	3.318	4L		8.4		1800				33.6	PG	EPA/CARB INTERIM TIER 4 LEVEL
		D	V3300-T-E2-BG	98	110	3.318	4L		10.78		1800				43.1	PG	EPA/CARB TIER 2 LEVEL
		D	V3600-T-E3-BG	98	120	3.62	4L		10.78		800				43.1	PG	EPA/CARB INTERIM TIER 4 LEVEL
		D	V3800DI-T-E2-BG	100	120	3.769	4L		12.38		1800				49.5	PG	EPA/CARB TIER 2 LEVEL
		D	V3800DI-T-E3-BG	100	120	3.769	4L		13.08		1800				52.3	PG	EPA/CARB TIER 3 LEVEL
continued		D	V3800DI-T-E3-BG	100	120	3.769	4L		12.7		1800				50.8	PG	EPA/CARB INTERIM TIER 4 LEVEL

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

DIESEL, NATURAL GAS & DUAL FUEL ENGINES

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
KUBOTA CORPORATION	158	D	V2403-M-E4-BG	87	102.4	2.434	4L		6.23		800				24.9	PG	EPA MARINE 2014 TIER 3
		D	V3300-E4-BG	98	110	3.318	4L		8.4		1800				33.6	PG	EPA MARINE 2014 TIER 3
		D	Z482-E2 (3000 RPM)	67	68	0.479	2L		3.75		3000				7.5	PG	-
		D	Z482-E3 (3000 RPM)	67	68	0.479	2L		3.75		3000				7.5	PG	EPA/CARB TIER 4 LEVEL, EU STAGE 5
		D	D722-E2 (3000 RPM)	67	68	0.719	3L		3.77		3000				11.3	PG	EPA/CARB TIER 2 LEVEL
		D	D722-E3 (3000 RPM)	67	68	0.719	3L		3.77		3000				11.3	PG	EPA/CARB TIER 4 LEVEL, EU STAGE 5
		D	Z482 (1500 RPM)	67	68	0.479	2L		1.8		1500				3.6	PG	EU STAGE 5
		D	D1105-BG2	78	78.4	1.123	3L		3.17		1500				9.5	PG	EU STAGE 5
		D	V1505-BG2	78	78.4	1.498	4L		3.13		1500				12.5	PG	EU STAGE 5
		D	D1703-E2-BG2	87	92.4	1.647	3L		5		1500				15	PG	-
		D	D1703-M-BG2	87	92.4	1.647	3L		5		1500				15	PG	-
		D	D1703-M-E4-BG2	87	92.4	1.647	3L		4.83		1500				14.5	PG	EU STAGE 5
		D	V2003-M-E3-BG2	83	92.4	1.999	4L		4.53		1500				18.1	PG	-
		D	V2003-T-E2-BG2	83	92.4	1.999	4L		5.63		1500				22.5	PG	EU STAGE 3A LEVEL
		D	V2203-E2-BG2	87	92.4	2.197	4L		5.03		1500				20.1	PG	EU STAGE 3A LEVEL
		D	V2203-M-E3-BG2	87	92.4	2.197	4L		5.03		1500				20.1	PG	EU STAGE 3A LEVEL
		D	V2203-M-E4-BG2	87	92.4	2.197	4L		4.25		1500				17	PG	EU STAGE 5
		D	V2403-M-E3-BG2	87	102.4	2.434	4L		5.5		1500				22	PG	EU STAGE 3A LEVEL
		D	V2003-M-T-E3-BG2	83	92.4	1.999	4L		5.63		1500				22.5	PG	EU STAGE 3A LEVEL
		D	V2403-CR-TE5-BG	87	102.4	2.434	4L		7.03		1500				28.1	PG	EU STAGE 5
		D	V3300-E2-BG2	98	110	3.318	4L		7.23		1500				28.9	PG	EU STAGE 3A LEVEL
		D	V3300-T-E2-BG2	98	110	3.318	4L		8.83		1500				35.3	PG	EU STAGE 2 LEVEL
		D	V3800DI-T-E2-BG2	10	120	3.769	4L		10.68		1500				42.7	PG	EU STAGE 2 LEVEL
		D	V3800DI-T-E3-BG2	10	120	3.769	4L		10.73		1500				42.9	PG	EU STAGE 3A LEVEL
		D	V3800-CR-TE5-BG	10	120	3.769	4L		10.7		1500				42.8	PG	EU STAGE 5
LIEBHERR MACHINES BULLE SA	202, 299, 320	D	D934 A7-00	122	150	1.8	4L	30	50	1500	1900			120	200	OH	NOT REGULATED
		D	D944 A7-00	130	150	2	4L	35	57.5	1500	1900			140	230	OH	NOT REGULATED
		D	D964 A7-00	135	157	2.2	4L	45	75	1500	1900			180	300	OH	NOT REGULATED
		D	D936 A7-00	122	150	1.8	6L	31.7	53.3	1500	1900			190	320	OH	NOT REGULATED
		D	D946 A7-00	130	150	2	6L	40	66.7	1500	1900			240	400	OH	NOT REGULATED
		D	D956 A7-00	130	150	2	6L	40	66.7	1500	1900			240	400	OH	NOT REGULATED
		D	D966 A7-00	135	157	2.2	6L	48.3	80	1500	1900			290	480	OH	NOT REGULATED
		D	D9508 A7-00	128	157	2	8V	42.5	71.3	1500	1900			340	570	OH	NOT REGULATED
		D	D976 A7-00	148	174	3	6L	81.7	103.3	1500	1900			490	620	OH	NOT REGULATED
		D	D9512 A7-00	128	157	2	12V	37.5	62.5	1500	1900			450	750	OH	NOT REGULATED
		D	D9612 A7-00	135	157	2.2	12V	46.7	92.8	1500	1900			560	1114	PG	NOT REGULATED
		D	D9616 A7-00	135	157	2.2	16V	54.4	90.6	1500	1900			870	1450	PG	NOT REGULATED
		D	D9620 A7-00	135	157	2.2	20V	57.5	95.5	1500	1900			1150	1910	PG	NOT REGULATED
continued		D	D934 A7-03	122	150	1.8	4L	30	50	1500	1900			120	200	OH	ECE-R.96, POWERBAND H (ANALOG TO EU STAGE 3A)

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
LIEBHERR MACHINES BULLE SA	202, 299, 320	D	D944 A7-03	130	150	2	4L	35	57.5	1500	1900			140	230	OH	ECE-R.96, POWERBAND H (ANALOG TO EU STAGE 3A)
		D	D936 A7-03	122	150	1.8	6L	31.7	53.3	1500	1900			190	320	OH	ECE-R.96, POWERBAND H (ANALOG TO EU STAGE 3A)
		D	D946 A7-03	130	150	2	6L	40	66.7	1500	1900			240	400	OH	ECE-R.96, POWERBAND H (ANALOG TO EU STAGE 3A)
		D	D9508 A7-03	128	157	2	8V	42.5	71.3	1500	1900			340	570	OH	ECE-R.96, POWERBAND H (ANALOG TO EU STAGE 3A)
		D	D964 A7-03	135	157	2.2	4L	47.5	80	1500	1900			190	320	OH	ECE-R.96, POWERBAND H (ANALOG TO EU STAGE 3A)
		D	D956 A7-03	130	150	2	6L	40	66.7	1500	1900			240	400	OH	ECE-R.96, POWERBAND H (ANALOG TO EU STAGE 3A)
		D	D966 A7-03	135	157	2.2	6L	48.3	80	1500	1900			290	480	OH	ECE-R.96, POWERBAND H (ANALOG TO EU STAGE 3A)
		D	D9512 A7-02	128	157	2	12V	37.5	62.5	1500	1900			450	750	OH	EPA TIER 2
		D	D934 A7-04	122	150	1.8	4L	30	50	1500	1900			120	200	OH	EPA TIER 4F
		D	D944 A7-04	130	150	2	4L	35	57.5	1500	1900			140	230	OH	EPA TIER 4F
		D	D964 A7-04	135	157	2.2	4L	45	75	1500	1900			180	300	OH	EPA TIER 4F
		D	D936 A7-04	122	150	1.8	6L	31.7	53.3	1500	1900			190	320	OH	EPA TIER 4F
		D	D946 A7-04	130	150	2	6L	40	66.7	1500	1900			240	400	OH	EPA TIER 4F
		D	D956 A7-04	130	150	2	6L	40	66.7	1500	1900			240	400	OH	EPA TIER 4F
		D	D966 A7-04	135	157	2.2	6L	48.3	80	1500	1900			290	480	OH	EPA TIER 4F
		D	D9508 A7-04	128	157	2	8V	42.5	71.3	1500	1900			340	570	OH	EPA TIER 4F
		D	D976 A7-04	148	174	3	6L	81.7	103.3	1500	1900			490	620	OH	EPA TIER 4F
		D	D9512 A7-04	128	157	2	12V	37.5	62.5	1500	1900			450	750	OH	EPA TIER 4F
		D	D9512 A7-04	128	157	2	12V	37.5	62.5	1500	1900			450	750	OH	IMO TIER 3
		D	D9612 A7-04	135	157	2.2	12V	46.7	92.8	1500	1900			560	1114	PG	EPA TIER 4F
		D	D9616 A7-04	135	157	2.2	16V	54.4	90.6	1500	1900			870	1450	PG	EPA TIER 4F
		D	D9620 A7-04	135	157	2.2	20V	57.5	95.5	1500	1900			1150	1910	PG	EPA TIER 4F
		D	D934 A7-05	122	150	1.8	4L	30	50	1500	1900			120	200	OH	EU STAGE 5
		D	D944 A7-05	130	150	2	4L	35	57.5	1500	1900			140	230	OH	EU STAGE 5
		D	D964 A7-05	135	157	2.2	4L	45	75	1500	1900			180	300	OH	EU STAGE 5
		D	D936 A7-05	122	150	1.8	6L	31.7	53.3	1500	1900			190	320	OH	EU STAGE 5
		D	D946 A7-05	130	150	2	6L	40	66.7	1500	1900			240	400	OH	EU STAGE 5
		D	D956 A7-05	130	150	2	6L	40	66.7	1500	1900			240	400	OH	EU STAGE 5
		D	D966 A7-05	135	157	2.2	6L	48.3	80	1500	1900			290	480	OH	EU STAGE 5
		D	D9508 A7-05	128	157	2	8V	42.5	71.3	1500	1900			340	570	OH	EU STAGE 5
		D	D976 A7-05	148	174	3	6L	81.7	103.3	1500	1900			490	620	OH	EU STAGE 5
		D	D9512 A7-05	128	157	2	12V	37.5	62.5	1500	1900			450	750	OH	EU STAGE 5
continued		SI	G944	130	150	2	4L	41	0	1500	1800			164		PG	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
LIEBHERR MACHINES BULLE SA	202, 299, 320	SI	G946	130	150	2	6L	41	0	1500	1800			246		PG	
		SI	G9512	130	157	2.1	12V	43	0	1500	1800			516		PG	
		SI	G9620	135	170	2.4	20V	53	0	1500	1800			1060		PG	
LIEBHERR-COMPONENTS COLMAR	202, 299, 320	D	D9812	175	215	5.2	12V	91.7	225	1200	1900			1100	2700	OH	EPA TIER 2
		D	D9812	175	215	5.2	12V	91.7	225	1200	1900			1100	2700	OH	EPA TIER 4F
		D	D9812	175	215	5.2	12V	91.7	225	1200	1900			1100	2700	PG	EPA TIER 2
		D	D9812	175	215	5.2	12V	91.7	225	1200	1900			1100	2700	PG	EPA TIER 4F
		D	D9816	175	215	5.2	16V	126.1	218.1	1200	1900			2017	3490	OH	EPA TIER 2
		D	D9816	175	215	5.2	16V	126.1	218.1	1200	1900			2017	3490	OH	EPA TIER 4F
		D	D9816	175	215	5.2	16V	126.1	218.1	1200	1900			2017	3490	PG	EPA TIER 2
		D	D9816	175	215	5.2	16V	126.1	218.1	1200	1900			2017	3490	PG	EPA TIER 4F
		D	D9820	175	215	5.2	20V	136.7	214.5	1200	1900			2733	4290	OH	EPA TIER 2
		D	D9820	175	215	5.2	20V	136.7	214.5	1200	1900			2733	4290	OH	EPA TIER 4F
		D	D9820	175	215	5.2	20V	136.7	214.5	1200	1900			2733	4290	PG	EPA TIER 2
		D	D9820	175	215	5.2	20V	136.7	214.5	1200	1900			2733	4290	PG	EPA TIER 4F
LISTER PETTER	170	D	T SERIES/TR1	98.4	101.6	0.77	1L	5.5	7.4	1500	1800	5.69	6.38	5.5	7.4	PG, OH, M	NON-REGULATED
		D	T SERIES/TR2	98.4	101.6	0.77	2L	5.5	7.2	1500	1800	5.69	6.21	10.99	14.4	PG, OH, M	NON-REGULATED
		D	T SERIES/TR3	98.4	101.6	0.77	3L	5.6	7.4	1500	1800	5.8	6.38	16.8	22.2	PG, OH, M	NON-REGULATED
		D	ALPHA/LPW2	86	80	0.46	2L	3.75	7.35	1500	3600	6.33	6.45	7.5	14.7	PG, OH, M	NON-REGULATED
		D	ALPHA/LPW3	86	80	0.46	3L	3.77	7.37	1500	3600	6.34	6.48	11.3	22.1	PG, OH, M	NON-REGULATED
		D	ALPHA/LPW4	86	80	0.46	4L	3.75	7.38	1500	3600	6.35	6.45	15	29.5	PG, OH, M	NON-REGULATED
		D	ALPHA/LPWT4	86	80	0.46	4L	4.73	9.38	1500	3000	8.07	8.13	18.9	37.5	PG, ST-IND, OH, M	NON-REGULATED
		D	ALPHA/LPWX2	86	86	0.5	2L	4.3	8.05	1500	3600	6.44	6.89	8.6	16.1	PG, OH, M	NON-REGULATED
		D	ALPHA/LPWX3	86	86	0.5	3L	4.3	8.1	1500	3600	6.48	6.89	12.9	24.3	PG, OH, M	NON-REGULATED
		D	ALPHA/LPWX4	86	86	0.5	4L	4.23	8.1	1500	3600	6.48	6.77	16.9	32.4	PG, OH, M	NON-REGULATED
		D	GAMMA/GW3	100	127	1	3L	10	12	1500	1800	8.02	8.02	30	36	PG, OH	NON-REGULATED
		D	GAMMA/GWT3	100	127	1	3L	15.33	19.33	1500	1800	12.3	12.92	46	58	PG, OH	NON-REGULATED
		D	GAMMA/GW4	100	127	1	4L	10.5	12.75	1500	1800	8.42	8.52	42	51	PG, OH, M	NON-REGULATED
		D	GAMMA/GWT4	100	127	1	4L	16.85	21.5	1500	1800	13.51	14.37	67.4	86	PG, OH, M	NON-REGULATED
		D	GAMMA/GWT6-1A	100	127	1	6L	14.38	18.62	1500	1800	11.53	12.44	86.3	111.7	PG, OH	NON-REGULATED
		D	GAMMA/ GWT6-2A	100	127	1	6L	15.73	20.6	1500	1800	12.62	13.77	94.4	123.6	PG, OH, M	NON-REGULATED
		D	GAMMA/GWTA6	100	127	1	6L	21.4	26.42	1500	1800	17.16	17.65	128.4	158.5	PG, OH, M	Non-regulated
		D	T SERIES/TR1	98.4	101.6	0.77	1L	5.5	9.5	1500	2500	5.69	6.36	5.5	9.5	ST-IND, OH	NON-REGULATED
		D	T SERIES/TR2	98.4	101.6	0.77	2L	5.5	9.5	1500	2500	5.69	5.9	11	19	ST-IND, OH, M	NON-REGULATED
		D	T SERIES/TR3	98.4	101.6	0.77	3L	5.6	9.5	1500	2500	5.8	5.9	16.8	28.5	ST-IND, OH, M	NON-REGULATED
		D	ALPHA/LPW2	86	80	0.46	2L	3.4	7.35	1500	3000	5.85	6.33	6.8	14.7	ST-IND, OH, M	NON-REGULATED
		D	ALPHA/LPW3	86	80	0.46	3L	3.43	7.37	1500	3000	5.91	6.34	10.3	22.1	ST-IND, OH, M	NON-REGULATED
		D	ALPHA/LPW4	86	80	0.46	4L	3.4	7.38	1500	3000	5.85	6.35	13.6	29.5	ST-IND, OH, M	NON-REGULATED
		D	ALPHA/LPWX2	86	86	0.5	2L	3.95	8.05	1500	3000	6.32	6.44	7.9	16.1	ST-IND, OH, M	NON-REGULATED
		D	ALPHA/LPWX3	86	86	0.5	3L	3.97	8.1	1500	3000	6.35	6.48	11.9	24.3	ST-IND, OH, M	NON-REGULATED
		D	ALPHA/LPWX4	86	86	0.5	4L	3.95	8.1	1500	3000	6.32	6.48	15.8	32.4	ST-IND, OH, M	NON-REGULATED
		D	GAMMA/GW3	100	127	1	3L	9.33	10	1500	1800	7.48	6.82	28	30	ST-IND, OH	NON-REGULATED
		D	GAMMA/GWT3	100	127	1	3L	14.67	16.67	1500	1800	11.14	11.76	44	50	ST-IND, OH	NON-REGULATED
		D	GAMMA/GW4	100	127	1	4L	10.25	12.5	1500	2200	6.83	8.22	41	50	ST-IND, OH	NON-REGULATED
continued		D	GAMMA/GWT4	100	127	1	4L	16.25	18.75	1500	2200	10.25	13.03	65	75	ST-IND, OH	NON-REGULATED

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
LISTER PETTER	170	D	GAMMA/ GWT6-2A	100	127	1	6L	12.5	15.33	1500	2200	8.38	10.02	75	92	ST-IND, OH	NON-REGULATED
		D	GAMMA/GWTA6	100	127	1	6L	19.33	22.5	1500	2200	12.3	15.5	116	135	ST-IND, OH	NON-REGULATED
		D	GAMMA/GWTA6	100	127	1	6L	19.33	22.5	1500	2200	12.3	15.5	116	135	ST-IND	NON-REGULATED
		D	T SERIES/TR1	98.4	101.6	0.77	1L	5.5	7.4	1500	1800	5.69	6.38	5.5	7.4	OH	NON-REGULATED
		D	T SERIES/TR2	98.4	101.6	0.77	2L	5.5	7.2	1500	1800	5.69	6.21	10.99	14.4	OH	NON-REGULATED
		D	T SERIES/TR3	98.4	101.6	0.77	3L	5.6	7.4	1500	1800	5.8	6.38	16.8	22.2	OH	NON-REGULATED
		D	ALPHA/LPW2	86	80	0.46	2L	3.75	7.35	1500	3600	6.33	6.45	7.5	14.7	OH	NON-REGULATED
		D	ALPHA/LPW3	86	80	0.46	3L	3.77	7.37	1500	3600	6.34	6.48	11.3	22.1	OH	NON-REGULATED
		D	ALPHA/LPW4	86	80	0.46	4L	3.75	7.38	1500	3600	6.35	6.45	15	29.5	OH	NON-REGULATED
		D	ALPHA/LPWT4	86	80	0.46	4L	4.73	9.38	1500	3000	8.07	8.13	18.9	37.5	OH	NON-REGULATED
		D	ALPHA/LPWX2	86	86	0.5	2L	4.3	8.05	1500	3600	6.44	6.89	8.6	16.1	OH	NON-REGULATED
		D	ALPHA/LPWX3	86	86	0.5	3L	4.3	8.1	1500	3600	6.48	6.89	12.9	24.3	OH	NON-REGULATED
		D	ALPHA/LPWX4	86	86	0.5	4L	4.23	8.1	1500	3600	6.48	6.77	16.9	32.4	OH	NON-REGULATED
		D	GAMMA/GW3	100	127	1	3L	10	12	1500	1800	8.02	8.02	30	36	OH	NON-REGULATED
		D	GAMMA/GWT3	100	127	1	3L	15.33	19.33	1500	1800	12.3	12.92	46	58	OH	NON-REGULATED
		D	GAMMA/GW4	100	127	1	4L	10.5	12.75	1500	1800	8.42	8.52	42	51	OH	NON-REGULATED
		D	GAMMA/GWT4	100	127	1	4L	16.85	21.5	1500	1800	13.51	14.37	67.4	86	OH	NON-REGULATED
		D	GAMMA/GWT6-1A	100	127	1	6L	14.38	18.62	1500	1800	11.53	12.44	86.3	111.7	OH	NON-REGULATED
		D	GAMMA/ GWT6-2A	100	127	1	6L	15.73	20.6	1500	1800	12.62	13.77	94.4	123.6	OH	NON-REGULATED
		D	GAMMA/GWTA6	100	127	1	6L	21.4	26.42	1500	1800	17.16	17.65	128.4	158.5	OH	NON-REGULATED
		D	T SERIES/TR1	98.4	101.6	0.77	1L	5.5	9.5	1500	2500	5.69	6.36	5.5	9.5	OH	NON-REGULATED
		D	T SERIES/TR2	98.4	101.6	0.77	2L	5.5	9.5	1500	2500	5.69	5.9	11	19	OH	NON-REGULATED
		D	T SERIES/TR3	98.4	101.6	0.77	3L	5.6	9.5	1500	2500	5.8	5.9	16.8	28.5	OH	NON-REGULATED
		D	ALPHA/LPW2	86	80	0.46	2L	3.4	7.35	1500	3000	5.85	6.33	6.8	14.7	OH	NON-REGULATED
		D	ALPHA/LPW3	86	80	0.46	3L	3.43	7.37	1500	3000	5.91	6.34	10.3	22.1	OH	NON-REGULATED
		D	ALPHA/LPW4	86	80	0.46	4L	3.4	7.38	1500	3000	5.85	6.35	13.6	29.5	OH	NON-REGULATED
		D	ALPHA/LPWT4	86	80	0.46	4L	4.73	9.38	1500	3000	8.07	8.13	18.9	37.5	OH	NON-REGULATED
		D	ALPHA/LPWX2	86	86	0.5	2L	3.95	8.05	1500	3000	6.32	6.44	7.9	16.1	OH	NON-REGULATED
		D	ALPHA/LPWX3	86	86	0.5	3L	3.97	8.1	1500	3000	6.35	6.48	11.9	24.3	OH	NON-REGULATED
		D	ALPHA/LPWX4	86	86	0.5	4L	3.95	8.1	1500	3000	6.32	6.48	15.8	32.4	OH	NON-REGULATED
		D	GAMMA/GW3	100	127	1	3L	9.33	10	1500	1800	7.48	6.82	28	30	OH	NON-REGULATED
		D	GAMMA/GWT3	100	127	1	3L	14.67	16.67	1500	1800	11.14	11.76	44	50	OH	NON-REGULATED
		D	GAMMA/GW4	100	127	1	4L	10.25	12.5	1500	2200	6.83	8.22	41	50	OH	NON-REGULATED
		D	GAMMA/GWT4	100	127	1	4L	16.25	18.75	1500	2200	10.25	13.03	65	75	OH	NON-REGULATED
		D	GAMMA/ GWT6-2A	100	127	1	6L	12.5	15.33	1500	2200	8.38	10.02	75	92	OH	NON-REGULATED
		D	GAMMA/GWTA6	100	127	1	6L	19.33	22.5	1500	2200	12.3	15.5	116	135	OH	NON-REGULATED
		D	T SERIES/TR1	98.4	101.6	0.77	1L	5.5	7.4	1500	1800	5.69	6.38	5.5	7.4	M	NON-REGULATED
		D	T SERIES/TR2	98.4	101.6	0.77	2L	5.5	7.2	1500	1800	5.69	6.21	10.99	14.4	M	NON-REGULATED
		D	T SERIES/TR3	98.4	101.6	0.77	3L	5.6	7.4	1500	1800	5.8	6.38	16.8	22.2	M	NON-REGULATED
		D	ALPHA/LPW2	86	80	0.46	2L	3.75	7.35	1500	3600	6.33	6.45	7.5	14.7	M	NON-REGULATED
		D	ALPHA/LPW3	86	80	0.46	3L	3.77	7.37	1500	3600	6.34	6.48	11.3	22.1	M	NON-REGULATED
		D	ALPHA/LPW4	86	80	0.46	4L	3.75	7.38	1500	3600	6.35	6.45	15	29.5	M	NON-REGULATED
		D	ALPHA/LPWT4	86	80	0.46	4L	4.73	9.38	1500	3000	8.07	8.13	18.9	37.5	M	NON-REGULATED
		D	ALPHA/LPWX2	86	86	0.5	2L	4.3	8.05	1500	3600	6.44	6.89	8.6	16.1	M	NON-REGULATED
continued		D	ALPHA/LPWX3	86	86	0.5	3L	4.3	8.1	1500	3600	6.48	6.89	12.9	24.3	M	NON-REGULATED

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
LISTER PETTER	170	D	ALPHA/LPWX4	86	86	0.5	4L	4.23	8.1	1500	3600	6.48	6.77	16.9	32.4	M	NON-REGULATED
		D	GAMMA/GW4	100	127	1	4L	10.5	12.75	1500	1800	8.42	8.52	42	51	M	NON-REGULATED
		D	GAMMA/GWT4	100	127	1	4L	16.85	21.5	1500	1800	13.51	14.37	67.4	86	M	NON-REGULATED
		D	GAMMA/ GWT6-2A	100	127	1	6L	15.73	20.6	1500	1800	12.62	13.77	94.4	123.6	M	NON-REGULATED
		D	GAMMA/GWTA6	100	127	1	6L	21.4	26.42	1500	1800	17.16	17.65	128.4	158.5	M	NON-REGULATED
		D	T SERIES/TR2	98.4	101.6	0.77	2L	5.5	9.5	1500	2500	5.69	5.9	11	19	M	NON-REGULATED
		D	T SERIES/TR3	98.4	101.6	0.77	3L	5.6	9.5	1500	2500	5.8	5.9	16.8	28.5	M	NON-REGULATED
		D	ALPHA/LPW2	86	80	0.46	2L	3.4	7.35	1500	3000	5.85	6.33	6.8	14.7	M	NON-REGULATED
		D	ALPHA/LPW3	86	80	0.46	3L	3.43	7.37	1500	3000	5.91	6.34	10.3	22.1	M	NON-REGULATED
		D	ALPHA/LPW4	86	80	0.46	4L	3.4	7.38	1500	3000	5.85	6.35	13.6	29.5	M	NON-REGULATED
		D	ALPHA/LPWT4	86	80	0.46	4L	4.73	9.38	1500	3000	8.07	8.13	18.9	37.5	M	NON-REGULATED
		D	ALPHA/LPWX2	86	86	0.5	2L	3.95	8.05	1500	3000	6.32	6.44	7.9	16.1	M	NON-REGULATED
		D	ALPHA/LPWX3	86	86	0.5	3L	3.97	8.1	1500	3000	6.35	6.48	11.9	24.3	M	NON-REGULATED
		D	ALPHA/LPWX4	86	86	0.5	4L	3.95	8.1	1500	3000	6.32	6.48	15.8	32.4	M	NON-REGULATED
MAN ENERGY SOLUTIONS SE - TURBO	206	#	K98ME7	980	2660		6L			90	97	15.4			87220		IMO TIER 2
# = MGO, MDO, HFO FUEL		#	K98MC7	980	2660		6L			90	97	15.4			87220		IMO TIER 2
¢ = NG, LPG FUEL		#	K98E6	980	2660		6L	4100	5720	84	94	14.6	18.2	24600	80080		IMO TIER 2
		#	K98MC6	980	2660		6L			84	94	14.6			80080		IMO TIER 2
		#	K98ME-C7	980	2400		6L								84280		IMO TIER 2
		#	K98MC-C7	980	2400		6L								84280		IMO TIER 2
		#	K98ME-C6	980	2400		6L								79940		IMO TIER 2
		#	K98MC-C6	980	2400		6L								79940		IMO TIER 2
		#	S90ME-C8	900	3188		6L	3890		66	78	16			47430		IMO TIER 2
		#	S90MC-C8	900	3188		6L	3890		66	78	16			47430		IMO TIER 2
		#	S90ME-C7	900	3188		6L	3140		61	76	15.2			44010		IMO TIER 2
		#	S90MC-C7	900	3188		6L	3140		61	76	15.2			44010		IMO TIER 2
		#	S90ME-C9	900	3260		5L			76	84	16			81340		IMO TIER 2
		#	K90ME9	900	2870		6L	4090		84	94	16			68640		IMO TIER 2
		#	K90MC9	900	2870		6L	4090		84	94	16			68640		IMO TIER 2
		#	K90ME-C9	900	2600		6L	4150							68760		IMO TIER 2
		#	K90MC-C9	900	2600		6L	4150							68760		IMO TIER 2
		#	K90ME-C6	900	2300		6L	3130							54840		IMO TIER 2
		#	K90MC-C6	900	2300		6L	3130							54840		IMO TIER 2
		#	G80ME-C9	800	3720		6L	3040		58	68	16.8			40050		IMO TIER 2
		#	S80ME-C9	800	3450		6L	3050		66	78	16			40590		IMO TIER 2
		#	S80MC-C9	800	3470		6L	3050		66	78	16			40590		IMO TIER 2
		#	S80ME-C8	800	3200		6L	2830		66	78	16			33440		IMO TIER 2
		#	S80MC-C8	800	3200		6L	2830		66	78	16			33440		IMO TIER 2
		#	S80ME-C7	800	3200		6L	2320		57	76	15.2			31040		IMO TIER 2
		#	S80MC-C7	800	3200		6L	2320		57	76	15.2			31040		IMO TIER 2
		#	S80MC6	800	3056		5L	2180		59	79	14.4			29120		IMO TIER 2
		#	K80ME-C9	800	2600		6L	3280							54360		IMO TIER 2
		#	K80MC-C9	800	2600		6L	3280							54360		IMO TIER 2
		#	K80ME-C6	800	2300		6L	2470							43320		IMO TIER 2
		#	K80MC-C6	800	2300		6L	2470							43320		IMO TIER 2
continued		#	S70ME-C8	700	2800		5L	2210		77	91	16			26160		IMO TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
MAN ENERGY SOLUTIONS SE - TURBO **# = MGO, MDO, HFO FUEL** **¢ = NG, LPG FUEL**	206	#, ¢	S70ME-GI8	700	2800		5L	2210		77	91	16			26160		IMO TIER 2
		#	S70MC-C8	700	2800		5L	2210		77	91	16			26160		IMO TIER 2
		#	S70ME-C7	700	2800		5L	1860		68	91	15.2			24880		IMO TIER 2
		#	S70MC-C7	700	2800		5L	1860		68	91	15.2			24880		IMO TIER 2
		#	S70MC6	700	2674		5L	1680		68	91	14.4			22480		IMO TIER 2
		#	L70ME-C8	700	2360		5L	2200							26160		IMO TIER 2
		#	L70MC-C8	700	2360		5L	2200							26160		IMO TIER 2
		#	L70ME-C7	700	2360		5L	2090							24880		IMO TIER 2
		#	L70MC-C7	700	2360		5L	2090							24880		IMO TIER 2
		#	S65ME-C8	650	2730		5L	1960	2870	81	95	16	20	9800	22960		IMO TIER 2
		#, ¢	S65ME-GI8	650			5L	1960		81	95	16			22960		IMO TIER 2
		#	S65MC-C8	650			5L	1960		81	95	16			22960		IMO TIER 2
		#	S60ME-C8	600			5L	1610							9040		IMO TIER 2
		#	S60ME-B8	600			5L	1610							9040		IMO TIER 2
		#, ¢	S60ME-GI8	600			5L	1610							9040		IMO TIER 2
		#	S60MC-C8	600			5L	1610							9040		IMO TIER 2
		#	S60ME-C7	600			5L	1360							8080		IMO TIER 2
		#	S60MC-C7	600			5L	1360							8080		IMO TIER 2
		#	S60MC6	600			5L	1230							6320		IMO TIER 2
		#	L60ME-C8	600			5L	1600							21060		IMO TIER 2
		#	L60MC-C8	600			5L	1600							21060		IMO TIER 2
		#	L60ME-C7	600			5L	1520							20070		IMO TIER 2
		#	L60MC-C7	600			5L	1520							20070		IMO TIER 2
		#	S50ME-B9	500			5L	1210							6020		IMO TIER 2
		#	S50ME-C8	500			5L	1130							14940		IMO TIER 2
		#	S50MC-C8	500			5L	1130							14940		IMO TIER 2
		#	S50ME-B8	500			5L	1130							14940		IMO TIER 2
		#	S50ME-C7	500			5L	950							4220		IMO TIER 2
		#	S50MC-C7	500			5L	950							4220		IMO TIER 2
		#	S50MC6	500			5L	860							1440		IMO TIER 2
		#	S46MC-C8	460			5L	940							11040		IMO TIER 2
		#	S46ME-B8	460			5L	940							11040		IMO TIER 2
		#	S46MC-C7	460			5L	880							10480		IMO TIER 2
		#	S42MC7	420			5L	730							12960		IMO TIER 2
		#	S40MC-C9	400			5L	1080							8640		IMO TIER 2
		#	S40ME-B9	400			5L	770							9080		IMO TIER 2
		#	S35MC7	350			5L	505	740						8880		IMO TIER 2
		#	S35ME-B9	350			5L	595	870						6960		IMO TIER 2
		#, ¢	S35ME-B9-GI	350			5L	595	870						6960		IMO TIER 2
		#	S35MC-C9	350			5L	740	740		142	21	21	3700	5920		IMO TIER 2
		#	L35MC6	350			5L	440	650						7800		IMO TIER 2
		#	S26MC6	260	980		5L	270	400						4800		IMO TIER 2
		#	K98ME7	980	2660		12L			90	97	15.4			87220		IMO TIER 2
		#	K98MC7	980	2660		12L			90	97	15.4			87220		IMO TIER 2
continued		#	K98E6	980	2660		12L	4100	5720	84	94	14.6	18.2	24600	80080		IMO TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
MAN ENERGY SOLUTIONS SE - TURBO # = MGO, MDO, HFO FUEL ¢ = NG, LPG FUEL	206	#	K98MC6	980	2660		12L			84	94	14.6			80080		IMO TIER 2
		#	K98ME-C7	980	2400		12L								84280		IMO TIER 2
		#	K98MC-C7	980	2400		12L								84280		IMO TIER 2
		#	K98ME-C6	980	2400		12L								79940		IMO TIER 2
		#	K98MC-C6	980	2400		12L								79940		IMO TIER 2
		#	S90ME-C8	900	3188		7L	3890		66	78	16			47430		IMO TIER 2
		#	S90MC-C8	900	3188		7L	3890		66	78	16			47430		IMO TIER 2
		#	S90ME-C7	900	3188		7L	3140		61	76	15.2			44010		IMO TIER 2
		#	S90MC-C7	900	3188		7L	3140		61	76	15.2			44010		IMO TIER 2
		#	S90ME-C9	900	3260		12L			76	84	16			81340		IMO TIER 2
		#	K90ME9	900	2870		7L	4090		84	94	16			68640		IMO TIER 2
		#	K90MC9	900	2870		7L	4090		84	94	16			68640		IMO TIER 2
		#	K90ME-C9	900	2600		7L	4150							68760		IMO TIER 2
		#	K90MC-C9	900	2600		7L	4150							68760		IMO TIER 2
		#	K90ME-C6	900	2300		7L	3130							54840		IMO TIER 2
		#	K90MC-C6	900	2300		7L	3130							54840		IMO TIER 2
		#	G80ME-C9	800	3720		7L	3040		58	68	16.8			40050		IMO TIER 2
		#	S80ME-C9	800	3450		7L	3050		66	78	16			40590		IMO TIER 2
		#	S80MC-C9	800	3470		7L	3050		66	78	16			40590		IMO TIER 2
		#	S80ME-C8	800	3200		7L	2830		66	78	16			33440		IMO TIER 2
		#	S80MC-C8	800	3200		7L	2830		66	78	16			33440		IMO TIER 2
		#	S80ME-C7	800	3200		7L	2320		57	76	15.2			31040		IMO TIER 2
		#	S80MC-C7	800	3200		7L	2320		57	76	15.2			31040		IMO TIER 2
		#	S80MC6	800	3056		6L	2180		59	79	14.4			29120		IMO TIER 2
		#	K80ME-C9	800	2600		7L	3280							54360		IMO TIER 2
		#	K80MC-C9	800	2600		7L	3280							54360		IMO TIER 2
		#	K80ME-C6	800	2300		7L	2470							43320		IMO TIER 2
		#	K80MC-C6	800	2300		7L	2470							43320		IMO TIER 2
		#	S70ME-C8	700	2800		6L	2210		77	91	16			26160		IMO TIER 2
		#, ¢	S70ME-GI8	700	2800		6L	2210		77	91	16			26160		IMO TIER 2
		#	S70MC-C8	700	2800		6L	2210		77	91	16			26160		IMO TIER 2
		#	S70ME-C7	700	2800		6L	1860		68	91	15.2			24880		IMO TIER 2
		#	S70MC-C7	700	2800		6L	1860		68	91	15.2			24880		IMO TIER 2
		#	S70MC6	700	2674		6L	1680		68	91	14.4			22480		IMO TIER 2
		#	L70ME-C8	700	2360		6L	2200							26160		IMO TIER 2
		#	L70MC-C8	700	2360		6L	2200							26160		IMO TIER 2
		#	L70ME-C7	700	2360		6L	2090							24880		IMO TIER 2
		#	L70MC-C7	700	2360		6L	2090							24880		IMO TIER 2
		#	S65ME-C8	650	2730		6L	1960	2870	81	95	16	20	9800	22960		IMO TIER 2
		#, ¢	S65ME-GI8	650			6L	1960		81	95	16			22960		IMO TIER 2
		#	S65MC-C8	650			6L	1960		81	95	16			22960		IMO TIER 2
		#	S60ME-C8	600			6L	1610							9040		IMO TIER 2
		#	S60ME-B8	600			6L	1610							9040		IMO TIER 2
		#, ¢	S60ME-GI8	600			6L	1610							9040		IMO TIER 2
continued		#	S60MC-C8	600			6L	1610							9040		IMO TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
MAN ENERGY SOLUTIONS SE - TURBO # = MGO, MDO, HFO FUEL ¢ = NG, LPG FUEL	206	#	S60ME-C7	600			6L	1360							8080		IMO TIER 2
		#	S60MC-C7	600			6L	1360							8080		IMO TIER 2
		#	S60MC6	600			6L	1230							6320		IMO TIER 2
		#	L60ME-C8	600			6L	1600							21060		IMO TIER 2
		#	L60MC-C8	600			6L	1600							21060		IMO TIER 2
		#	L60ME-C7	600			6L	1520							20070		IMO TIER 2
		#	L60MC-C7	600			6L	1520							20070		IMO TIER 2
		#	S50ME-B9	500			6L	1210							6020		IMO Tier 2
		#	S50ME-C8	500			6L	1130							14940		IMO Tier 2
		#	S50MC-C8	500			6L	1130							14940		IMO Tier 2
		#	S50ME-B8	500			6L	1130							14940		IMO Tier 2
		#	S50ME-C7	500			6L	950							4220		IMO Tier 2
		#	S50MC-C7	500			6L	950							4220		IMO Tier 2
		#	S50MC6	500			6L	860							1440		IMO Tier 2
		#	S46MC-C8	460			6L	940							11040		IMO Tier 2
		#	S46ME-B8	460			6L	940							11040		IMO TIER 2
		#	S46MC-C7	460			6L	880							10480		IMO TIER 2
		#	S42MC7	420			6L	730							12960		IMO TIER 2
		#	S40MC-C9	400			6L	1080							8640		IMO TIER 2
		#	S40ME-B9	400			6L	770							9080		IMO TIER 2
		#	S35MC7	350			6L	505	740						8880		IMO TIER 2
		#	S35ME-B9	350			6L	595	870						6960		IMO TIER 2
		#, ¢	S35ME-B9-GI	350			6L	595	870						6960		IMO TIER 2
		#	S35MC-C9	350			6L	740	740		142	21	21	3700	5920		IMO Tier 2
		#	L35MC6	350			6L	440	650						7800		IMO TIER 2
		#	S26MC6	260	980		6L	270	400						4800		IMO TIER 2
		#	K98ME7	980	2660		14L			90	97	15.4			87220		IMO TIER 2
		#	K98MC7	980	2660		14L			90	97	15.4			87220		IMO TIER 2
		#	K98E6	980	2660		14L	4100	5720	84	94	14.6	18.2	24600	80080		IMO TIER 2
		#	K98MC6	980	2660		14L			84	94	14.6			80080		IMO TIER 2
		#	K98ME-C7	980	2400		14L								84280		IMO TIER 2
		#	K98MC-C7	980	2400		14L								84280		IMO TIER 2
		#	K98ME-C6	980	2400		14L								79940		IMO TIER 2
		#	K98MC-C6	980	2400		14L								79940		IMO TIER 2
		#	S90ME-C8	900	3188		8L	3890		66	78	16			47430		IMO TIER 2
		#	S90MC-C8	900	3188		8L	3890		66	78	16			47430		IMO TIER 2
		#	S90ME-C7	900	3188		8L	3140		61	76	15.2			44010		IMO TIER 2
		#	S90MC-C7	900	3188		8L	3140		61	76	15.2			44010		IMO TIER 2
		#	S90ME-C9	900	3260		14L			76	84	16			81340		IMO TIER 2
		#	K90ME9	900	2870		8L	4090		84	94	16			68640		IMO TIER 2
		#	K90MC9	900	2870		8L	4090		84	94	16			68640		IMO TIER 2
		#	K90ME-C9	900	2600		8L	4150							68760		IMO TIER 2
		#	K90MC-C9	900	2600		8L	4150							68760		IMO Tier 2
		#	K90ME-C6	900	2300		8L	3130							54840		IMO Tier 2
continued		#	K90MC-C6	900	2300		8L	3130							54840		IMO TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
MAN ENERGY SOLUTIONS SE - TURBO # = MGO, MDO, HFO FUEL ¢ = NG, LPG FUEL	206	#	G80ME-C9	800	3720		8L	3040		58	68	16.8			40050		IMO TIER 2
		#	S80ME-C9	800	3450		8L	3050		66	78	16			40590		IMO TIER 2
		#	S80MC-C9	800	3470		8L	3050		66	78	16			40590		IMO TIER 2
		#	S80ME-C8	800	3200		8L	2830		66	78	16			33440		IMO TIER 2
		#	S80MC-C8	800	3200		8L	2830		66	78	16			33440		IMO TIER 2
		#	S80ME-C7	800	3200		8L	2320		57	76	15.2			31040		IMO TIER 2
		#	S80MC-C7	800	3200		8L	2320		57	76	15.2			31040		IMO TIER 2
		#	S80MC6	800	3056		7L	2180		59	79	14.4			29120		IMO TIER 2
		#	K80ME-C9	800	2600		8L	3280							54360		IMO TIER 2
		#	K80MC-C9	800	2600		8L	3280							54360		IMO TIER 2
		#	K80ME-C6	800	2300		8L	2470							43320		IMO TIER 2
		#	K80MC-C6	800	2300		8L	2470							43320		IMO TIER 2
		#	S70ME-C8	700	2800		7L	2210		77	91	16			26160		IMO TIER 2
		#, ¢	S70ME-GI8	700	2800		7L	2210		77	91	16			26160		IMO TIER 2
		#	S70MC-C8	700	2800		7L	2210		77	91	16			26160		IMO TIER 2
		#	S70ME-C7	700	2800		7L	1860		68	91	15.2			24880		IMO TIER 2
		#	S70MC-C7	700	2800		7L	1860		68	91	15.2			24880		IMO TIER 2
		#	S70MC6	700	2674		7L	1680		68	91	14.4			22480		IMO TIER 2
		#	L70ME-C8	700	2360		7L	2200							26160		IMO TIER 2
		#	L70MC-C8	700	2360		7L	2200							26160		IMO TIER 2
		#	L70ME-C7	700	2360		7L	2090							24880		IMO TIER 2
		#	L70MC-C7	700	2360		7L	2090							24880		IMO Tier 2
		#	S65ME-C8	650	2730		7L	1960	2870	81	95	16	20	9800	22960		IMO Tier 2
		#, ¢	S65ME-GI8	650			7L	1960		81	95	16			22960		IMO Tier 2
		#	S65MC-C8	650			7L	1960		81	95	16			22960		IMO Tier 2
		#	S60ME-C8	600			7L	1610							9040		IMO Tier 2
		#	S60ME-B8	600			7L	1610							9040		IMO Tier 2
		#, ¢	S60ME-GI8	600			7L	1610							9040		IMO Tier 2
		#	S60MC-C8	600			7L	1610							9040		IMO Tier 2
		#	S60ME-C7	600			7L	1360							8080		IMO Tier 2
		#	S60MC-C7	600			7L	1360							8080		IMO Tier 2
		#	S60MC6	600			7L	1230							6320		IMO Tier 2
		#	L60ME-C8	600			7L	1600							21060		IMO Tier 2
		#	L60MC-C8	600			7L	1600							21060		IMO Tier 2
		#	L60ME-C7	600			7L	1520							20070		IMO Tier 2
		#	L60MC-C7	600			7L	1520							20070		IMO Tier 2
		#	S50ME-B9	500			7L	1210							6020		IMO Tier 2
		#	S50ME-C8	500			7L	1130							14940		IMO Tier 2
		#	S50MC-C8	500			7L	1130							14940		IMO Tier 2
		#	S50ME-B8	500			7L	1130							14940		IMO Tier 2
		#	S50ME-C7	500			7L	950							4220		IMO Tier 2
		#	S50MC-C7	500			7L	950							4220		IMO Tier 2
		#	S50MC6	500			7L	860							1440		IMO Tier 2
		#	S46MC-C8	460			7L	940							11040		IMO Tier 2
continued		#	S46ME-B8	460			7L	940							11040		IMO Tier 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
MAN ENERGY SOLUTIONS SE - TURBO	206	#	S46MC-C7	460			7L	880							10480		IMO Tier 2
# = MGO, MDO, HFO FUEL		#	S42MC7	420			7L	730							12960		IMO Tier 2
¢ = NG, LPG FUEL		#	S40MC-C9	400			7L	1080							8640		IMO Tier 2
		#	S40ME-B9	400			7L	770							9080		IMO Tier 2
		#	S35MC7	350			7L	505	740						8880		IMO Tier 2
		#	S35ME-B9	350			7L	595	870						6960		IMO Tier 2
		#, ¢	S35ME-B9-GI	350			7L	595	870						6960		IMO Tier 2
		#	S35MC-C9	350			7L	740	740		142	21	21	3700	5920		IMO Tier 2
		#	L35MC6	350			7L	440	650						7800		IMO Tier 2
		#	S26MC6	260	980		7L	270	400						4800		IMO Tier 2
		#	S90ME-C8	900	3188		9L	3890		66	78	16			47430		IMO Tier 2
		#	S90MC-C8	900	3188		9L	3890		66	78	16			47430		IMO Tier 2
		#	S90ME-C7	900	3188		9L	3140		61	76	15.2			44010		IMO Tier 2
		#	S90MC-C7	900	3188		9L	3140		61	76	15.2			44010		IMO Tier 2
		#	K90ME9	900	2870		9L	4090		84	94	16			68640		IMO Tier 2
		#	K90MC9	900	2870		9L	4090		84	94	16			68640		IMO Tier 2
		#	K90ME-C9	900	2600		9L	4150							68760		IMO Tier 2
		#	K90MC-C9	900	2600		9L	4150							68760		IMO Tier 2
		#	K90ME-C6	900	2300		9L	3130							54840		IMO Tier 2
		#	K90MC-C6	900	2300		9L	3130							54840		IMO Tier 2
		#	G80ME-C9	800	3720		9L	3040		58	68	16.8			40050		IMO Tier 2
		#	S80ME-C9	800	3450		9L	3050		66	78	16			40590		IMO TIER 2
		#	S80MC-C9	800	3470		9L	3050		66	78	16			40590		IMO TIER 2
		#	S80MC6	800	3056		8L	2180		59	79	14.4			29120		IMO TIER 2
		#	K80ME-C9	800	2600		9L	3280							54360		IMO TIER 2
		#	K80MC-C9	800	2600		9L	3280							54360		IMO TIER 2
		#	K80ME-C6	800	2300		9L	2470							43320		IMO TIER 2
		#	K80MC-C6	800	2300		9L	2470							43320		IMO TIER 2
		#	S70ME-C8	700	2800		8L	2210		77	91	16			26160		IMO TIER 2
		#, ¢	S70ME-GI8	700	2800		8L	2210		77	91	16			26160		IMO TIER 2
		#	S70MC-C8	700	2800		8L	2210		77	91	16			26160		IMO TIER 2
		#	S70ME-C7	700	2800		8L	1860		68	91	15.2			24880		IMO TIER 2
		#	S70MC-C7	700	2800		8L	1860		68	91	15.2			24880		IMO TIER 2
		#	S70MC6	700	2674		8L	1680		68	91	14.4			22480		IMO TIER 2
		#	L70ME-C8	700	2360		8L	2200							26160		IMO TIER 2
		#	L70MC-C8	700	2360		8L	2200							26160		IMO TIER 2
		#	L70ME-C7	700	2360		8L	2090							24880		IMO TIER 2
		#	L70MC-C7	700	2360		8L	2090							24880		IMO TIER 2
		#	S65ME-C8	650	2730		8L	1960	2870	81	95	16	20	9800	22960		IMO TIER 2
		#, ¢	S65ME-GI8	650			8L	1960		81	95	16			22960		IMO TIER 2
		#	S65MC-C8	650			8L	1960		81	95	16			22960		IMO TIER 2
		#	S60ME-C8	600			8L	1610							9040		IMO TIER 2
		#	S60ME-B8	600			8L	1610							9040		IMO TIER 2
		#, ¢	S60ME-GI8	600			8L	1610							9040		IMO TIER 2
		#	S60MC-C8	600			8L	1610							9040		IMO TIER 2
continued		#	S60ME-C7	600			8L	1360							8080		IMO TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
MAN ENERGY SOLUTIONS SE - TURBO	206	#	S60MC-C7	600			8L	1360							8080		IMO TIER 2
# = MGO, MDO, HFO FUEL		#	S60MC6	600			8L	1230							6320		IMO TIER 2
¢ = NG, LPG FUEL		#	L60ME-C8	600			8L	1600							21060		IMO TIER 2
		#	L60MC-C8	600			8L	1600							21060		IMO TIER 2
		#	L60ME-C7	600			8L	1520							20070		IMO TIER 2
		#	L60MC-C7	600			8L	1520							20070		IMO TIER 2
		#	S50ME-B9	500			8L	1210							6020		IMO TIER 2
		#	S50ME-C8	500			8L	1130							14940		IMO TIER 2
		#	S50MC-C8	500			8L	1130							14940		IMO TIER 2
		#	S50ME-B8	500			8L	1130							14940		IMO TIER 2
		#	S50ME-C7	500			8L	950							4220		IMO TIER 2
		#	S50MC-C7	500			8L	950							4220		IMO TIER 2
		#	S50MC6	500			8L	860							1440		IMO TIER 2
		#	S46MC-C8	460			8L	940							11040		IMO TIER 2
		#	S46ME-B8	460			8L	940							11040		IMO TIER 2
		#	S46MC-C7	460			8L	880							10480		IMO TIER 2
		#	S42MC7	420			8L	730							12960		IMO TIER 2
		#	S40MC-C9	400			8L	1080							8640		IMO TIER 2
		#	S40ME-B9	400			8L	770							9080		IMO TIER 2
		#	S35MC7	350			8L	505	740						8880		IMO TIER 2
		#	S35ME-B9	350			8L	595	870						6960		IMO TIER 2
		#, ¢	S35ME-B9-GI	350			8L	595	870						6960		IMO TIER 2
		#	S35MC-C9	350			8L	740	740		142	21	21	3700	5920		IMO TIER 2
		#	L35MC6	350			8L	440	650						7800		IMO TIER 2
		#	S26MC6	260	980		8L	270	400						4800		IMO TIER 2
		#	K90ME9	900	2870		10L	4090		84	94	16			68640		IMO TIER 2
		#	K90MC9	900	2870		10L	4090		84	94	16			68640		IMO TIER 2
		#	K90ME-C9	900	2600		10L	4150							68760		IMO TIER 2
		#	K90MC-C9	900	2600		10L	4150							68760		IMO TIER 2
		#	K90ME-C6	900	2300		10L	3130							54840		IMO TIER 2
		#	K90MC-C6	900	2300		10L	3130							54840		IMO TIER 2
		#	K80ME-C9	800	2600		10L	3280							54360		IMO TIER 2
		#	K80MC-C9	800	2600		10L	3280							54360		IMO TIER 2
		#	K80ME-C6	800	2300		10L	2470							43320		IMO TIER 2
		#	K80MC-C6	800	2300		10L	2470							43320		IMO TIER 2
		#	L60ME-C8	600			9L	1600							21060		IMO TIER 2
		#	L60MC-C8	600			9L	1600							21060		IMO TIER 2
		#	L60ME-C7	600			9L	1520							20070		IMO TIER 2
		#	L60MC-C7	600			9L	1520							20070		IMO TIER 2
		#	S50ME-B9	500			9L	1210							6020		IMO TIER 2
		#	S50ME-C8	500			9L	1130							14940		IMO TIER 2
		#	S50MC-C8	500			9L	1130							14940		IMO TIER 2
		#	S50ME-B8	500			9L	1130							14940		IMO TIER 2
		#	S50ME-C7	500			9L	950							4220		IMO TIER 2
continued		#	S50MC-C7	500			9L	950							4220		IMO TIER 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
MAN ENERGY SOLUTIONS SE - TURBO	206	#	S42MC7	420			9L	730							12960		IMO TIER 2
# = MGO, MDO, HFO FUEL		#	S35MC7	350			9L	505	740						8880		IMO TIER 2
¢ = NG, LPG FUEL		#	L35MC6	350			9L	440	650						7800		IMO TIER 2
		#	S26MC6	260	980		9L	270	400						4800		IMO TIER 2
		#	K90ME9	900	2870		11L	4090		84	94	16			68640		IMO TIER 2
		#	K90MC9	900	2870		11L	4090		84	94	16			68640		IMO TIER 2
		#	K90ME-C9	900	2600		11L	4150							68760		IMO TIER 2
		#	K90MC-C9	900	2600		11L	4150							68760		IMO TIER 2
		#	K90ME-C6	900	2300		11L	3130							54840		IMO TIER 2
		#	K90MC-C6	900	2300		11L	3130							54840		IMO TIER 2
		#	K80ME-C9	800	2600		11L	3280							54360		IMO TIER 2
		#	K80MC-C9	800	2600		11L	3280							54360		IMO TIER 2
		#	K80ME-C6	800	2300		11L	2470							43320		IMO TIER 2
		#	K80MC-C6	800	2300		11L	2470							43320		IMO TIER 2
		#	S42MC7	420			10L	730							12960		IMO TIER 2
		#	S35MC7	350			10L	505	740						8880		IMO TIER 2
		#	L35MC6	350			10L	440	650						7800		IMO TIER 2
		#	S26MC6	260	980		10L	270	400						4800		IMO TIER 2
		#	K90ME9	900	2870		12L	4090		84	94	16			68640		IMO TIER 2
		#	K90MC9	900	2870		12L	4090		84	94	16			68640		IMO TIER 2
		#	K90ME-C9	900	2600		12L	4150							68760		IMO TIER 2
		#	K90MC-C9	900	2600		12L	4150							68760		IMO TIER 2
		#	K90ME-C6	900	2300		12L	3130							54840		IMO TIER 2
		#	K90MC-C6	900	2300		12L	3130							54840		IMO TIER 2
		#	K80ME-C9	800	2600		12L	3280							54360		IMO TIER 2
		#	K80MC-C9	800	2600		12L	3280							54360		IMO TIER 2
		#	K80ME-C6	800	2300		12L	2470							43320		IMO TIER 2
		#	K80MC-C6	800	2300		12L	2470							43320		IMO TIER 2
		#	S42MC7	420			11L	730							12960		IMO TIER 2
		#	S35MC7	350			11L	505	740						8880		IMO TIER 2
		#	L35MC6	350			11L	440	650						7800		IMO TIER 2
		#	S26MC6	260	980		11L	270	400						4800		IMO TIER 2
		#	S42MC7	420			12L	730							12960		IMO TIER 2
		#	S35MC7	350			12L	505	740						8880		IMO TIER 2
		#	L35MC6	350			12L	440	650						7800		IMO TIER 2
		#	S26MC6	260	980		12L	270	400						4800		IMO TIER 2
MAN ENERGY SOLUTIONS SE - POWER	206	D	51/60	510	600		6L	1050	-	500	514			6300	-	PG	WB2007/ 2008
		D	51/60	510	600		9L	1050	-	500	514			9450	-	PG	WB2007/ 2008
		D	51/60	510	600		12V	1050	-	500	514			12600	-	PG	WB2007/ 2008
		D	51/60	510	600		18V	1050	-	500	514			18900	-	PG	WB2007/ 2008
		D	51/60TS	510	600		18V	1050	1200	500	514			18900	21600	PG	WB2007/ 2008
		DF	51/60DF	510	600		6L	1050	1150	500	514			6300	6900	PG	WB2007/ 2008
		DF	51/60DF	510	600		12V	1050	1150	500	514			12600	13800	PG	WB2007/ 2008
		DF	51/60DF	510	600		18V	1050	1150	500	514			18900	20700	PG	WB2007/ 2008
continued		DF	51/60DF TS	510	600		18V	1050	-	500	514			18900	-	PG	WB2007/ 2008

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
MAN ENERGY SOLUTIONS SE - POWER	206	SI	51/60G	510	600		18V	1050	1150	500	514			18900	20700	PG	TA-LUFT
		SI	51/60GTS	510	600		18V	1050	1150	500	514			18900	20700	PG	TA-LUFT
		SI	35/44G	350	440		20V	510	530	720	750			10200	10600	PG	TA-LUFT
		SI	35/44GTS	350	440		12V	614	640	720	750			7368	7680	PG	TA-LUFT
		SI	35/44GTS	350	440		20V	614	640	720	750			12280	12800	PG	TA-LUFT
MAN TRUCK & BUS AG	173	D	D1556	115	145	1.5	6L	34.2	54.0	1900				205	324	OH	LRC STAGE 3A/3B, EPA TIER 4, EU STAGE 5
		D	D3876	138	170	2.5	6L	69.2	80.8	1800	1900			415	485	OH	LRC STAGE 3A/3B, EU STAGE 4, EPA TIER 4, EU STAGE 5
		D	D2862	128	157	2.03	12V	49.0	68.0	1800				588	816	OH	LRC EPA TIER 2, EPA TIER 4, EU STAGE 5, NON REGULATED
		D	D2868	128	157	2.02	8V	71.3		1800				570		OH	LRC EPA TIER 2, NON REGULATED
		D	D2676	126	166	2.07	6L	49.0	67.3	1950				294	404	OH	LRC STAGE 3A/3B, EU STAGE 4, EPA TIER 4, EU STAGE 5
		D	D0836	108	125	1.15	6L	30.7	39.2	2400				184	235	OH	LRC STAGE 3A/3B, EU STAGE 4, EPA TIER 4, EU STAGE 5
		D	D0834	108	125	1.15	4L	29.5	40.5	2400				118	162	OH	LRC STAGE 3A/3B, EU STAGE 4, EPA TIER 4, EU STAGE 5
		D	D4276	142	170	2.7	6L	75.0	96.8	1800				450	581	OH	LRC STAGE 3A/3B, EU STAGE 4, EPA TIER 4, EU STAGE 5
		D	D2862	128	157	2.02	12V	49.0	61.3	1800		17.4	20.7	588	735	R	EU STAGE 3B
		D	D2676	126	166	2.07	6L	56.3	63.7	1800		22.3	24.6	338	382	R	EU STAGE 3B
		D	D2876	128	166	2.13	6H	49.0	65.0	1800	2000	18.6	22.5	294	390	R	EU STAGE 3B
		D	D3876	138	170	2.55	6L	69.2	78.5	1800		22.2	24.6	415	471	R	EU STAGE 5
		D	D0834	108	125	1.15	4L	27.5	40.5	2400				110	162	ON	EURO 5/EEV
		D	D0834	108	125	1.15	4L	27.5	40.5	2300				110	162	ON	EURO 6C
		D	D0836	108	125	1.15	6L	29.5	41.7	2300				177	250	ON	EURO 5/EEV, EURO 4, EURO 3
		D	D0836	108	125	1.15	6L	30.7	41.8	2200	2300			184	251	ON	EURO 6C
		SI	E0836	108	125	1.15	6L	27.0	34.3	2200				162	206	ON	EEV
		SI	E0836	108	125	1.15	6L	27.0	34.3	2200				162	206	ON	EURO 6C
		D	D2066	120	155	1.75	6H	38.0	49.0	1700	1900			228	294	ON	EURO 5/EEV, EURO 4, EURO 3
		D	D2066	120	155	1.75	6L	39.2	54.0	1900				235	324	ON	EURO 5/EEV, EURO 4, EURO 3
		D	D2066	120	155	1.75	6H	34.3	44.2	1700	1900			206	265	ON	EURO 6C
		D	D2066	120	155	1.75	6L	39.2	44.2	1800				235	265	ON	EURO 6C
		D	D2676	126	166	2.07	6L	54.0	66.2	1900				324	397	ON	EURO 5/EEV, EURO 4, EURO 3
		D	D2676	126	166	2.07	6L	51.5	61.3	1800				309	368	ON	EURO 6C
		SI	E2876	128	166	2.14	6H	33.3	38.0	2000				200	228	ON	EEV
		D	D3876	138	170	2.5	6L	66.2	78.5	1800				471	471	ON	EURO 6C
		D	D2676	126	166	2.07	6L	44.0	73.3	1500	1800	16.9	28.3	264	440	PG	
		D	D2862	128	157	2.02	12V	46.7	93.1	1500	1800	23	30.7	560	1117	PG	
		SI	E2676	126	166	2.07	6L	23.3	41.7	1500	1800	8.5	14.2	140	250	PG	
continued		SI	E3268	132	157	2.15	8V	40.0	48.8	1500	1800	14.9	17.2	320	390	PG	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R-Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
MAN TRUCK & BUS AG	173	SI	E3262	132	157	2.15	12V	22.9	48.3	1500	1800	7.8	17.1	275	580	PG	
		SI	E0834	108	125	1.15	4L	9.3	20.0	1500	1800	6.5	11.9	37	80	PG	
		SI	E0836	108	125	1.15	6L	9.3	18.3	1500	1800	6.5	12.8	56	110	PG	
		SI	E2876	128	166	2.13	6L	23.3	36.7	1500	1800	9.4	13.8	140	220	PG	
		D	D2676	126	166	2.07	6L	24.5	104.2	1800	2300	7.9	24.7	147	625	M	IMO TIER 2, RCD 2013/53/EC, EPA TIER 3, 97/68/EC, IMO TIER 3, EU STAGE 5
		D	D2868	128	157	2.02	8V	55.1	119.5	1800	2300	18.2	28.48	441	956	M	IMO TIER 2, EPA TIER 3, RCD 2013/53/EC, 97/68/EC, IMO TIER 3, EU STAGE 5
		D	D2862	128	157	2.02	12V	45.9	122.6	1800	2300	15.1	30.1	551	1471	M	IMO TIER 3, EPA TIER 4, IMO TIER 2, EPA TIER 3, RCD 2013/53/EC, 97/68/EC
		D	I6	126	166	2.07	6L	89.5	104.2	2300	2300	22.6	24.7	537	625	M	IMO TIER 2, EPA TIER 3, RCD 2013/53/EC, 97/68/EC, IMO TIER 3, EU STAGE 5
		D	V8	128	157	2.02	8V	91.9	119.5	2300	2300	23.7	28.5	735	956	M	IMO TIER 2, EPA TIER 3, RCD 2013/53/EC, 97/68/EC, IMO TIER 3, EU STAGE 5
		D	V12	128	157	2.02	12V	85.8	122.6	2300	2300	22.2	30.1	1029	1471	M	IMO TIER 2, EPA TIER 3, RCD 2013/53/EC, 97/68/EC, IMO TIER 3, EU STAGE5
		D	D2676	126	166	2.07	6L	31.7	74.2	1500	1800			190	445	AUX	IMO TIER 2, EU STAGE 5
		D	D2862	128	157	2.02	12V	100.0	133.3	1500	1800			600	800	AUX	IMO TIER 1, IMO TIER 2, IMO TIER 3
		SI	E3262	128	157	2.02	12V	83.3	96.7	1500	1800			500	580	AUX	IMO TIER 3 READY
MITSUBISHI	*	D	L2E	76	70	0.635	2L		2.6						5.15 @ 1800	PG, ST-IND	EPA TIER 4F
		D	L3E	76	70	0.095	3L		4.1						12.4 @2400	OH	EPA TIER 4F
		D	L3E	76	70	0.095	3L		3.0						9.1 @ 1800	PG, ST-IND	EPA TIER 4F
		D	L3E	76	70	0.095	3L		4.5						13.6 @ 1800	PG, ST-IND	EPA TIER 4F
		D	S3L2	78	92	1.3	3L		6.1						18.34 @ 2500	OH	EPA TIER 4F
		D	S3L3	78	92	1.3	3L		6.9						20.6 @ 3000	OH	EPA TIER 4F
		D	S4L	78	92	1.5	4L		5.8						23.34 @ 1800	PG, ST-IND	EPA TIER 4F
		D	D03CJ	86	95	1.65	3L		9.0						27 @ 2500	OH	EPA TIER 4F
		D	D03CJ	86	95	1.65	3L		10.3						31 @ 2500	OH	EPA TIER 4F
		D	D03CJ	86	95	1.65	3L		12.0						36 @ 2500	OH	EPA TIER 4F
		D	D03CJ	86	95	1.65	3L		11.7						35 @ 1800	PG, ST-IND	
		D	D04CJ	86	95	2.2	4L		13.3						40 @ 2500	OH	EPA TIER 4F
		D	D04CJ	86	95	2.2	4L		14.7						44 @ 2500	OH	EPA TIER 4F
continued		D	D04CJ	86	95	2.2	4L		13.6						54.5 @ 1800	PG, ST-IND	EPA TIER 4F

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
MITSUBISHI	*	D	D04EG	94	120	3.33	4L		12.0						36 @ 2300	OH	EPA TIER 4F
		D	S6R-Y2PTAW-1	170	180	24.51	6L		103.8						623 @ 1800	PG, ST-IND	EPA TIER 2
		D	S12A2-Y2PTAW-2	150	160	33.93	12V		68.3						820 @ 1800	PG, ST-IND	EPA TIER 2
		D	S12H-Y2PTAW-1	150	175	37.11	12V		86.3						1036 @ 1800	PG, ST-IND	EPA TIER 2
		D	S12R-Y2PTAW-1	170	180	49.03	12V		106.3						1275 @ 1800	PG, ST-IND	EPA TIER 2
		D	S16R-Y2PTAW-1	170	180	65.37	16V		99.4						1591 @ 1800	PG, ST-IND	EPA TIER 2
		D	S16R-Y2PTAW2-1	170	180	65.37	16V		123.9						1982 @ 1800	PG, ST-IND	EPA TIER 2
		D	S6R-Y1PTA-4	170	180	24.51	6L		34.8						609 @ 1800	PG, ST-IND	EPA TIER 1
		D	S12A2-Y1PTA-1	150	160	33.93	12V		68.3						820 @ 1800	PG, ST-IND	EPA TIER 1
		D	S12H-Y1PTA-3	150	175	37.11	12V		86.3						1036 @ 1800	PG, ST-IND	EPA TIER 1
		D	S12R-Y1PTA-2	170	180	49.03	12V		106.3						1275 @1800	PG, ST-IND	EPA TIER 1
		D	S16R-Y1PTA2	170	180	65.37	16V		99.4						1591 @ 1800	PG, ST-IND	EPA TIER 1
		D	S16R-Y1PTAA2-1	170	180	65.37	16V		122.2						1955 @ 1800	PG, ST-IND	EPA TIER 1
		SI	GS6R2	170	220	30	6L		75.0						450 @ 1200	PG, ST-IND	NOT CERTIFIED
		SI	GS16R	170	220	65	16V		50.9						815 @ 1200	PG, ST-IND	NOT CERTIFIED
		SI	GS16R2	170	220	80	16V		62.5						1000 @ 1200	PG, ST-IND	NOT CERTIFIED
		SI	GS16R2	170	220	80	16V		75.0						1200 @ 1200	PG, ST-IND	NOT CERTIFIED
		SI	GS16R2	170	220	80	16V		93.8						1500 @ 1500	PG, ST-IND	NOT CERTIFIED
MTU FRIEDRICHSHAFEN GMBH	Inside Front Cover, 217, 269	D	1600	122	150	1.8	12V	43.7	61.3	1500	1900			524	736	PG, RAIL	EPA TIER 2 COMPL., EPA TIER 2 (ESP), EU STAGE 3B COMPL., EU STAGE 5
		D	1600	122	150	1.8	10V	40.7	56.1	1500	1800			407	561	PG	EPA TIER 2 COMPL., EPA TIER 2 (ESP)
		D	2000	130	150	2	18V	40	72.8	1500	2350		23.6	720	1310	PG	EPA TIER 2 COMPL., EPA TIER 2 (ESP)
		D	2000	135	156	2.2	10V	90	119.3	2250	2450		24.6	900	1193	M	IMO 2, EPA TIER 2 COMPL.
		D	2000	135	156	2.2	12V	54.6	119.3	2250	2450		24.6	655	1432	OH, M, PG, ST-IND	IMO 2, EPA TIER 2 COMPL., EPA TIER 2 (ESP), EPA TIER 4I COMP., CHINA NRMM STAGE 3
		D	2000	135	156	2.2	16V	44.3	121.2	2250	2450		24.6	709	1939	OH, M, PG, ST-IND	IMO 2, EPA TIER 2 COMPL., EPA TIER 2 (ESP), EPA TIER 4I COMP., CHINA NRMM STAGE 3
		D	4000	165	190	4.1	12V	99.4	125.8	1500	2100		23.9	1193	1510	ST-IND	EPA TIER 2 COMPL.
		D	4000	165	190	4.1	16V	100	132.8	1500	2100		23.9	1600	2125	ST-IND	EPA TIER 2 COMPL.
continued		D	4000	170	190	4.3	12V	137.5	215	1970	2100		27.6	1650	2580	M	EPA TIER 2 COMPL., IMO 2

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
MTU FRIEDRICHSHAFEN GMBH	Inside Front Cover, 217, 269	D	4000	170	190	4.3	16V	137.5	215	1970	2100		27.6	2200	3440	M	EPA TIER 2 COMPL., IMO 2
		D	4000	170	190	4.3	20V	150.8	215	1970	2100		27.6	3015	4300	M	EPA TIER 2 COMPL., IMO 2
		D	4000	170	210	4.8	12V	95	160	1500	1800		19.6	1140	1920	M, R, PG, ST-IND	EPA TIER 2 COMPL., EPA TIER 2 (ESP), EPA MARINE T4, IMO 2, IMO 3, EU STAGE 3A COMPL., EU STAGE 3B COMPL., EU STAGE 5, UIC 3A, CHINA NRMM STAGE 3
		D	4000	170	210	4.8	16V	93.3	171.3	1500	1800		19.6	1492	2740	M, R, PG, ST-IND	EPA 2 COMPL.,EPA 2 (ESP), EPA MARINE T4, IMO 2, IMO 3, EU 3A COMPL., EU 3B COMPL., EU 5, UIC 3A, CHINA NRMM STAGE 3
		D	4000	170	210	4.8	20V	100	174.5	1500	1800		19.6	2000	3490	R, PG, ST-IND	EPA TIER 2 COMPL., EPA TIER 2 (ESP), IMO 2, EU STAGE 3A COMPL., UIC 3A, CHINA NRMM STAGE 3
		D	1163	230	280	11.6	16V	300	370		1150		29.4	4800	5920	M	IMO 2
		D	1163	230	280	11.6	20V	300	370		1150		29.4	6000	7400	M	IMO 2
		D	8000	265	315	17.4	20V	360	500		1150		27	7200	10000	M	IMO 2, EPA TIER 2 COMPL.
		D	8000	265	315	17.4	16V	455	500		1150		27	7280	8000	M	IMO 2
		D	900	102	130	2	4L	18.8	36.3		2200		11.4	75	145	OH, ON, ST-IND	EPA TIER 3 COMPL., EU STAGE 3A COMPL., CHINA NRMM STAGE 3
		D	900	102	130	2	6L	21.7	40		2200		11.4	130	240	OH, ON, ST-IND	EPA TIER 3 COMPL., EU STAGE 3A COMPL., CHINA NRMM STAGE 3
		D	900	106	136	1.2	4L	23.8	37.5		2200		14.5	95	150	ON, OH, ST-IND	EPA TIER 4I COMPL., EU STAGE 3B COMPL., CHINA NRMM STAGE 3
		D	900	106	136	1.2	6L	29.2	40		2200		14.5	175	240	OH, ON, ST-IND	EPA TIER 4I COMPL., EU STAGE 3B COMPL., CHINA NRMM STAGE 3
		D	460	128	166	2.1	6L	36.7	62.5		1800		18.8	220	375	OH, ON, ST-IND	EPA TIER 4I COMPL., EU STAGE 3B COMPL., CHINA NRMM STAGE 3, CHINA ONROAD STAGE 5
		D	S 60	130	160	2.1	6L	37.3	62.2	2100	2200		15.2	224	373	OH, ON, ST-IND	EPA TIER 2 COMPL.
		D	S 60	133	168	2.3	6L	37.3	102.5	1800	2300		23.1	224	615	OH, ON, M, ST-IND	IMO 2, EPA TIER 2 COMPL., EPA TIER 3 COMPL., EU STAGE 3A COMPL., CHINA NRMM STAGE 3
		D	1800	128	166	2.1	6H	52.5	65		1800		17.2	315	390	R	EU STAGE 3B COMPL., EU 5
		D	2000	130	150	2	12V	42.9	74.2	1500	2350		23.6	515	890	PG	EPA TIER 2 COMPL., EPA 2 (ESP)
continued		D	2000	130	150	2	16V	40.9	69.7	1500	2350		23.6	655	1115	PG	EPA TIER 2 COMPL., EPA 2 (ESP)

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
MTU FRIEDRICHSHAFEN GMBH	Inside Front Cover, 217, 269	D	4000	170	210	4.8	8V	93.3	150	1500	1800		19.6	746	1200	M, R	IMO 2, EPA 2 COMPL., EPA 3 COMPL., EU 3A COMPLIANT, UIC 3A
		D	1000	110	135	1.28	4L	28.8	42.5		2200			115	170	ON, ST-IND	EPA TIER 4, EU STAGE 5, MSHA / CANMET APPROVED
		D	1000	110	135	1.28	6L	30	46.7		2200			180	280	ON, ST-IND	EPA TIER 4, EU STAGE 5, MSHA / CANMET APPROVED
		D	1100	125	145	1.77	6L	40	56.7		1700			240	340	ON, ST-IND	EPA TIER 4, EU STAGE 5, CANMET APPROVED
		D	1300	132	156	2.13	6L	53.3	65		1700			320	390	ON, ST-IND	EPA TIER 4, EU STAGE 5, CANMET APPROVED
		D	1500	139	171	2.6	6L	63.3	80		1700			380	480	ON, ST-IND	EPA TIER 4, EU STAGE 5
PERKINS ENGINES COMPANY LIMITED	181	D	402D-05	67	72	0.5	2L		5.1		3600		7.54		10.2	OH	UN ECE R96 STAGE 3A OR BELOW
		D	402J-05	67	72	0.5	2L		4.4		3000		7.54		8.8	OH	EU STAGE 5, TIER 4F
		D	403D-07	67	72	0.7	3L		5.1		3600		7.44		15.3	OH	UN ECE R96 STAGE 3A OR BELOW
		D	403J-07	67	72	0.7	3L		4.4		3600		7.28		13.3	OH	EU STAGE 5, TIER 4F
		D	403J-11	77	81	1.1	3L		6.3		2800		7.86		18.9	OH	EU STAGE 5, TIER 4F
		D	403D-15	84	90	1.5	3L		8.3		3000		8.04		25	OH	UN ECE R96 STAGE 3A OR BELOW
		D	403D-15T	84	90	1.5	3L		10.0		3000		8.8		30	OH	UN ECE R96 STAGE 3A OR BELOW
		D	403F-15	84	90	1.5	3L		6.1		2100		7.2		18.4	OH	TIER 4F
		D	403J-17	84	100	1.7	3L		6.3		2800		6.43		18.9	OH	EU STAGE 5, TIER 4F
		D	403J-17T	84	100	1.7	3L		6.3		2800		6.84		18.9	OH	EU STAGE 5, TIER 4F
		D	PERKINS SYNCRO 1.7L	84	100	1.7	3L		10.0		2800		9.24		30	OH	TIER 4F
		D	PERKINS SYNCRO 1.7L	84	100	1.7	3L		12.0		2800		12.27		36	OH	EU STAGE 5, TIER 4F
		D	404D-22	84	100	2.2	4L		9.5		3000		8.17		38	OH	UN ECE R96 STAGE 3A OR BELOW
		D	404D-22T	84	100	2.2	4L		11.5		3000		10.8		46	OH	UN ECE R96 STAGE 3A OR BELOW
		D	404D-22TA	84	100	2.2	4L		12.3		2800		11.88		49	OH	UN ECE R96 STAGE 3A OR BELOW
		D	PERKINS SYNCRO 2.2L	84	100	2.2	4L		9.0		2800		9.42		36	OH	TIER 4F
		D	PERKINS SYNCRO 2.2L	84	100	2.2	4L		11.3		2800		12.68		45	OH	EU STAGE 5, TIER 4F
		D	PERKINS SYNCRO 2.2L	84	100	2.2	4L		13.8		2800		14.28		55	OH	EU STAGE 5, TIER 4F
		D	PERKINS SYNCRO 2.8L	90	110	2.8	4L		13.8	2200	2400		13.46		55	OH	EU STAGE 5, TIER 4F OR EU STAGE 3A
		D	PERKINS SYNCRO 2.8L	90	110	2.8	4L		13.8		2400		17.05		55	OH	EU STAGE 5, TIER 4F
		D	PERKINS SYNCRO 3.6L	98	120	3.6	4L		13.8	2200	2400		14.8		55	OH	EU STAGE 5, TIER 4F OR EU STAGE 3A
		D	PERKINS SYNCRO 3.6L	98	120	3.6	4L		20.5	2000	2400		15.71		82	OH	EU STAGE 5, TIER 4F OR EU STAGE 3A
		D	PERKINS SYNCRO 3.6L	98	120	3.6	4L		22.5	2000	2400		17.45		90	OH	EU STAGE 5, TIER 4F OR EU STAGE 3A
		D	PERKINS SYNCRO 3.6L	98	120	3.6	4L		25.0	2000	2200		19.2		100	OH	EU STAGE 5, TIER 4F
		D	1104D-44	105	127	4.4	4L		14.0		2200		7.57		56	OH	UN ECE R96 STAGE 3A OR BELOW
continued		D	1104D-44T	105	127	4.4	4L		18.8		2200		11.2		75	OH	UN ECE R96 STAGE 3A OR BELOW

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
PERKINS ENGINES COMPANY LIMITED	181	D	1104D-44TA	105	127	4.4	4L		20.8		2200		11.94		83	OH	UN ECE R96 STAGE 3A OR BELOW
		D	1104D-E44T	105	127	4.4	4L		18.8		2200		12		75	OH	UN ECE R96 STAGE 3A OR BELOW
		D	1104D-E44TA	105	127	4.4	4L		26.5		2200		15.94		106	OH	UN ECE R96 STAGE 3A OR BELOW
		D	1204J-E44TA	105	127	4.4	4L		27.5	2000	2200		15.99		110	OH	EU STAGE 5, TIER 4F
		D	1204J-E44TTA	105	127	4.4	4L		37.5		2200		23.56		150	OH	EU STAGE 5, TIER 4F
		D	1106D-70TA	105	135	7	6L		18.7		2200		12.06		112	OH	UN ECE R96 STAGE 3A OR BELOW
		D	1106D-E70TA	105	135	7	6L		34.2		2200		18.85		205	OH	UN ECE R96 STAGE 3A OR BELOW
		D	1206J-E70TA	105	135	7	6L		25.2	1800	2200		15.62		151	OH	EU STAGE 5, TIER 4F
		D	1206J-E70TTA	105	135	7	6L		39.8		2200		22.76		239	OH	EU STAGE 5, TIER 4F
		D	1706J-E93TA	115	149	9.3	6L		56.7	1800	2200		28.21		340	OH	EU STAGE 5, TIER 4F
		D	2206D-E13TA	130	157	12.5	6L		64.7	1800	2100		22.27		388	OH	UN ECE R96 STAGE 3A OR BELOW
		D	2406J-E13TA	130	157	12.5	6L		66.7	1800	2100		24.69		400	OH	EU STAGE 5, TIER 4F
		D	2406J-E13TA	130	157	12.5	6L		71.7	1800	2100		26.54		430	OH	EU STAGE 5, TIER 4F
		D	2506J-E15TA	137	171	15.2	6L		72.2	1800	2100		21.95		433	OH	EU STAGE 5, TIER 4F
		D	2806D-E18TTA	145	183	18.1	6L		87.0	1800	2100		22.22		522	OH	UN ECE R96 STAGE 3A OR BELOW
		D	2806C-E18TTA	145	183	18.1	6L		99.5	1800	2100		25.38		597	OH	UN ECE R96 STAGE 3A OR BELOW
		D	2806J-E18TA	145	183	18.1	6L		78.3	1800	2000		20.5		470	OH	EU STAGE 5, TIER 4F
		D	2806J-E18TTA	145	183	18.1	6L		78.3	1800	2000		25.9		597	OH	EU STAGE 5, TIER 4F
		D	402J-05G	67	72	0.5	2L		2.0		1800		4.8		4	PG	EU STAGE 5
		D	403D-11G	77	81	1.1	3L		6.0		3000		6.55	17	18	PG	EU STAGE 3A
		D	403D-15G	84	90	1.5	3L		6.7		3000		5.33	18	20	PG	EU STAGE 3A
		D	404D-22G	84	100	2.2	4L		5.0		1500		7.27		20	PG	EU STAGE 3A
		D	1103D-33G2	105	127	3.3	3L		10.7		1500		7.76		32	PG	EU STAGE 3A
		D	1103D-33G3	105	127	3.3	3L		10.7		1500		7.76		32	PG	EU STAGE 3A
		D	1104D-44TG2	105	127	4.4	4L		14.8		1500		10.73		59	PG	EU STAGE 3A
		D	1104D-44TG3	105	127	4.4	4L		14.8		1500		10.73		59	PG	EU STAGE 3A
		D	1104D-E44TAG1	105	127	4.4	4L		20.3		1500		14.73		81	PG	EU STAGE 3A
		D	1104D-E44TAG2	105	127	4.4	4L		25.3		1500		18.36		101	PG	EU STAGE 3A
		D	1106D-E70TAG2	105	135	7	6L		23.8		1500		16.34		143	PG	EU STAGE 3A
		D	1106D-E70TAG3	105	135	7	6L		26.0		1500		17.83		156	PG	EU STAGE 3A
		D	1106D-E70TAG4	105	135	7	6L		30.3		1500		20.8		182	PG	EU STAGE 3A
		D	2506D-E15TAG2	137	171	15.2	6L		79.7		1500		25.16		478	PG	INDIA CPCBII, EU STAGE 3A
		D	402D-05G	67	72	0.5	2L		2.5		1800		6.67		5	PG	TIER 4F PRE-NTE AND NRTC EMISSIONS STANDARDS
		D	403D-07G	67	72	0.7	3L		2.3		1800		6.95	7	7	PG	TIER 4F PRE-NTE AND NRTC EMISSIONS STANDARDS
		D	403F-11G	77	81	1.1	3L		3.0		1800		5.45	9	9	PG	TIER 4F
		D	403D-11G	77	81	1.1	3L		3.7		1800		6.67	10	11	PG	TIER 4F PRE-NTE AND NRTC EMISSIONS STANDARDS
continued		D	403F-15G	84	90	1.5	3L		4.7		1800		6.22	12	14	PG	TIER 4F

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
PERKINS ENGINES COMPANY LIMITED	181	D	403D-15G	84	90	1.5	3L		5.3		1800		7.11	14	16	PG	TIER 4F PRE-NTE AND NRTC EMISSIONS STANDARDS
		D	404D-22G	84	100	2.2	4L		6.0		1800		7.27	22	24	PG	EPA TIER 4 INTERIM - ESE
		D	404D-22TG	84	100	2.2	4L		8.3		1800		10	30	33	PG	EPA TIER 4 INTERIM - ESE
		D	404D-22TAG	84	100	2.2	4L		9.0		1800		10.91	32	36	PG	EPA TIER 4 INTERIM - ESE
		D	1104D-E44TG1	105	127	4.4	4L		17.5		1800		10.91	64	70	PG	EPA TIER 3
		D	1104D-E44TAG1	105	127	4.4	4L		23.3		1800		14.09	84	93	PG	EPA TIER 3
		D	1104D-E44TAG2	105	127	4.4	4L		27.8		1800		17.42	100	111	PG	EPA TIER 3
		D	1106D-E70TAG2	105	135	7	6L		26.8		1800		15.33	145	161	PG	EPA TIER 3
		D	1106D-E70TAG3	105	135	7	6L		28.8		1800		16.48	157	173	PG	EPA TIER 3
		D	1106D-E70TAG4	105	135	7	6L		33.2		1800		18.95	180	199	PG	EPA TIER 3
		D	1106D-E70TAG5	105	135	7	6L		37.3		1800		21.33	202	224	PG	EPA TIER 3
		D	2206D-E13TAG2	130	157	12.5	6L		63.5		1800		20.32	349	381	PG	EPA TIER 3
		D	2206D-E13TAG3	130	157	12.5	6L		72.5		1800		23.2	381	435	PG	EPA TIER 3
		D	2206F-E13TAG2	130	157	12.5	6L		65.8		1800		20.41	358	395	PG	EPA TIER 4F
		D	2506D-E15TAG1	137	171	15.2	6L		81.7		1800		21.49	435	490	PG	EPA TIER 3
		D	2506C-E15TAG3	137	171	15.2	6L		93.7		1800		23.82	509	562	PG	EPA TIER 2
		D	2506C-E15TAG4	137	171	15.2	6L		99.5		1800		26.18	-	597	PG	EPA TIER 2
		D	2806C-E18TAG3	145	183	18.1	6L		108.7		1800		24.01	592	652	PG	EPA TIER 2
		D	2806F-E18TAG1	145	183	18.1	6L		176.3		1800		20.41	475	529	PG	EPA TIER 4F
		D	2806C-E18TTAG7	145	183	18.1	6L		131.6		1800		30.53	716	790	PG	EPA TIER 2
		D	403D-07G	67	72	0.7	3L		2.0		1500		6.74	5	6	PG	N/A <19KW
		D	403A-11G1	77	81	1.1	3L		3.0		1500		6.55	8	9	PG	FUEL OPTIMISED
		D	403A-15G1	84	90	1.5	3L		4.3		1500		6.93	12	13	PG	FUEL OPTIMISED
		D	403A-15G2	84	90	1.5	3L		5.0		1500		8	14	15	PG	FUEL OPTIMISED
		D	404A-22G1	84	100	2.2	4L		5.0		1500		7.27	18	20	PG	FUEL OPTIMISED
		D	404D-22TG	84	100	2.2	4L		6.8		1500		9.82	25	27	PG	EU STAGE 3A
		D	1103A-33G	105	127	3.3	3L		10.0		1500		7.27	28	30	PG	FUEL OPTIMISED
		D	1104C-44G1	105	127	4.4	4L		10.8		1500		7.82	39	43	PG	FUEL OPTIMISED
		D	1103C-33TG2	105	127	3.3	3L		15.3		1500		11.15	41	46	PG	FUEL OPTIMISED
		D	1103A-33TG1	105	127	3.3	3L		11.5		1500		11.15	41	46	PG	FUEL OPTIMISED
		D	1104C-44TG2	105	127	4.4	4L		14.8		1500		10.73	54	59	PG	FUEL OPTIMISED
		D	1103A-33TG2	105	127	3.3	3L		19.7		1500		14.3	54	59	PG	FUEL OPTIMISED
		D	1104A-44TG1	105	127	4.4	4L		16.0		1500		11.64	58	64	PG	FUEL OPTIMISED
		D	1104A-44TG2	105	127	4.4	4L		19.8		1500		14.36	72	79	PG	FUEL OPTIMISED
		D	1104C-44TAG1	105	127	4.4	4L		19.8		1500		14.36	72	79	PG	FUEL OPTIMISED
		D	1104C-44TAG2	105	127	4.4	4L		25		1500		18.18	90	100	PG	FUEL OPTIMISED
		D	1106A-70TG1	105	135	7	6L		22		1500		14.97	118	131	PG	FUEL OPTIMISED
		D	1106A-70TAG2	105	135	7	6L		24.0		1500		16.46	131	144	PG	FUEL OPTIMISED
		D	1106A-70TAG3	105	135	7	6L		29.2		1500		20	158	175	PG	FUEL OPTIMISED
		D	1106A-70TAG4	105	135	7	6L		31.8		1500		21.83	174	191	PG	FUEL OPTIMISED
		D	1506A-E88TAG4	112	149	8.8	6L		44.5		1500		24.36	244	267	PG	FUEL OPTIMISED
continued		D	1506A-E88TAG5	112	149	8.8	6L		48.8		1500		26.64	268	293	PG	FUEL OPTIMISED

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
PERKINS ENGINES COMPANY LIMITED	181	D	2206A-E13TAG2	130	157	12.5	6L		58.2		1500		22.34	305	349	PG	FUEL OPTIMISED
		D	2206C-E13TAG2	130	157	12.5	6L		58.2		1500		22.34	305	349	PG	FUEL OPTIMISED
		D	2206A-E13TAG3	130	157	12.5	6L		65.3		1500		25.09	349	392	PG	FUEL OPTIMISED
		D	2206C-E13TAG3	130	157	12.5	6L		65.3		1500		25.09	349	392	PG	FUEL OPTIMISED
		D	2506A-E15TAG1	137	171	15.2	6L		72.3		1500		22.84	396	434	PG	FUEL OPTIMISED
		D	2506C-E15TAG1	137	171	15.2	6L		72.5		1500		22.89	396	435	PG	FUEL OPTIMISED
		D	2506A-E15TAG2	137	171	15.2	6L		79.7		1500		26.41	435	478	PG	FUEL OPTIMISED
		D	2506C-E15TAG2	137	171	15.2	6L		79.7		1500		26.41	435	478	PG	FUEL OPTIMISED
		D	2806A-E18TAG1A	145	183	18.1	6L		94.2		1500		25.77	514	565	PG	FUEL OPTIMISED
		D	2806A-E18TAG2	145	183	18.1	6L		101.5		1500		27.71	565	609	PG	FUEL OPTIMISED
		D	2806A-E18TTAG5	145	183	18.1	6L		119.3		1500		32.98	648	716	PG	FUEL OPTIMISED
		D	2806A-E18TTAG7	145	183	18.1	6L		131.7		1800		30.53	716	790	PG	FUEL OPTIMISED
		D	4006-23TAG2A	160	190	23	6L		115.8		1500			632	695	PG	FUEL OPTIMISED
		D	4006-23TAG3A	160	190	23	6L		126.0		1500			675	756	PG	FUEL OPTIMISED
		D	4008TAG1A	160	190	30.6	8L		105.5		1500			767	844	PG	FUEL OPTIMISED
		D	4008-30TAG1	160	190	30.6	8L		105.3		1500			758	842	PG	FUEL OPTIMISED
		D	4008-30TAG2	160	190	30.6	8L		118.4		1500			851	947	PG	FUEL OPTIMISED
		D	4008-30TAG3	160	190	30.6	8L		131.9		1500			947	1055	PG	FUEL OPTIMISED
		D	4008TAG2A	160	190	30.6	8L		118.4		1500			861	947	PG	FUEL OPTIMISED
		D	4012-46TAG0A	160	190	45.8	12V		96.5		1500			1053	1158	PG	FUEL OPTIMISED
		D	4012-46TWG2A	160	190	45.8	12V		97.2		1500			1055	1166	PG	FUEL OPTIMISED
		D	4012-46TAG1A	160	190	45.8	12V		105.3		1500			1148	1263	PG	FUEL OPTIMISED
		D	4012-46TWG3A	160	190	45.8	12V		105.3		1500			1149	1263	PG	FUEL OPTIMISED
		D	4012-46TWG4A	160	190	45.8	12V		111.8		1500			1254	1342	PG	FUEL OPTIMISED
		D	4012-46TAG2A	160	190	45.8	12V		116.3		1500			1267	1395	PG	FUEL OPTIMISED
		D	4012-46TAG3A	160	190	45.8	12V		131.9		1500			1440	1583	PG	FUEL OPTIMISED
		D	4016TAG1A	160	190	61.1	16V		105.6		1500			1537	1690	PG	FUEL OPTIMISED
		D	4016-61TRG1	160	190	61.1	16V		105.3		1500			1558	1684	PG	FUEL OPTIMISED
		D	4016-61TRG2	160	190	61.1	16V		118.4		1500			1684	1895	PG	FUEL OPTIMISED
		D	4016TAG2A	160	190	61.1	16V		117.9		1500			1715	1886	PG	FUEL OPTIMISED
		D	4016-61TRG3	160	190	61.1	16V		130		1500			1875	2083	PG	FUEL OPTIMISED
		D	5008C-E30TAG5	160	190	30.6	8L		66		1800			947	1053	PG	EPA TIER 2
SCANIA	*	D		130	140 - 160	1.9 - 2.1	5L, 6L, 8V	30.6 - 59.8	58.8 - 92.0	1500 - 2100	1800 - 2300			162 - 478	257 - 736		
SIEMENS ENERGY GLOBAL GMBH & CO. KG	243	SI	S - SGE-18SL	152	165	3	6L	42	52.5	1200	1800	14	13	252	350	PG, ST-IND	
		SI	S - SGE-24SL	152	165	3	8L	41.9	52.4	1200	1800	14	12.6	335	453	PG, ST-IND	
		SI	S - SGE-36SL	152	165	3	12V	41.9	52.5	1200	1800	14	13	503	700	PG, ST-IND	
		SI	S - SGE-48SL	152	165	3	16V	41.9	52.4	1200	1800	14	12.6	670	906	PG, ST-IND	
		SI	S - SGE-56SL	160	175	3.52	16V	49.3	61.6	1200	1800	14	14	788	1067	PG, ST-IND	
		SI	S - SGE-56SM	160	175	3.52	16V	65.9	68.75	1500	1800	15	13	1055	1100	PG, ST-IND	
		SI	S - SGE-18SR	152	165	3	6L	46.8	46.8	1800	1800	10.4	10.4	281	281	PG, ST-IND	
		SI	S - SGE-24SR	152	165	3	8L	46.9	46.9	1800	1800	10.4	10.4	375	375	PG, ST-IND	
		SI	S - SGE-36SR	152	165	3	12V	46.8	46.8	1800	1800	10.4	10.4	562	562	PG, ST-IND	
		SI	S - SGE-48SR	152	165	3	16V	46.9	46.9	1800	1800	10.4	10.4	750	750	PG, ST-IND	
continued		SI	S - SGE-56SR	160	175	3	16V	54.4	54.4	1800	1800	10.4	10.4	870	870	PG, ST-IND	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
SIEMENS ENERGY GLOBAL GMBH & CO. KG	243	SI	H - SGE-24HM	152	165	3	8L	65	65	1500	1800	17.4	14.5	520	520	PG, ST-IND	
		SI	H - SGE-42HM	160	175	3.52	12V	86.6	86.6	1500	1800	16.4	19.7	1040	1040	PG, ST-IND	
		SI	H - SGE-56HM	160	175	3.52	16V	65	84.3	1200	1800	16	19.2	1040	1350	PG, ST-IND	
		SI	E - SGE-86EM	195	240	7	12V	172	172	1500	1500	19.2	19.2	2065	2065	PG, ST-IND	
		SI	E - SGE-100EM	195	280	7	12V	172	172	1200	1200	20.7	20.7	2065	2065	PG, ST-IND	
STEYR MOTORS	*	D		85	94	0.5	2L, 4L, 6L		9-37.5		1500-4000		21.1-21.2		26.4-222	ON, OH, PG, ST-IND	
VOLVO PENTA	*	D				0.95 - 2.88	4L, 6L			1500	2500			75 - 593	83 - 655	OH, PG, ST-IND	
WÄRTSILÄ CORPORATION	*	D, DF		20-960	20-3468	8.8-1809	4L, 5L, 6L, 7L, 8L, 9L, 10L, 11L, 12L, 13L, 14L, 12V, 14V, 16V, 18V, 20V	180 - 1150	176 - 5720	61 - 327	76 - 1200	19 - 26	19 - 28	720 - 34,320	800 - 80,080		
WEIFANG HUADONG DIESEL ENGINE CO. LTD.	*	D	4100D	100	115	3.61	L	7.5	12.0	1500	1800	30.1	48	650	914	PG	EURO 2
YANMAR CO., LTD.	175, 177	D	2TNV70	70	74	0.6	2L			2000	3600			6	10.5	OH	
		D	3TN86CHT	86	90	1.6	3L				2600				40.1	OH	
		D	3TNM68	68	72	0.8	3L			1500	3600			6	14.7	OH	
		D	3TNM72	72	74	0.9	3L			1500	3600			7	18.2	OH	
		D	3TNM74F	74	77	1	3L			1800	3600			8	17.8	OH	
		D	3TNV70	70	74	0.9	3L			1500	3600			7	17	OH	
		D	3TNV74F	74	77	1	3L			2400	3000			11	14	OH	
		D	3TNV76	76	82	1.1	3L			1500	3600			9	18.4	OH	
		D	3TNV80F	80	84	1.3	3L			1800	3000			11	17.8	OH	
		D	3TNV80F-Z	80	84	1.3	3L				2800				18.4	OH	
		D	3TNV80FT	80	84	1.3	3L				2600				18.4	OH	
		D	3TNV82A	82	84	1.3	3L			1500	3000			10	23	OH	
		D	3TNV84	84	90	1.5	3L			1500	3000			11	24.6	OH	
		D	3TNV86CHT	86	90	1.6	3L				2600				33.3	OH	
		D	3TNV86CT	86	90	1.6	3L			2500	3000			27	32.4	OH	
		D	3TNV88-B	88	90	1.6	3L			1500	3000			12	27.1	OH	
		D	3TNV88C	88	90	1.6	3L			2400	3000			22	28	OH	
		D	3TNV88F	88	90	1.6	3L			1800	2400			16	18	OH	
		D	3TNV84T	84	90	1.5	3L			1800	2800			19.5	30	OH	
		D	3TNV84T-B	84	90	1.5	3L			1800	2800			18	30	OH	
		D	4TN86CHT	86	90	2.1	4L				2600				55	OH	
		D	4TNV84T	84	90	2	4L			1500	2600			19	36.1	OH	
		D	4TNV84T-B	84	90	2	4L			1500	2600			19	35.7	OH	
		D	4TNV84T-Z	84	90	2	4L			2700	3000			38.3	41.2	OH	
		D	4TNV86CHT	86	90	2.1	4L				2600				48.5	OH	
		D	4TNV86CT	86	90	2.1	4L			1500	3000			23	44	OH	
		D	4TNV88-B	88	90	2.2	4L			1500	3000			16	35	OH	
		D	4TNV88C	88	90	2.2	4L			2200	3000			26.7	35.5	OH	
		D	4TNE92	92	100	2.7	4L			2050	2450			29	35	OH	
		D	4TNE94L	94	110	3.1	4L				2200				35.3	OH	
		D	4TNV94FHT	94	110	3.1	4L			2000	2500			70	88.4	OH	
		D	4TNE98	98	110	3.3	4L				2300				43.7	OH	
continued		D	4TNV98	98	110	3.3	4L			1500	2500			31	52.1	OH	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
YANMAR CO., LTD.	175, 177	D	4TNV98C	98	110	3.3	4L			1500	2500			32	52	OH	
		D	4TNV98CT	98	110	3.3	4L			1500	2500			40	53.7	OH	
		D	4TNV94L	94	110	3.1	4L			2000	2200			35.9	36.2	OH	
		D	4TNV94L-Z	94	110	3.1	4L			2000	2200			35.9	36.2	OH	
		D	4TNV98T	98	110	3.3	4L			1500	2500			37.9	62.5	OH	
		D	4TN101FHT	101	120	3.8	4L			2000	2200			77	85	OH	
		D	4TN101FDT	101	120	3.8	4L			2000	2200			96	105	OH	
		D	4TN107FHT	107	127	4.6	4L			1800	2200			90	110	OH	
		D	4TN107FTT	107	127	4.6	4L			1800	2200			127	155	OH	
		SI	4TN88G	88	90	2.2	4L				2600				44.2	OH	
		SI	4TN98G	98	110	3.3	4L				2500				63	OH	
		D	L100N	86	75	0.4	1L			3000	3600			7	7.4	OH	
		D	L100V	86	75	0.4	1L			3000	3600			6	6.8	OH	
		D	L100W	86	75	0.4	1L				3600				6.8	OH	
		D	L48N	70	57	0.2	1L			3000	3600			3	3.5	OH	
		D	L48V	70	57	0.2	1L			3000	3600			3	3	OH	
		D	L70N	78	67	0.3	1L			3000	3600			5	5	OH	
		D	L70V	78	67	0.3	1L			3000	3600			4	5	OH	
		D	L70W	78	67	0.3	1L				3600				5	OH	
		D	1GM10	75	72	0.3	1L	5.9	6.7	3400	3600			6	7	M	
		D	2YM15	70	74	0.6	2L		5.0		3600				10	M	
		D	3YM20	70	74	0.9	3L		5.0		3600				16	M	
		D	3YM30AE	80	84	1.3	3L		5.0		3200				21	M	
		D	3JH5	88	90	1.6	3L		9.6		3000				29	M	
		D	3JH40	88	90	1.6	3L		9.8		3000				29	M	
		D	4JH3	84	90	2	4L		22.3		3800				89	M	
		D	4JH4	84	90	2	4L	13.8	20.2		3200			55	81	M	
		D	4JH5	88	90	2.2	4L		9.9		3000				40	M	
		D	4JH-CR	88	90	2.2	4L	8.3	10.5		3000			33	42	M	
		D	4JH-CR	84	90	2	4L	14.7	20.2		3200			59	81	M	
		D	4LV	92	104	2.8	4L	27.5	45.8	3500	3800			110	184	M	
		D	8LV	86	96	4.5	8V	29.4	34.0		3800			235	272	M	
		D	6LPA-STP2	94	100	4.2	6L		36.7		3800				220	M	
		D	4LH	100	110	3.5	4L	22.8	44.3	3100	3300			91	177	M	
		D	6LY	106	110	5.8	6L	40.5	54.0	3200	3300			243	324	M	
		D	2GMY	72	72	0.3	2L		4.4	3200	3200				9	M	
		D	3YM27A	76	82	0.4	3L	6.5	7.1	3101	3200	7	7	19	21	M	
		D	4JHYE	78	86	0.4	4L	6.4	7.4	3400	3600			26	29	M	
		D	4CHE3	105	125	1.1	4L	14.4	15.6	2550	2600	6.2	6.7	57	63	M	
		D	4CHL	105	125	1.1	4L	7	13.6	1500	1800	5.7	8.4	28	54	M	
		D	6CHE3	105	125	1.1	6L	14.1	34.3	2550	2600	6.1	14.8	85	206	M	
		D	6CHL	105	125	1.1	6L	7.6	17.8	1500	1800	5.6	10.9	46	107	M	
		D	4HAL2	130	165	2.2	4L	12	22.5	1200	1800	8.1	10.5	72	135	M	
		D	6HA2M	130	165	2.2	6L	34	49.7	1880	1950	9.9	14	204	298	M	
continued		D	6HAL2	130	165	2.2	6L	15	50.8	1200	1800	6.8	15.5	90	305	M	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl)		Rated Speed Range (r/min)		Maximum Brake Mean Effective Pressure (bar)		Output Range (kW)		Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R - Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
								min	max	min	max	min	max	min	max		
YANMAR CO., LTD.	175, 177	D	6LY2M	106	110	1	6L	40.5	46.2		3200	14.7	16.8	243	277	M	
		D	6CXBM-GT	110	130	1.2	6L	44.2	62.3	2400	2700	17.9	22.4	265	374	M	
		D	6HYM	133	165	2.3	6L	61.3	85.8	1950	2200	16.5	20.5	368	515	M	
		D	6AYM	155	180	3.4	6L	80.8	111.7	1840	1940	15	20.4	485	670	M	
		D	6AYL	155	180	3.4	6L	58.8	81.8	1500	1800	11.5	17.2	353	491	M	
		D	12AYM	155	180	3.4	12V	73.5	111.7	1850	1940	14	20.3	882	1340	M	
		D	6AYEM	155	180	3.4	6L	80.8	124.8	1840	2000	15	22.1	485	749	M	
		D	6EY17W	170	230	5.2	6L	62.3	139.5	1350	1450	10.6	22.1	374	837	M	
		D	6EY18(A)LW	180	280	7.1	6L	66.7	133.3	720	1000	12.8	25	400	800	M	
		D	6N21AW	210	290	10	6L	110.3	159.3	800	850	16.5	22.4	662	956	M	
		D	6EY21ALW	210	290	10	6L	146.7	170.0	900	900	19.5	22.6	880	1020	M	
		D	6EY22(A)LW	220	320	12.2	6L	110	250.0	720	1000	14.5	25	660	1500	M	
		D	6EY22AW	220	320	12.2	6L	147.5	228.3	900	900	16.2	25	885	1370	M	
		D	6EY26LW	260	385	20.4	6L	233.3	306.7	720	750	18.3	25	1400	1840	M	
		D	6EY26W	260	385	20.4	6L	245.2	320.0	750	750	19.2	25	1471	1920	M	
		D	8EY26LW	260	385	20.4	8L	237.5	306.3	720	750	18.6	25	1900	2450	M	
		D	8EY26W	260	385	20.4	8L	257.5	320.0	750	750	20.2	25	2060	2560	M	
		D	6EY33LW	330	440	37.6	6L	400	600.0	720	750	17	26.6	2400	3600	M	
		D	6EY33W	330	440	37.6	6L	416.7	560.0		750	17.7	23.8	2500	3360	M	
		D	8EY33LW	330	440	37.6	8L	500	600.0	720	750	21.3	26.6	4000	4800	M	
		D	8EY33W	330	440	37.6	8L	450	562.5		750	19.1	23.9	3600	4500	M	
		D	6NY16LW	160	200	4	6L	33.3	73.5	1000	1200	10	18.3	200	441	M	
		D	6N165LW	165	232	5	6L	58.8	88.3	900	1200	14.2	17.8	353	530	M	
		DF	6EY26DF	260	385	20.4	6L		255.5		750	19.2	20		1533	M	
		DF	8EY26DF	260	385	20.4	8L		255.5		750	19.2	20		2044	M	
		DF	6EY35DF	350	440	42.3	6L		530.0		750	19.3	20.1		3180	M	
		DF	8EY35DF	350	440	42.3	8L		530.0		750	19.3	20.1		4240	M	
		D	AY20L-ET	155	180	20.4	6L	90.7	94.2	1500	1800			544	565	PG	
		D	AY40L-ET	155	180	40.8	12V	92.2	93.9	1500	1800			1106	1127	PG	
		SI	AYG20L-SE	155	180	20.4	6L	63.7	72.3	1500	1800			382	434	PG	
		SI	AYG40L-SE	155	180	40.8	12V	60.2	68.75	1500	1800			722	825	PG	
		D	4JH-CR	84	90	2	4L	14.7	20.2		3200			59	81	M	
		D	4LV	92	104	2.8	4L	27.5	45.8	3500	3800			110	184	M	
		D	8LV	86	96	4.5	8V	29.4	34.0		3800			235	272	M	
		D	6LPA-STP2	94	100	4.2	6L		36.7		3800				220	M	
		D	4LH	100	110	3.5	4L	22.8	44.3	3100	3300			91	177	M	
		D	6LY	106	110	5.8	6L	40.5	54.0	3200	3300			243	324	M	
		D	2GMY	72	72	0.3	2L		4.4	3200	3200				9	M	
		D	3YM27A	76	82	0.4	3L	6.5	7.1	3101	3200	7	7	19	21	M	
		D	4JHYE	78	86	0.4	4L	6.4	7.4	3400	3600			26	29	M	
		D	4CHE3	105	125	1.1	4L	14.4	15.6	2550	2600	6.2	6.7	57	63	M	
		D	4CHL	105	125	1.1	4L	7	13.6	1500	1800	5.7	8.4	28	54	M	
		D	6CHE3	105	125	1.1	6L	14.1	34.3	2550	2600	6.1	14.8	85	206	M	
		D	6CHL	105	125	1.1	6L	7.6	17.8	1500	1800	5.6	10.9	46	107	M	
continued		D	4HAL2	130	165	2.2	4L	12	22.5	1200	1800	8.1	10.5	72	135	M	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Fuel Type D: Diesel or Heavy Fuel DF: Dual Fuel SI: Spark Ignited	Engine Series/Model	Bore (mm)	Stroke (mm)	Displacement (L/cyl)	Cylinders L: In-Line V: Vee-Type H: Horizontal O: Opposed	Output per Cylinder Range (kW/cyl) min	Output per Cylinder Range (kW/cyl) max	Rated Speed Range (r/min) min	Rated Speed Range (r/min) max	Maximum Brake Mean Effective Pressure (bar) min	Maximum Brake Mean Effective Pressure (bar) max	Output Range (kW) min	Output Range (kW) max	Application OH - Off-Highway ON - On-Highway PG - Power Gen M - Marine, ST - IND Stationary Ind, R -Rail	Emissions Level (EPA Tier 3, Euro 4, EU Stage 3a, etc.)
YANMAR CO., LTD.	175, 177	D	6HA2M	130	165	2.2	6L	34	49.7	1880	1950	9.9	14	204	298	M	
		D	6HAL2	130	165	2.2	6L	15	50.8	1200	1800	6.8	15.5	90	305	M	
		D	6LY2M	106	110	1	6L	40.5	46.2		3200	14.7	16.8	243	277	M	
		D	6CXBM-GT	110	130	1.2	6L	44.2	62.3	2400	2700	17.9	22.4	265	374	M	
		D	6HYM	133	165	2.3	6L	61.3	85.8	1950	2200	16.5	20.5	368	515	M	
		D	6AYM	155	180	3.4	6L	80.8	111.7	1840	1940	15	20.4	485	670	M	
		D	6AYL	155	180	3.4	6L	58.8	81.8	1500	1800	11.5	17.2	353	491	M	
		D	12AYM	155	180	3.4	12V	73.5	111.7	1850	1940	14	20.3	882	1340	M	
		D	6AYEM	155	180	3.4	6L	80.8	124.8	1840	2000	15	22.1	485	749	M	
		D	6EY17W	170	230	5.2	6L	62.3	139.5	1350	1450	10.6	22.1	374	837	M	
		D	6EY18(A)LW	180	280	7.1	6L	66.7	133.3	720	1000	12.8	25	400	800	M	
		D	6N21AW	210	290	10	6L	110.3	159.3	800	850	16.5	22.4	662	956	M	
		D	6EY21ALW	210	290	10	6L	146.7	170.0	900	900	19.5	22.6	880	1020	M	
		D	6EY22(A)LW	220	320	12.2	6L	110	250.0	720	1000	14.5	25	660	1500	M	
		D	6EY22AW	220	320	12.2	6L	147.5	228.3	900	900	16.2	25	885	1370	M	
		D	6EY26LW	260	385	20.4	6L	233.3	306.7	720	750	18.3	25	1400	1840	M	
		D	6EY26W	260	385	20.4	6L	245.2	320.0	750	750	19.2	25	1471	1920	M	
		D	8EY26LW	260	385	20.4	8L	237.5	306.3	720	750	18.6	25	1900	2450	M	
		D	8EY26W	260	385	20.4	8L	257.5	320.0	750	750	20.2	25	2060	2560	M	
		D	6EY33LW	330	440	37.6	6L	400	600.0	720	750	17	26.6	2400	3600	M	
		D	6EY33W	330	440	37.6	6L	416.7	560.0		750	17.7	23.8	2500	3360	M	
		D	8EY33LW	330	440	37.6	8L	500	600.0	720	750	21.3	26.6	4000	4800	M	
		D	8EY33W	330	440	37.6	8L	450	562.5		750	19.1	23.9	3600	4500	M	
		D	6NY16LW	160	200	4	6L	33.3	73.5	1000	1200	10	18.3	200	441	M	
		D	6N165LW	165	232	5	6L	58.8	88.3	900	1200	14.2	17.8	353	530	M	
		DF	6EY26DF	260	385	20.4	6L		255.5		750	19.2	20		1533	M	
		DF	8EY26DF	260	385	20.4	8L		255.5		750	19.2	20		2044	M	
		DF	6EY35DF	350	440	42.3	6L		530.0		750	19.3	20.1		3180	M	
		DF	8EY35DF	350	440	42.3	8L		530.0		750	19.3	20.1		4240	M	
		D	AY20L-ET	155	180	20.4	6L	90.7	94.2	1500	1800			544	565	PG	
		D	AY40L-ET	155	180	40.8	12V	92.2	93.9	1500	1800			1106	1127	PG	
		SI	AYG20L-SE	155	180	20.4	6L	63.7	72.3	1500	1800			382	434	PG	
		SI	AYG40L-SE	155	180	40.8	12V	60.2	68.75	1500	1800			722	825	PG	

* This engine builder is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

PLUG-AND-PLAY POWER

Isuzu launching new power units targeting power generation applications. By **Mike Brezonick**

While there is likely never a period when engineering time and resources aren't at a premium for OEMs and distributors, that situation has only been exacerbated by the COVID-19 pandemic. Companies are being stretched thinner than ever and often can dedicate fewer people to product development projects.

In an effort to make the development process simpler, less expensive and less time-consuming for products such as generator sets, light towers and welders, Isuzu Motors America LLC, Plymouth, Mich., is launching a new range of engineered power units designed to take much of the engineering work out of the process.

REDTECH DIESEL

The first of the new power units, based on the company's 4J-Series constant speed (1800 rpm) diesel engines, are being launched now, with 4H-Series and 6H-Series constant speed power units scheduled for release in the fourth quarter and early 2021, respectively.

Part of the company's REDTech (Reliable Eco-Friendly, Durable and Technologically Advanced Diesel Technology) engine range, the Tier 4 final certified 4J-Series diesel is an inline four-cylinder available in constant speed ratings of 95 hp at 1800 rpm and variable speed outputs up to 113 hp at 2200 hp.

The power units are built using common components that provide a range of configuration options, while keeping the same overall footprint, reducing inventory costs and streamlining supply chains, Isuzu said.

The power unit engine incorporates oil pressure, coolant temperature, intake air pressure and temperature and engine speed sensors and shutdowns. The standard power unit package adds an air intake system with dual element air cleaner, exhaust system, a complete cooling package and oil filter.

TURNKEY PACKAGE

The engine and accessories are mounted on a skid base, with the engine positioned on vibration isolators. Isuzu uses a common wire harness across its 4J- and 4H-based power units.

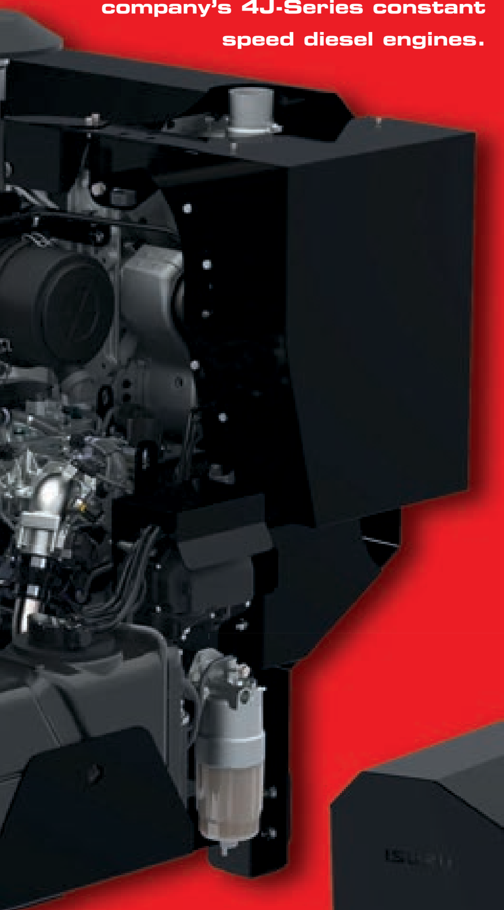
The new 4J-Series power units also include a PCV heater that mitigates PCV line freeze-up and a crankcase pressure switch to prevent damage from excessive crankcase pressure.

"It's basically it's a turnkey package, minus the control panel," said Cody Garcelon, director, Applications and Sales Engineering at Isuzu. "That includes things like urea lines, urea tanks, the supply module and every other electronic or mechanical component.

"There are only two things that we don't sell with the power unit. One is the control panel and the other is the

Canada's Westquip Diesel Sales is using the Isuzu 4J-Series power unit as the foundation of its newest WQ60 generator set rated 60 kW prime and 65 kW standby.

Isuzu Motors America is launching a new range of engineered power units targeting power generation and other stationary applications. The new units are based on the company's 4J-Series constant speed diesel engines.



Along with the company's REDTech (Reliable Eco-Friendly Diesel Technology) 4J-Series diesel, the power units are built using common components that provide a range of configuration options, while keeping the same overall footprint, reducing inventory costs and streamlining supply chains, Isuzu said.

generator. We have 100% validated one complete generator model/frame line, so if they use one of these complete generator designs (power unit, generator, skid base) that makes the installation review process very simple." In addition various cross members for mounting seven different common generator brands/models to the power unit have been designed, he said.

To keep the OEM equipment as compact as possible while accommodating the broadest range of options, Isuzu also has the ability to mount the selective catalytic reduction (SCR) aftertreatment horizontally. At ConExpo, Isuzu debuted its horizontal SCR configuration.

"We had previously had a vertical SCR system and we realized it was not very flexible for some applications," said Ken Martin, director of Sales & Service at Isuzu. "So we've now launched a horizontal version that we're able to apply to applications where there's a requirement for low height or some different positioning. It uses the same SCR components, just in a different location where it can fit the application better."

WESTQUIP GEN-SET

An initial application for the new 4J-Series power unit is a generator set packaged by Westquip Diesel Sales, Ltd. Headquartered in Acheson, Alberta, Canada, Westquip is a 39-year-old engine distributor and packager that also manufactures its own line of engine-powered generator sets, pump sets and light towers.

The company is using the Isuzu 4J-Series power unit as the foundation of its newest WQ60 generator set. An addition to the WQ60 line, the new Tier 4 certified gen-set is rated 60 kW prime and 65 kW standby and uses a single bearing, brushless Stamford Newage alternator with automatic voltage regulation driven by the engine to deliver from 120 to 600 V power at 60 Hz.

"The biggest time savings for engineering was the testing done at Isuzu," said Darren Dumont, operations manager at Westquip. "We used their standard power unit with the rear bell housing mount SCR configuration. No customization was necessary.

"We completed the original prototype generator and shipped it down to them for testing. This probably saved us at least 40 hours – and probably around $4000 savings."

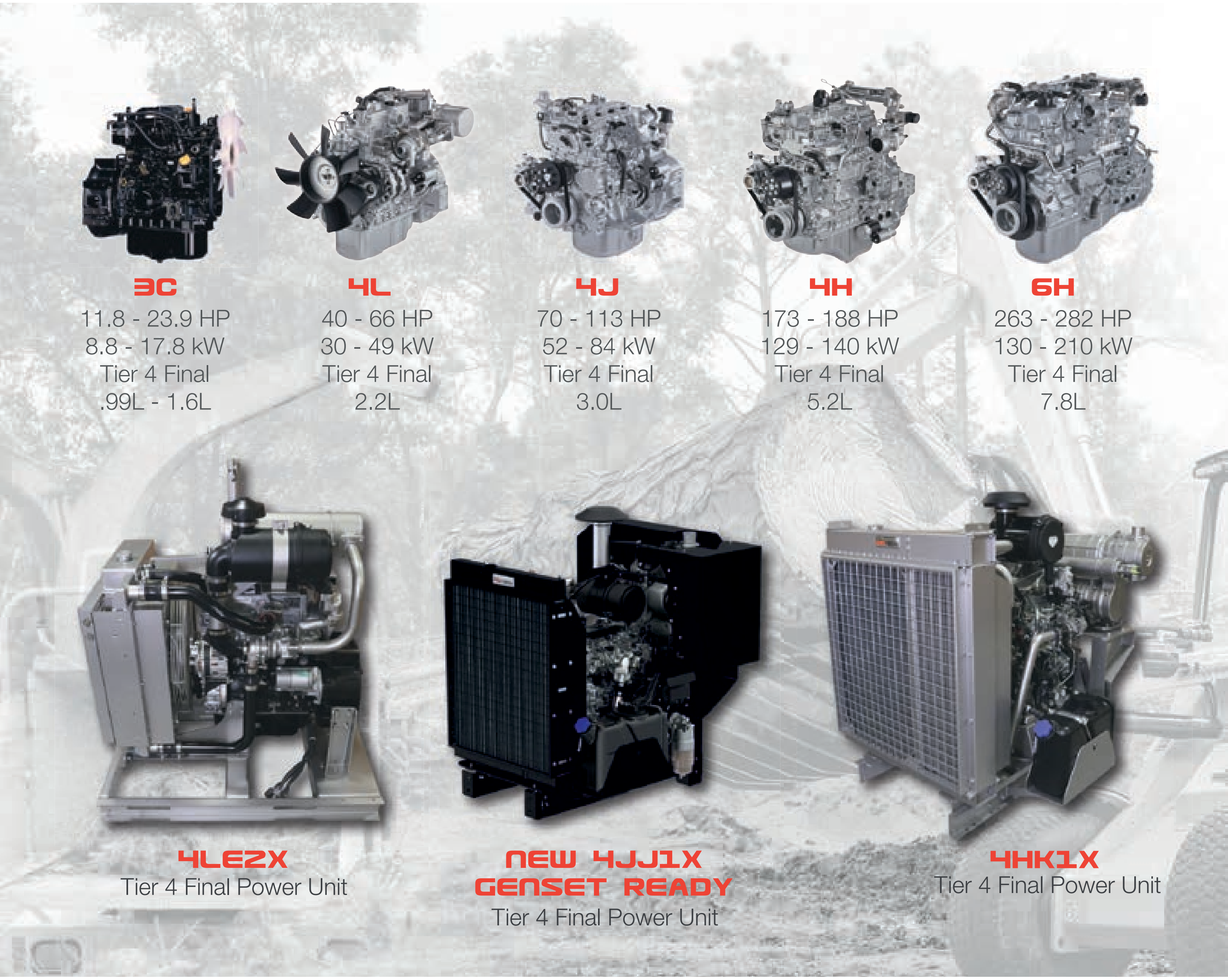
That kind of time – and money – savings is not atypical, Garcelon said.

"In the past, to do all the validation for something like a gen-set, it could take weeks if everything goes great on the first pass," Garcelon said. "With the power units, we're able to do all standard installation tests much quicker, eliminating a lot of time and expense for both the OEM and our network." ■

www.isuzuengines.com

ISUZU

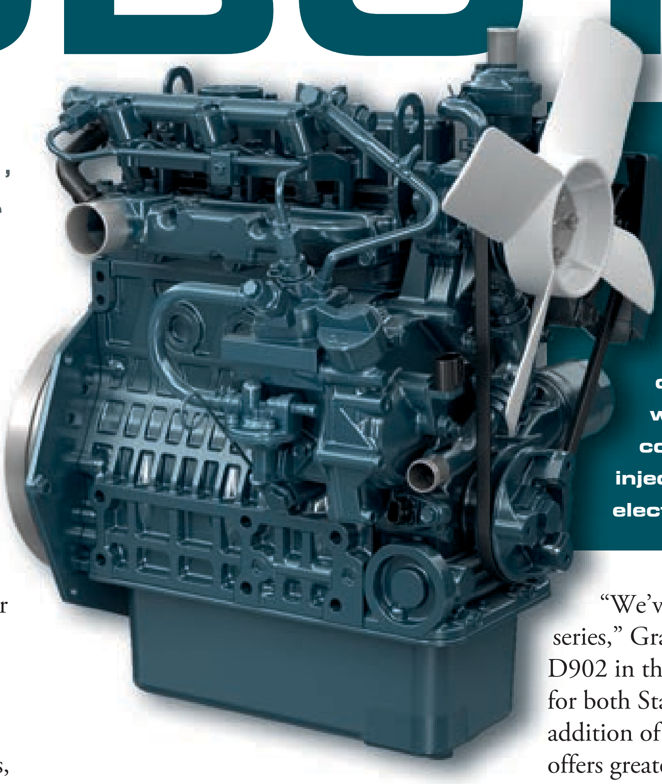
The **power** behind it all.™



We design "the power behind it all" to meet multiple applications with Tier 4 and Stage V emissions requirements built-in for cleaner, fuel efficient power with proven reliability. Isuzu has built over 28 million engines for multiple on- and off-road applications spanning over 100 countries. Our Engines and Power Units are engineered to meet your exact needs and fine-tuned for each application. Ask about our new alternative Dual-Fuel and just released Genset-ready Power Units by contacting us or your local Isuzu Distributor to see how many sizes we can build for you today!

SMALL STILL KUBOTA

With proprietary combustion system, new D902-K Super Mini diesel set for global emissions compliance. By **Mike Brezonick**



Kubota recently launched the D902-K, the company's first diesel under 25 hp (19 kW) to employ an all-new proprietary combustion system with a high-pressure common rail fuel injection system and full electronic controls.

Since it began making diesel engines for dry land applications in the early 1930s, Kubota has forged its reputation as one of the premier global suppliers of smaller displacement diesel engines.

Some might have wondered about that heritage the last couple of years, as the Japanese company successively debuted 200 hp and then 300 hp diesels, its most powerful ever for off-highway applications.

Yet anyone thinking that those bigger engines represented any kind of shift in Kubota's overall engine focus will have to think again after the company recently unveiled what might be its most advanced small diesel yet.

A FIRST FOR KUBOTA

The new D902-K the newest member of the Super Mini engine range, is the company's first diesel under 25 hp (19 kW) to employ an all-new proprietary combustion system incorporating a high-pressure common rail fuel injection and full electronic controls.

And it aptly demonstrates Kubota's ability to innovate on both ends of its engine spectrum at the same time, said Daniel Grant, manager, marketing intelligence for the Kubota engine business unit in Europe.

"We've been progressing for a number of years on starting to establish the brand of Kubota in the higher capacity and higher displacement sector," Grant said. "And definitely, the perception may be that we've focused a lot of effort on our 200 hp and 300 hp offerings.

"But we never lost sight of our legacy markets and the engineering teams and the product development teams have not forgotten or neglected our other important series."

In reality, while it was easy to be distracted by the 200 hp V5009 and 300 hp S7509 launches, a closer look indicates Kubota never slowed the pace of development on its small engine range, introducing the first 902 series engine at ConExpo-Con/Agg in 2017, then following up with a turbocharged version in 2018.

"We've continued to develop the series," Grant said. "We can offer the D902 in the standard mechanical form for both Stage 5 and Tier 4 final. The addition of the turbocharged model offers greater torque performance and is also particularly for applications where altitude can be a factor. Now in addition is the K model with the common rail system.

"It might have seemed like it was done under the radar or it was overlooked because we seemed to focus a lot of our effort on the 200 and now 300 hp offerings. This puts the some much-deserved spotlight back on the smaller categories in our series that Kubota is probably widely recognized for."

TVCR TECHNOLOGY

The D902-K is an inline, liquid-cooled, three-cylinder diesel displacing 0.898 L and bore and stroke dimensions of 72 x 33.6 mm. Maximum rated output is 24.8 hp (18.5 kW) at 3600 rpm, with a maximum torque output of 41.4 lb. ft. (56.1 Nm) at 2600 rpm.

The D902-K is equipped with a new

BIG FOR

Kubota-designed TVCR combustion system equipped with what the company called a one-of-a-kind common rail system that delivers a 5% increase in fuel economy over the mechanically controlled D902, Kubota said.

"When you talk about common rail fuel injection systems, it is normally regarded as a medium- to large-size engine technology, and it is pretty much the industry standard now," said Grant. "Trying to condense that into what is a very, very small engine architecture takes a considerable amount of redesign, particularly around the cylinder head. So the combustion and fuel system have been bespoke designed to suit that engine architecture without compromising in terms of durability, reliability and performance."

NO AFTERTREATMENT

The TVCR and the common rail technology also enables the D902-K to meet EU Stage 5 and U.S. EPA Tier 4 final exhaust emissions regulations without requiring aftertreatment, the company said, along with the China 4 non-road standards scheduled to go into effect next year and the Class 3 rules regulating black smoke emissions in urban environments and low-emissions zones that was implemented in China in 2018.

"It's a challenge for any engine manufacturer to minimize visible smoke practically down to zero," said Grant. "But it's even more of a challenge with smaller compact engines and the type of products in which they are used.

"So part of the overall scope of development was to bring a product to market that could satisfy that Class 3 regulation, that satisfy China 4 and EPA and Stage 5 and do it with the objective to make sure the engine architecture itself is not altered."

That objective was met, as the D902-K has the same external dimensions as the mechanical version – it is 17.1 in. long, 15.8 in. wide and 21.4 in. high (434 mm x 401 mm x 544 mm) – and intake and exhaust positions, engine mount mounting positions and PTOs are also the same. Dry weight is 159 lb. (72 kg)

DESIGNED TO DROP IN

Thus, the D902-K is a virtual drop-in for a broad range of machines using Kubota's D902 engines, including aerial work platforms and access equipment, compact construction equipment such as wheel loaders and mini excavators and turf to name a few. It is also suitable for hybrid applications, the company said.

Another critical benefit to the electronic control is that it utilizes CAN communications protocols, which provides acquisition of engine data and adjustment of operating parameters in real-time, as well as enabling such things as telematics, Grant said.

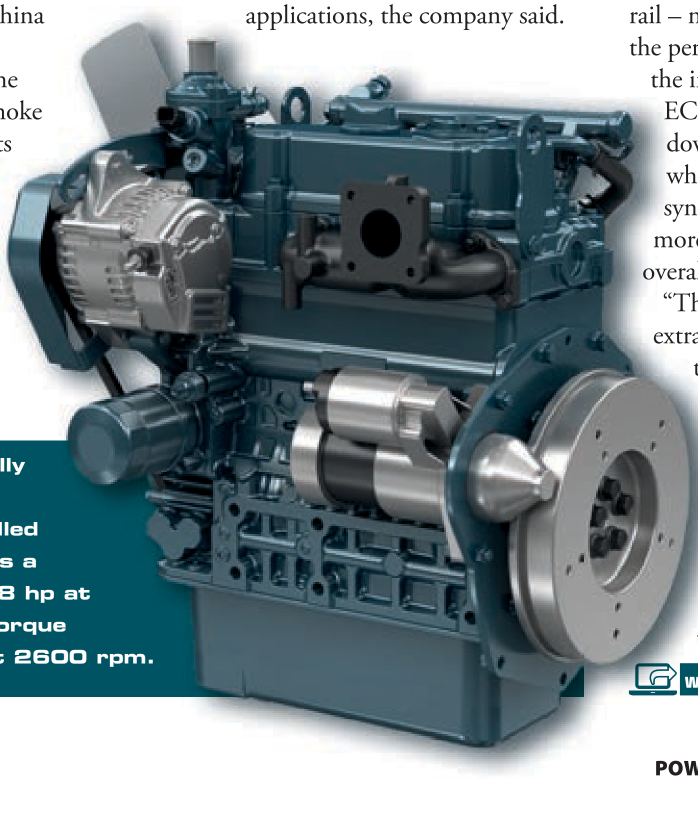
"One of the key things is that the OEM is looking for greater productivity and harmonization in terms of what the engine brings and what it does," Grant said. "this allows us to bring digitalization and electronic control to us to a series that has traditionally been very mechanical, or almost you could say, analog controlled.

"This allows our OEMs that are using ECU control in their medium to upper range products to synchronize right through their product range. It also allows for optimization in terms of customers who are developing things such as diesel hybrid systems where they require CANbus communication and communication links between the machine side and the engine side.

"Traditionally, that was somewhat limited with a mechanical engine. Inevitably there was always going to be an interface between the engine and the machine side where digital had to turn to analog. This new K series model allows us then to bring the advantages of common rail – not just the fuel efficiencies and the performance values – but also the, the interface between the machine ECU and the engine ECU, for the downsizing campaigns we're seeing where customers are looking to synchronize and incorporate a much more compact power unit within their overall machine architecture.

"The K series will bring something extra to the market for those customers that are looking to bring more digitalization, maybe also telemetry and maybe also various other sorts of digital services to their products," he said.

Mass production of the D902-K is scheduled to begin in 2022 at Kubota's engine plant in Japan. ■



While maintaining virtually the same dimensions as the mechanically controlled version, the D902-K has a maximum output of 24.8 hp at 3600 rpm and a peak torque output of 41.4 lb. ft. at 2600 rpm.

www.kubotaengine.com

Reprinted from May 2021 **Diesel Progress**


Enhancing
Kubota 09 Series
4 / 6 cylinder diesel engine
Kubota, The Answer
V4309
4.3-liter 115.7kW
V5009
5-liter 157.3kW
S7509
7.5-liter 228.4kW
For Earth, For Life
Kubota
https://engine.kubota.com

KUBOTA INDUSTRIAL DIESEL ENGINES

KUBOTA 09 SERIES

4 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output rating from 115.7 to 228.4 kW.

Engine model	Emission regulation	Cylinders	Bore and stroke	Displacement	Aspiration	Aftertreatment	Rated output / speed*1	Maximum torque / speed*1	Combustion system	Fuel system	Length x Width x Height*2 (without aftertreatment unit)	Length x Width x Height*3 (with aftertreatment unit)	Dry weight*3
			mm (in)	L (cu.in)			kW (HP) / rpm	Nm (lb-ft) / rpm			mm (in)	mm (in)	kg (lb)
S7509	EPA/CARB Tier 4 + EU Stage Ⅴ ready	6	110.0 x 132.0 (4.331 x 5.197)	7.527 (459.3)	Turbocharged + Turbo after cooler	DOC*5 + DPF*6 + SCR*7	228.4(306.2) / 1900	1324.7 (910.7) / 1500-1600	Direct injection	Common rail system	—	1160 x 713 x 987 (45.7 x 28.1 x 38.9)	1000 (2204.6)
V5009	EPA/CARB Tier 4 + EU Stage Ⅴ	4	110.0 x 132.0 (4.331 x 5.197)	5.018 (306.2)	Turbocharged + Turbo after cooler	DOC + DPF + SCR	157.3 (210.9) / 2200	883.1 (651.3) / 1500-1600	Direct injection	Common rail system	898 x 693 x 967 (35.0 x 27.3 x 38.1)	—	625 (1377)
V4309	EPA/CARB Tier 4 + EU Stage Ⅴ	4	110.0 x 112.0 (4.331 x 4.409)	4.257 (259.8)	Turbocharged + Turbo after cooler	DOC + DPF + SCR	115.7 (155.2) / 2200	649.6 (479.1) / 1500-1600	Direct injection	Common rail system	898 x 649 x 972 (35.4 x 25.6 x 38.3)	—	600 (1323)
V5009	China NR Ⅳ ready (below 130 kW category)	4	110.0 x 132.0 (4.331 x 5.197)	5.018 (306.2)	Turbocharged + Turbo after cooler	DOC + DPF	Net without fan*4: 129.4(173.5) / 2200 Gross intermittent*1: 131.3(176.1) / 2200	Net without fan*4: 850(627) / 1400 Gross intermittent*1: 863(636) / 1400	Direct injection	Common rail system	898 x 656 x 978 (35.4 x 25.8 x 38.5)	—	632 (1393)

KUBOTA V3 SERIES

4 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output rating from 55.4 to 96.4 kW.

Engine model	Emission regulation	Cylinders	Bore and stroke	Displacement	Aspiration	Aftertreatment	Rated output / speed*1	Maximum torque / speed*1	Combustion system	Fuel system	Length x Width x Height*2 (without aftertreatment unit)	Length x Width x Height*3 (with aftertreatment unit)	Dry weight*3
			mm (in)	L (cu.in)			kW (HP) / rpm	Nm (lb-ft) / rpm			mm (in)	mm (in)	kg (lb)
V3800DI-T-E3B	EPA/CARB Tier 3 + EU Stage ⅢA	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	—	74.0 (99.2) / 2600	325.0 (239.7) / 1600	Direct injection	In-line pump	699 x 544 x 793 (27.5 x 21.4 x 31.2)	—	275 (606)
V3800-CR-T-E4B (2600 rpm)	EPA/CARB interim Tier 4 level + EU Stage ⅢB level	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	DOC*5 + DPF*6	74.5 (99.9) / 2600	335.0 (247.1) / 1500	Direct injection	Common rail system	699 x 581 x 852 (27.5 x 22.9 x 33.5)	845 x 581 x 852 (33.3 x 22.9 x 33.5)	325 (717)
V3800-CR-T-E4B (2200 rpm)	EPA/CARB Tier 4 + EU Stage ⅢB + EU Stage Ⅴ	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	DOC + DPF	55.4 (74.3) / 2200	310.0 (228.7) / 1500	Direct injection	Common rail system	699 x 581 x 852 (27.5 x 22.9 x 33.5)	845 x 581 x 852 (33.3 x 22.9 x 33.5)	325 (717)
V3800-CR-TI-E4B	EPA/CARB interim Tier 4 level + EU Stage ⅢB level + EU Stage Ⅴ	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged + Turbo after cooler	DOC + DPF	84.8 (113.7) / 2600	375.1 (276.7) / 1500	Direct injection	Common rail system	699 x 581 x 852 (27.5 x 22.9 x 33.5)	845 x 581 x 852 (33.3 x 22.9 x 33.5)	325 (717)
V3800-TIE4B	EPA/CARB Tier 4 + EU Stage ⅢB	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged + Turbo after cooler	DOC	55.4 (74.3) / 2200	310.0 (228.7) / 1500	Direct injection	Common rail system	699 x 617 x 837 (27.5 x 24.3 x 33.0)	845 x 617 x 852 (33.3 x 24.3 x 33.5)	324 (714)
V3800-CR-T (2200rpm)	EU Stage Ⅴ	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	DOC + DPF	55.4 (74.3) / 2200	310.0 (228.7) / 1500	Direct injection	Common rail system	699 x 581 x 852 (27.5 x 22.9 x 33.5)	845 x 581 x 852 (33.3 x 22.9 x 33.5)	325 (717)
V3800-TIEF4	EPA/CARB Tier 4 Final + EU Stage Ⅳ + EU Stage Ⅴ	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged + Turbo after cooler	DOC + DPF + SCR*7	86.4 (115.9) / 2600	385.0 (284.0) / 1500	Direct injection	Common rail system	699 x 617 x 837 (27.5 x 24.3 x 33.0)	845 x 653 x 1191 (33.3 x 25.7 x 46.89)	400 (882)
V3800-CR-TIEF4H	EU Stage Ⅴ	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged + Turbo after cooler	DOC + DPF + SCR	96.4 (130.9) / 2400	446.6 (324.5) / 1800	Direct injection	Common rail system	699 x 617 x 837 (27.5 x 24.3 x 33.0)	845 x 653 x 1191 (33.3 x 25.7 x 46.89)	400 (882)

KUBOTA 07 SERIES

4 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output rating from 36.5 to 55.4 kW.

Engine model	Emission regulation	Cylinders	Bore and stroke	Displacement	Aspiration	Aftertreatment	Rated output / speed*1	Maximum torque / speed*1	Combustion system	Fuel system	Length x Width x Height*2 (without aftertreatment unit)	Length x Width x Height*3 (with aftertreatment unit)	Dry weight*3
			mm (in)	L (cu.in)			kW (HP) / rpm	Nm (lb-ft) / rpm			mm (in)	mm (in)	kg (lb)
V2607-DI-E3B	EPA/CARB interim Tier 4 level + EU Stage ⅢA	4	87.0 x 110.0 (3.43 x 4.331)	2.615 (159.6)	Naturally aspirated	—	36.5 (48.9) / 2700	170.0 (125.4) / 1600	Direct injection	In-line pump	623 x 481 x 640 (24.5 x 18.9 x 25.2)	—	225 (496)
V2607-DI-T-E3B	EPA/CARB interim Tier 4 + EU Stage ⅢA	4	87.0 x 110.0 (3.43 x 4.331)	2.615 (159.6)	Turbocharged	—	49.2 (66.0) / 2700	220.3 (162.5) / 1600	Direct injection	In-line pump	623 x 481 x 682 (24.5 x 18.9 x 26.9)	—	235 (518)
V2607-CR-T-E4B	EPA/CARB Tier 4 + EU Stage ⅢB	4	87.0 x 110.0 (3.43 x 4.331)	2.615 (159.6)	Turbocharged	DOC*5 + DPF*6	53.0 (71.1) / 2700	225.0 (166.0) / 1600	Direct injection	Common rail system	623 x 522 x 701 (24.5 x 20.6 x 27.6)	833 x 522 x 723 (32.8 x 20.6 x 28.5)	272 (600)
V2607-CR-TI-E4B	EPA/CARB Tier 4 + EU Stage ⅢB	4	87.0 x 110.0 (3.43 x 4.331)	2.615 (159.6)	Turbocharged + Turbo after cooler	DOC	53.0 (71.1) / 2700	225.0 (166.0) / 1600	Direct injection	Common rail system	623 x 522 x 699 (24.5 x 20.6 x 27.5)	821 x 522 x 723 (32.3 x 20.6 x 28.5)	259 (571)
V2607-CR-E5	EPA/CARB Tier4 + EU Stage Ⅴ	4	87.0 x 110.0 (3.43 x 4.331)	2.615 (159.6)	Naturally aspirated	—	42.0 (56.3) / 2700	174.1 (128.4) / 1600	Direct injection	Common rail system	623 x 522 x 700 (24.5 x 20.6 x 27.6)	833 x 522 x 723 (32.8 x 20.6 x 28.5)	267 (589)
V2607-CR-T-E5	EPA/CARB Tier4 + EU Stage Ⅴ	4	87.0 x 110.0 (3.43 x 4.331)	2.615 (159.6)	Turbocharged	DOC + DPF	53.0 (71.1) / 2700	225.0 (166.0) / 1600	Direct injection	Common rail system	623 x 522 x 701 (24.5 x 20.6 x 27.6)	833 x 522 x 723 (32.8 x 20.6 x 28.5)	272 (600)
V2607-CR-TI-E5	EPA/CARB Tier4 + EU Stage Ⅴ	4	87.0 x 110.0 (3.43 x 4.331)	2.615 (159.6)	Turbocharged + Turbo after cooler	DOC + DPF	55.4 (74.3) / 2700	269.0 (198.4) / 1600	Direct injection	Common rail system	623 x 522 x 699 (24.5 x 20.6 x 27.5)	833 x 522 x 723 (32.8 x 20.6 x 28.5)	272 (600)
V3307-DI-T-E3B	EPA/CARB interim Tier 4 + EU Stage ⅢA	4	94.0 x 120.0 (3.70 x 4.724)	3.331 (203.3)	Turbocharged	—	55.4 (74.3) / 2600	265.0 (195.0) / 1600	Direct injection	In-line pump	655 x 500 x 739 (25.8 x 19.7 x 29.1)	—	268 (591)
V3307-CR-T-E4B	EPA/CARB Tier 4 + EU Stage ⅢB + EU Stage Ⅴ	4	94.0 x 120.0 (3.70 x 4.724)	3.331 (203.3)	Turbocharged	DOC + DPF	55.4 (74.3) / 2600	265.0 (195.5) / 1500	Direct injection	Common rail system	655 x 561 x 752 (25.8 x 22.1 x 29.6)	856 x 561 x 752 (33.7 x 22.1 x 29.6)	305 (672)
V3307-CR-TI-E4B	EPA/CARB Tier 4 + EU Stage ⅢB + EU Stage Ⅴ	4	94.0 x 120.0 (3.70 x 4.724)	3.331 (203.3)	Turbocharged + Turbo after cooler	DOC	55.4 (74.3) / 2600	265.0 (195.5) / 1500	Direct injection	Common rail system	655 x 555 x 730 (25.8 x 21.9 x 28.7)	835 x 555 x 744 (32.9 x 21.9 x 29.3)	295 (650)
V3307-CR-T-E5	EPA/CARB Tier4 + EU Stage Ⅴ + China NR Ⅳ	4	94.0 x 120.0 (3.70 x 4.724)	3.331 (203.3)	Turbocharged	DOC + DPF	55.4 (74.3) / 2600	265.0 (195.5) / 1500	Direct injection	Common rail system	655 x 561 x 752 (25.8 x 22.1 x 29.6)	856 x 561 x 752 (33.7 x 22.1 x 29.6)	305 (672)
V3307-CR-TI-E5	EPA/CARB Tier4 + EU Stage Ⅴ	4	94.0 x 120.0 (3.70 x 4.724)	3.331 (203.3)	Turbocharged + Turbo after cooler	DOC + DPF	55.4 (74.3) / 2600	335.0 (247.1) / 1600	Direct injection	Common rail system	655 x 557 x 730 (25.8 x 21.9 x 28.7)	856 x 557 x 749 (33.7 x 21.9 x 29.5)	299 (659)

Specifications are subject to change without notice.
Dimensions and dry weight are according to Kubota's standard specification.
Dimensions and weight depend on completed specifications.

*1 : SAE J1995 gross intermittent *2 : Exclude DPF muffler, SCR muffler, and cooling fan *3 : Exclude cooling fan *4 : ISO14396 *5 : Diesel Oxidation Catalyst (DOC)
*6 : Diesel Particulate Filter(DPF) *7 : Selective Catalytic Reduction(SCR)

KUBOTA INDUSTRIAL DIESEL ENGINES

KUBOTA 03 SERIES

3-4 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output rating from 18.5 to 55.4 kW.

Engine model	Emission regulation	Cylinders	Bore and stroke	Displacement	Aspiration	Aftertreatment	Rated output / speed*1	Maximum torque / speed*1	Combustion system	Fuel system	Length x Width x Height*2 (without aftertreatment unit)	Length x Width x Height*3 (with aftertreatment unit)	Dry weight*3
			mm (in)	L (cu.in)			kW (HP) / rpm	Nm (lb-ft) / rpm			mm (in)	mm (in)	kg (lb)
D1503-M-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	3	83.0 x 92.4 (3.27 x 3.64)	1.499 (91.47)	Naturally aspirated	—	23.8 (31.9) / 2800	94.9 (70.0) / 1600	Indirect injection	In-line pump	547 x 495 x 679 (21.5 x 19.5 x 26.7)	—	148 (326)
D1703-M-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	3	87.0 x 92.4 (3.43 x 3.64)	1.647 (100.5)	Naturally aspirated	—	26.1 (35.0) / 2800	104.3 (76.9) / 1600	Indirect injection	In-line pump	547 x 495 x 679 (21.5 x 19.5 x 26.7)	—	148 (326)
D1703-M-DI-E4B	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	87.0 x 92.4 (3.43 x 3.64)	1.647 (100.5)	Naturally aspirated	—	18.5 (24.8) / 2200	97.4 (71.8) / 1500	Direct injection	In-line pump	547 x 495 x 679 (21.5 x 19.5 x 26.7)	—	148 (326)
D1803-M-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA + EU Stage V	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Naturally aspirated	—	27.9 (37.4) / 2700	115.6 (85.3) / 1600	Indirect injection	In-line pump	551 x 495 x 684 (21.7 x 19.5 x 26.9)	—	151 (333)
D1803-M-DI-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Naturally aspirated	—	27.9 (37.4) / 2700	115.6 (85.3) / 1600	Direct injection	In-line pump	551 x 495 x 684 (21.7 x 19.5 x 26.9)	—	151 (333)
D1803-CR-E4B	EPA/CARB Tier 4 + EU Stage IIIA + EU Stage V	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Naturally aspirated	DOC*4 + DPF*5	28.0 (37.5) / 2700	115.8 (85.4) / 1600	Direct injection	Common rail system	551 x 536 x 711 (21.7 x 21.1 x 28.0)	746 x 536 x 721 (29.4 x 21.1 x 28.4)	185 (407)
D1803-CR-T-E4B	EPA/CARB Tier 4 + EU Stage IIIB + EU Stage V	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Turbocharged	DOC + DPF	37.0 (49.6) / 2700	150.5 (111.0) / 1600	Direct injection	Common rail system	551 x 536 x 742 (21.7 x 21.1 x 29.2)	746 x 536 x 742 (29.4 x 21.1 x 29.2)	196 (432)
D1803-CR-TI-E4B	EPA/CARB Tier 4 + EU Stage IIIB + EU Stage V	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Turbocharged + Turbo after cooler	DOC	37.0 (49.6) / 2700	150.5 (111.0) / 1600	Direct injection	Common rail system	551 x 536 x 728 (21.7 x 21.1 x 28.7)	746 x 536 x 728 (29.4 x 21.1 x 28.7)	195 (430)
D1803-CR-E5B	EPA/CARB Tier4 + EU Stage V	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Naturally aspirated	DOC + DPF	28.0 (37.5) / 2700	115.8 (85.4) / 1600	Direct injection	Common rail system	551 x 536 x 711 (21.7 x 21.1 x 28.0)	746 x 536 x 721 (29.4 x 21.1 x 28.4)	185 (407)
D1803-CR-T-E5	EPA/CARB Tier4 + EU Stage V	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Turbocharged	DOC + DPF	37.0 (49.6) / 2700	150.5 (111.0) / 1600	Direct injection	Common rail system	551 x 536 x 742 (21.7 x 21.1 x 29.2)	746 x 536 x 742 (29.4 x 21.1 x 29.2)	196 (432)
D1803-CR-TI-E5	EPA/CARB Tier4 + EU Stage V	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Turbocharged + Turbo after cooler	DOC + DPF	42.0 (56.3) / 2700	182.7 (134.8) / 1600	Direct injection	Common rail system	551 x 536 x 726 (21.7 x 21.1 x 28.6)	746 x 536 x 745 (29.4 x 21.1 x 29.3)	204 (450)
V2003-M-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	4	83.0 x 92.4 (3.27 x 3.64)	1.999 (122.0)	Naturally aspirated	—	32.6 (43.7) / 2800	130.3 (96.10) / 1600	Indirect injection	In-line pump	642 x 495 x 679 (25.3 x 19.5 x 24.9)	—	180 (397)
V2203-M-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	4	87.0 x 92.4 (3.43 x 3.64)	2.197 (134.1)	Naturally aspirated	—	35.9 (48.1) / 2800	143.2 (105.6) / 1600	Indirect injection	In-line pump	642 x 495 x 679 (25.3 x 19.5 x 24.9)	—	180 (397)
V2403-M-DI-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Naturally aspirated	—	36.5 (48.9) / 2700	158.6 (117.0) / 1600	Direct injection	In-line pump	646 x 495 x 684 (25.4 x 19.5 x 26.9)	—	184 (406)
V2403-M-DI-T-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Turbocharged	—	36.5 (48.9) / 2200	183.0 (135.0) / 1200	Direct injection	In-line pump	646 x 495 x 728 (25.4 x 19.5 x 28.7)	—	201 (443)
V2403-CR-E4B	EPA/CARB Tier 4 + EU Stage IIIB + EU Stage V	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Naturally aspirated	DOC + DPF	37.4 (50.2) / 2700	159.8 (117.9) / 1600	Direct injection	Common rail system	646 x 540 x 711 (25.4 x 21.3 x 28.0)	842 x 540 x 727 (33.1 x 21.3 x 28.6)	221 (487)
V2403-CR-T-E4B	EPA/CARB Tier 4 + EU Stage IIIB + EU Stage V	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Turbocharged	DOC + DPF	48.6 (65.2) / 2700	198.5 (146.4) / 1600	Direct injection	Common rail system	646 x 540 x 735 (25.4 x 21.3 x 28.9)	842 x 540 x 735 (33.1 x 21.3 x 28.9)	233 (514)
V2403-CR-TI-E4B	EPA/CARB Tier 4 + EU Stage IIIB + EU Stage V	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Turbocharged + Turbo after cooler	DOC	48.6 (65.2) / 2700	198.5 (146.4) / 1600	Direct injection	Common rail system	646 x 540 x 728 (25.4 x 21.3 x 28.7)	842 x 540 x 728 (33.1 x 21.3 x 28.7)	232 (511)
V2403-CR-E5	EPA/CARB Tier4 + EU Stage V	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Naturally aspirated	DOC + DPF	37.4 (50.2) / 2700	159.8 (117.9) / 1600	Direct injection	Common rail system	646 x 540 x 711 (25.4 x 21.3 x 28.0)	842 x 540 x 727 (33.1 x 21.3 x 28.6)	221 (487)
V2403-CR-T-E5	EPA/CARB Tier4 + EU Stage V	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Turbocharged	DOC + DPF	50.0 (67.1) / 2700	198.5 (146.4) / 1600	Direct injection	Common rail system	646 x 540 x 735 (25.4 x 21.3 x 28.9)	842 x 540 x 735 (33.1 x 21.3 x 28.9)	233 (514)
V2403-CR-TI-E5	EPA/CARB Tier4 + EU Stage V	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Turbocharged + Turbo after cooler	DOC + DPF	55.4 (74.3) / 2700	248.7 (183.4) / 1600	Direct injection	Common rail system	646 x 540 x 726 (25.4 x 21.3 x 28.6)	866 x 540 x 753 (34.1 x 21.3 x 29.6)	245 (540)

Specifications are subject to change without notice.
Dimensions and dry weight are according to Kubota's standard specification.
Dimensions and weight depend on completed specifications.

*1 : SAE J1995 gross intermittent
*2 : Exclude cooling fan and exclude aftertreatment unit
*3 : Exclude cooling fan and include aftertreatment unit on engine
*4 : Diesel Oxidation Catalyst (DOC)
*5 : Diesel Particulate Filter(DPF)

KUBOTA INDUSTRIAL DIESEL ENGINES

KUBOTA 05 SERIES

3-4 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output rating from 17.5 to 33.0 kW.

Engine model	Emission regulation	Cylinders	Bore and stroke mm (in)	Displacement L (cu.in)	Aspiration	Aftertreatment	Rated output / speed*1 kW (HP) / rpm	Maximum torque / speed*1 Nm (lb-ft) / rpm	Combustion system	Fuel system	Length x Width x Height*2 (without aftertreatment unit) mm (in)	Length x Width x Height*3 (with aftertreatment unit) mm (in)	Dry weight*3 kg (lb)
D1005-E4B (3200rpm)	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	76.0 x 73.6 (2.99 x 2.90)	1.001 (61.08)	Naturally aspirated	—	18.5 (24.8) / 3200	62.2 (45.9) / 2400	Indirect injection	In-line pump	480 x 396 x 605 (18.9 x 15.6 x 23.8)	—	93 (205)
D1005-E4B (3000rpm)	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	76.0 x 73.6 (2.99 x 2.90)	1.001 (61.08)	Naturally aspirated	—	17.5 (23.5) / 3000	62.8 (46.3) / 2200	Indirect injection	In-line pump	480 x 396 x 605 (18.9 x 15.6 x 23.8)	—	93 (205)
D1105-E3B (3600 rpm)	EPA/CARB interim Tier 4 level + EU Stage IIIA	3	78.0 x 78.4 (3.07 x 3.09)	1.123 (68.53)	Naturally aspirated	—	21.7 (29.1) / 3600	65.2 (48.1) / 2600	Indirect injection	In-line pump	480 x 396 x 605 (18.9 x 15.6 x 23.8)	—	93 (205)
D1105-E3B (3000 rpm)	EPA/CARB Tier 4 level	3	78.0 x 78.4 (3.07 x 3.09)	1.123 (68.53)	Naturally aspirated	—	18.5 (24.8) / 3000	71.5 (52.7) / 2200	Indirect injection	In-line pump	480 x 396 x 605 (18.9 x 15.6 x 23.8)	—	93 (205)
D1105-E4B	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	78.0 x 78.4 (3.07 x 3.09)	1.123 (68.53)	Naturally aspirated	—	18.5 (24.8) / 3000	71.5 (52.7) / 2200	Indirect injection	In-line pump	480 x 396 x 605 (18.9 x 15.6 x 23.8)	—	93 (205)
D1105-T-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	3	78.0 x 78.4 (3.07 x 3.09)	1.123 (68.53)	Turbocharged	—	24.5 (32.9) / 3000	88.1 (65.0) / 2000	Indirect injection	In-line pump	480 x 433 x 629 (18.9 x 17.0 x 24.8)	—	97 (214)
D1305-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	3	78.0 x 88.0 (3.07 x 3.46)	1.261 (76.95)	Naturally aspirated	—	21.7 (29.1) / 3000	80.1 (59.1) / 2000	Indirect injection	In-line pump	480 x 396 x 590 (18.9 x 15.6 x 23.2)	—	95 (209)
D1305-E4B	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	78.0 x 88.0 (3.07 x 3.46)	1.261 (76.95)	Naturally aspirated	—	18.5 (24.8) / 2600	80.1 (59.1) / 1700	Indirect injection	In-line pump	480 x 396 x 590 (18.9 x 15.6 x 23.2)	—	95 (209)
V1505-E3B (3600 rpm)	EPA/CARB interim Tier 4 level + EU Stage IIIA	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Naturally aspirated	—	29.0 (38.9) / 3600	87.0 (64.2) / 2600	Indirect injection	In-line pump	565 x 396 x 607 (22.2 x 15.6 x 23.9)	—	110 (243)
V1505-E3B (3000 rpm)	EPA/CARB interim Tier 4 level + EU Stage IIIA	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Naturally aspirated	—	26.5 (35.5) / 3000	93.9 (69.3) / 2200	Indirect injection	In-line pump	565 x 396 x 607 (22.2 x 15.6 x 23.9)	—	110 (243)
V1505-E4B	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Naturally aspirated	—	18.5 (24.8) / 2300	92.6 (68.3) / 1700	Indirect injection	In-line pump	565 x 396 x 607 (22.2 x 15.6 x 23.9)	—	110 (243)
V1505-T-E3B	EPA/CARB interim Tier 4 level + EU Stage IIIA	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Turbocharged	—	33.0 (44.3) / 3000	118.6 (87.5) / 2000	Indirect injection	In-line pump	565 x 433 x 621 (22.2 x 17.0 x 24.4)	—	114 (251)
V1505-CR-TE5	EPA/CARB Tier4 Final + EU Stage V	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Turbocharged	DOC*4 + DPF*5	33.0 (44.3) / 3000	118.6 (87.5) / 2000	Direct injection	Common rail system	758 x 474 x 691 (29.8 x 18.7 x 27.2)	—	173 (381)

KUBOTA SUPER MINI SERIES

2-3 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output rating from 9.9 to 18.5 kW.

Engine model	Emission regulation	Cylinders	Bore and stroke mm (in)	Displacement L (cu.in)	Aspiration	Aftertreatment	Rated output / speed*1 kW (HP) / rpm	Maximum torque / speed*1 Nm (lb-ft) / rpm	Combustion system	Fuel system	Length x Width x Height*2 (without aftertreatment unit) mm (in)	Length x Width x Height*3 (with aftertreatment unit) mm (in)	Dry weight*3 kg (lb)
Z482-E4B	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	9.9 (13.3) / 3600	29.7 (21.9) / 2600	Indirect injection	In-line pump	338 x 386 x 564 (13.3 x 15.2 x 22.2)	—	53 (117)
Z602-E4B	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	2	72.0 x 73.6 (2.83 x 2.90)	0.599 (36.55)	Naturally aspirated	—	12.5 (16.8) / 3600	37.8 (27.9) / 2600	Indirect injection	In-line pump	351 x 401 x 544 (13.8 x 15.8 x 21.4)	—	57 (120)
D722-E4B	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	67.0 x 68.0 (2.64 x 2.68)	0.719 (43.88)	Naturally aspirated	—	14.9 (20.0) / 3600	45.8 (33.8) / 2600	Indirect injection	In-line pump	407 x 386 x 564 (16.0 x 15.2 x 22.2)	—	63 (139)
D902-E4B	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	72.0 x 73.6 (2.83 x 2.90)	0.898 (54.80)	Naturally aspirated	—	18.5 (24.8) / 3600	56.1 (41.4) / 2600	Indirect injection	In-line pump	434 x 401 x 544 (17.1 x 15.8 x 21.4)	—	72 (159)
D902-T	EPA/CARB Tier 4 + EU Stage V	3	72.0 x 73.6 (2.83 x 2.90)	0.898 (54.80)	Turbocharged	—	18.5 (24.8) / 3200	72.2 (53.3) / 2400	Indirect injection	In-line pump	434 x 404 x 544 (17.1 x 15.9 x 21.4)	—	75 (165)
D902-K	EPA/CARB Tier 4 + EU Stage V + China NR IV ready	3	72.0 x 73.6 (2.83 x 2.90)	0.898 (54.80)	Naturally aspirated	—	18.5 (24.8) / 3600	56.1 (41.4) / 2600	TVCR™	TVCR™	434 x 401 x 544 (17.1 x 15.8 x 21.4)	—	72 (159)

KUBOTA EA/OC SERIES

1 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output from 4.5 to 7.0 kW.

Engine model	Emission regulation	Cylinders	Bore and stroke mm (in)	Displacement L (cu.in)	Maximum output / speed*6 kW (HP) / rpm	Continuous output / speed kW (HP) / rpm	Maximum torque / speed*6 Nm (lb-ft) / rpm	Combustion system	Fuel tank capacity	Lubricating oil capacity	Starter capacity	Charging dynamo	Length x Width x Height mm (in)	Dry weight*7 kg (lb)
OC60-E4	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	1	72.0 x 68.0 (2.83 x 2.68)	0.276 (16.8)	4.5 (6.0) / 3600	4.1 (5.5) / 3600	13.2 (9.7) / 2000 to 2600	Indirect injection	3.5 (0.92)	1.3 (0.34)	12 - 0.7	12 - 48 (L1 model: 12 - 170)	403 x 461 x 458 (15.9 x 18.1 x 18.0)	38 (84)
OC95-E4	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	1	83.0 x 77.0 (3.27 x 3.03)	0.416 (25.4)	7.0 (9.4) / 3600	6.25 (8.38) / 3600	21.6 (15.9) / 2300	Indirect injection	5.5 (1.5)	1.7 (0.45)	12 - 1.2	12 - 48 (L1 model: 12 - 170)	451 x 503 x 501 (17.8 x 19.8 x 19.7)	56 (120)
EA330-E4	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	1	77.0 x 70.0 (3.03 x 2.76)	0.325 (19.8)	5.15 (6.91) / 3000	4.4 (5.9) / 3000	17.65 (13.02) / 2000	Indirect injection	4.8 (1.3)	1.3 (0.34)	12 - 1.1	12 - 60	312 x 566 x 457 (12.3 x 22.3 x 18.0)	54 (120)

Specifications are subject to change without notice.
Dimensions and dry weight are according to Kubota's standard specification.
Dimensions and weight depend on completed specifications.

*1 : SAE J1995 gross intermittent *2 : Exclude cooling fan and exclude aftertreatment unit *3 : Exclude cooling fan and include aftertreatment unit on engine
*4 : Diesel Oxidation Catalyst (DOC) *5 : Diesel Particulate Filter(DPF) *6 : SAE J1349 net intermittent *7 : Three Vortex Combustion System(TVCS)

KUBOTA INDUSTRIAL GASOLINE/LPG and NATURAL GAS ENGINES

KUBOTA WG SERIES

3-4 cylinder, 4-cycle liquid-cooled gasoline,LPG and natural gas engines with the maximum output rating from 17.7 to 70.0 kW.

Engine model	Emission regulation	Fuel type	Cylinders	Bore and stroke	Displacement	Aspiration	Aftertreatment	Rated output / speed*1	Maximum torque / speed*1	Length x Width x Height*2	Dry weight*2
				mm (in)	L (cu.in)			kW (HP) / rpm	Nm (lb-ft) / rpm	mm (in)	kg (lb)
WG752-G-E3	EPA Phase 3 / CARB Phase 3 + EU Stage V	Gasoline	3	68.0 x 68.0 (2.68 x 2.68)	0.740 (45.2)	Naturally aspirated	Three-way catalyst	18.5 (24.8) / 3600	56.0 (41.3) / 2400	410 x 397 x 540 (16.1 x 15.6 x 21.3)	62 (137)
WG752-GL-E3	EPA Phase 3 / CARB Phase 3 + EU Stage V	Gasoline	3	68.0 x 68.0 (2.68 x 2.68)	0.740 (45.2)	Naturally aspirated	Three-way catalyst	18.5 (24.8) / 3600	56.0 (41.3) / 2400	410 x 397 x 540 (16.1 x 15.6 x 21.3)	62 (137)
WG752-GL-E3	EPA Phase 3 / CARB Phase 3 + EU Stage V	LPG*3	3	68.0 x 68.0 (2.68 x 2.68)	0.740 (45.2)	Naturally aspirated	Three-way catalyst	17.7 (23.7) / 3600	53.2 (39.2) / 2400	410 x 397 x 540 (16.1 x 15.6 x 21.3)	62 (137)
WG972-G-E3	EPA Phase 3 + EU Stage V	Gasoline	3	74.5 x 73.6 (2.93 x 2.90)	0.962 (58.7)	Naturally aspirated	Three-way catalyst	24.2 (32.5) / 3600	68.6 (50.6) / 2400	434 x 416 x 503 (17.1 x 16.4 x 19.8)	72 (159)
WG972-GL-E3	EPA Phase 3 + EU Stage V	Gasoline	3	74.5 x 73.6 (2.93 x 2.90)	0.962 (58.7)	Naturally aspirated	Three-way catalyst	24.2 (32.5) / 3600	68.6 (50.6) / 2400	434 x 416 x 503 (17.1 x 16.4 x 19.8)	72 (159)
WG972-GL-E3	EPA Phase 3 + EU Stage V	LPG	3	74.5 x 73.6 (2.93 x 2.90)	0.962 (58.7)	Naturally aspirated	Three-way catalyst	23.1 (31.0) / 3600	64.6 (47.6) / 2400	434 x 416 x 503 (17.1 x 16.4 x 19.8)	72 (159)
WG972-G-E4	EPA Phase 3 / CARB Phase 4 + EU Stage V	Gasoline	3	74.5 x 73.6 (2.93 x 2.90)	0.962 (58.7)	Naturally aspirated	Three-way catalyst	24.2 (32.5) / 3600	68.6 (50.6) / 2400	434 x 392 x 503 (17.1 x 15.4 x 19.8)	74 (163)
WG972-GL-E4	EPA Phase 3 / CARB Phase 4 + EU Stage V	Gasoline	3	74.5 x 73.6 (2.93 x 2.90)	0.962 (58.7)	Naturally aspirated	Three-way catalyst	23.2 (31.1) / 3600	66.6 (49.1) / 2400	496 x 392 x 503 (19.5 x 15.4 x 19.8)	78 (172)
WG972-GL-E4	EPA Phase 3 / CARB Phase 4 + EU Stage V	LPG	3	74.5 x 73.6 (2.93 x 2.90)	0.962 (58.7)	Naturally aspirated	Three-way catalyst	22.0 (29.5) / 3600	66.2 (48.8) / 1800	496 x 392 x 503 (19.5 x 15.4 x 19.8)	78 (172)
WG972-L-E4	EPA Phase 3 / CARB Phase 4 + EU Stage V	LPG	3	74.5 x 73.6 (2.93 x 2.90)	0.962 (58.7)	Naturally aspirated	Three-way catalyst	22.0 (29.5) / 3600	66.2 (48.8) / 1800	496 x 392 x 503 (19.5 x 15.4 x 19.8)	77 (170)
WG972-N-E4	EPA Phase 3/ CARB Phase 4 + EU Stage V	CNG*4	3	74.5 x 73.6 (2.93 x 2.90)	0.962 (58.7)	Naturally aspirated	Three-way catalyst	20.4 (27.4) / 3600	63.1 (46.5) / 2000	496 x 392 x 503 (19.5 x 15.4 x 19.8)	77 (170)
WG1605-G-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	42.5 (57.0) / 3600	120.0 (88.6) / 2400	566 x 459 x 692 (22.3 x 18.1 x 27.2)	120 (265)
WG1605-GL-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	42.5 (57.0) / 3600	120.0 (88.6) / 2400	566 x 459 x 692 (22.3 x 18.1 x 27.2)	122 (269)
WG1605-GL-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	41.0 (55.0) / 3600	117.0 (86.3) / 2400	566 x 459 x 692 (22.3 x 18.1 x 27.2)	122 (269)
WG1605-GLN-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	42.5 (57.0) / 3600	120.0 (88.6) / 2400	566 x 459 x 692 (22.3 x 18.1 x 27.2)	122 (269)
WG1605-GLN-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	41.0 (55.0) / 3600	117.0 (86.3) / 2400	566 x 459 x 692 (22.3 x 18.1 x 27.2)	122 (269)
WG1605-GLN-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	NG*5	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	38.4 (51.5) / 3600	110.1 (81.3) / 2600	566 x 459 x 692 (22.3 x 18.1 x 27.2)	122 (269)
WG1605-L-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	41.0 (55.0) / 3600	117.0 (86.3) / 2400	566 x 459 x 692 (22.3 x 18.1 x 27.2)	121 (267)
WG1605-LN-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	41.0 (55.0) / 3600	117.0 (86.3) / 2400	566 x 459 x 692 (22.3 x 18.1 x 27.2)	121 (267)
WG1605-LN-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	NG	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	38.4 (51.5) / 3600	110.1 (81.3) / 2600	566 x 459 x 692 (22.3 x 18.1 x 27.2)	121 (267)
WG1605-N-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	NG	4	79.0 x 78.4 (3.11 x 3.09)	1.537 (93.79)	Naturally aspirated	Three-way catalyst	38.4 (51.5) / 3600	110.1 (81.3) / 2600	566 x 459 x 692 (22.3 x 18.1 x 27.2)	121 (267)
WG1903-G	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	3	88.0 x 102.4 (3.465 x 4.031)	1.868 (114.0)	Naturally aspirated	Three way catalyst	35.0 (46.9) / 2700	133 (98.1) / 1800	551 x 534 x 701 (21.7 x 21.0 x 28.2)	165 (364)
WG1903-GL	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	3	88.0 x 102.4 (3.465 x 4.031)	1.868 (114.0)	Naturally aspirated	Three way catalyst	35.0 (46.9) / 2700	140 (103) / 1400	551 x 534 x 701 (21.7 x 21.0 x 28.2)	167 (368)
WG1903-GL	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	3	88.0 x 102.4 (3.465 x 4.031)	1.868 (114.0)	Naturally aspirated	Three way catalyst	35.0 (46.9) / 2700	140 (103) / 1400	551 x 534 x 701 (21.7 x 21.0 x 28.2)	167 (368)
WG1903-L-LM	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	3	88.0 x 102.4 (3.465 x 4.031)	1.868 (114.0)	Naturally aspirated	Three way catalyst	32.6 (43.7) / 2400	140 (103) / 1400	551 x 549 x 716 (21.7 x 21.6 x 28.2)	172 (380)
WG1903-N	EPA Tier 2 / CARB Tier 3 + EU Stage V	NG	3	88.0 x 102.4 (3.465 x 4.031)	1.868 (114.0)	Naturally aspirated	Three way catalyst	32.5 (43.6) / 2700	132 (97.4) / 1200	551 x 534 x 701 (21.7 x 21.0 x 28.2)	166 (366)
WG2503-G-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	4	88.0 x 102.4 (3.46 x 4.031)	2.491 (152.0)	Naturally aspirated	Three-way catalyst	45.5 (61.0) / 2700	171.0 (126.1) / 1800	646 x 509 x 761 (25.4 x 20.0 x 30.0)	195 (430)
WG2503-GL-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	4	88.0 x 102.4 (3.46 x 4.031)	2.491 (152.0)	Naturally aspirated	Three-way catalyst	45.5 (61.0) / 2700	171.0 (126.1) / 1800	646 x 509 x 761 (25.4 x 20.0 x 30.0)	197 (434)
WG2503-GL-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	88.0 x 102.4 (3.46 x 4.031)	2.491 (152.0)	Naturally aspirated	Three-way catalyst	46.0 (61.7) / 2700	178.0 (131.3) / 1400	646 x 509 x 761 (25.4 x 20.0 x 30.0)	197 (434)
WG2503-L-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	88.0 x 102.4 (3.46 x 4.031)	2.491 (152.0)	Naturally aspirated	Three-way catalyst	46.0 (61.7) / 2700	178.0 (131.3) / 1400	646 x 509 x 761 (25.4 x 20.0 x 30.0)	196 (432)
WG2503-N-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	NG	4	88.0 x 102.4 (3.46 x 4.031)	2.491 (152.0)	Naturally aspirated	Three-way catalyst	42.4 (56.8) / 2700	160.0 (118.0) / 1200	646 x 509 x 761 (25.4 x 20.0 x 30.0)	196 (432)
WG3800-G-E3	EPA Tier 2 / CARB Tier 3	Gasoline	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	65.0 (87.1) / 2600	256.0 (188.9) / 1400	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-G-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	55.4 (74.3) / 2600	256.0 (188.9) / 1400	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-GL-E3	EPA Tier 2 / CARB Tier 3	Gasoline	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	65.0 (87.1) / 2600	256.0 (188.9) / 1400	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-GL-E3	EPA Tier 2 / CARB Tier 3	LPG	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	68.0 (91.1) / 2600	280.0 (206.5) / 1200	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-GL-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	Gasoline	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	55.4 (74.3) / 2600	256.0 (188.9) / 1400	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-GL-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	55.4 (74.3) / 2600	280.0 (206.5) / 1200	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-L-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	70.0 (93.8) / 2600	290.0 (213.9) / 1200	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-L-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	LPG	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	55.4 (74.3) / 2600	290.0 (213.9) / 1200	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-N-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	NG	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	65.0 (87.1) / 2600	269.0 (198.4) / 1200	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)
WG3800-N-E3	EPA Tier 2 / CARB Tier 3 + EU Stage V	NG	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Naturally aspirated	Three-way catalyst	55.4 (74.3) / 2600	269.0 (198.4) / 1200	700 x 579 x 799 (27.6 x 22.8 x 31.5)	288 (635)

Specifications are subject to change without notice. Dimensions and dry weight are according to Kubota's standard specification. Dimensions and weight depend on completed specifications.
LPG: Commercial liquid propane gas only. Equivalent to propane HD-5 of GPA standard.(GPA:Gas Processors Association(U.S.A)) The performance shown is with Japanese standard CNG.
Natural gas: Commercial Compressed Natural Gas only.

*1 : SAE J1995 gross intermittent *2 : Exclude cooling fan and exclude aftertreatment unit *3 : Liquefied Petroleum Gas(LPG) *4 : Compressed Natural Gas(CNG) *5 : Natural Gas(NG)

KUBOTA GENERATOR ENGINES

GENERATOR ENGINES

60Hz

2-4 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output rating from 4.2 to 33.6kW.

Series	Engine model	Emission regulation	Cylinders	Bore and stroke mm (in)	Displacement L (cu.in)	Aspiration	Aftertreatment	Stand-by output / speed*1 kW (HP) / rpm	Continuous output / speed*2 Nm (lb-ft) / rpm	Combustion system	Fuel system	Length x Width x Height*3 (without aftertreatment unit) mm (in)	Length x Width x Height*4 (with aftertreatment unit) mm (in)	Dry weight kg (lb)
KUBOTA SUPER MINI SERIES	Z482-E2 (3600 rpm)	EPA/CARB Tier 2 level	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	8.9 (11.9) / 3600	8.1 (10.9) / 3600	Indirect injection	In-line pump	413 x 386 x 564 (16.3 x 15.2 x 22.2)	—	78 (172)
	Z482-E3 (3600 rpm)	EPA/CARB Tier 4 level	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	8.9 (11.9) / 3600	8.1 (10.9) / 3600	Indirect injection	In-line pump	413 x 386 x 564 (16.3 x 15.2 x 22.2)	—	78 (172)
	Z482-E4 (3600 rpm)	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	8.9 (11.9) / 3600	8.1 (10.9) / 3600	Indirect injection	In-line pump	413 x 386 x 564 (16.3 x 15.2 x 22.2)	—	78 (172)
	D722-E2 (3600 rpm)	EPA/CARB Tier 2 level	3	67.0 x 68.0 (2.64 x 2.68)	0.719 (43.88)	Naturally aspirated	—	13.3 (17.8) / 3600	12.2 (16.4) / 3600	Indirect injection	In-line pump	485 x 386 x 564 (19.1 x 15.2 x 22.2)	—	88 (194)
	D722-E3 (3600 rpm)	EPA/CARB Tier 4 level	3	67.0 x 68.0 (2.64 x 2.68)	0.719 (43.88)	Naturally aspirated	—	13.3 (17.8) / 3600	12.2 (16.4) / 3600	Indirect injection	In-line pump	485 x 386 x 564 (19.1 x 15.2 x 22.2)	—	88 (194)
	D722-E4	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	67.0 x 68.0 (2.64 x 2.68)	0.719 (43.88)	Naturally aspirated	—	13.3 (17.8) / 3600	12.2 (16.4) / 3600	Indirect injection	In-line pump	485 x 386 x 564 (19.1 x 15.2 x 22.2)	—	88 (194)

Series	Engine model	Emission regulation	Cylinders	Bore and stroke mm (in)	Displacement L (cu.in)	Aspiration	Aftertreatment	Stand-by output / speed*1 kW (HP) / rpm	Continuous output / speed*2 Nm (lb-ft) / rpm	Combustion system	Fuel system	Length x Width x Height*3 (without aftertreatment unit) mm (in)	Length x Width x Height*4 (with aftertreatment unit) mm (in)	Dry weight kg (lb)
KUBOTA SUPER MINI SERIES	Z482 (1800 rpm)	—	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	4.4 (5.9) / 1800	4.1 (5.5) / 1800	Indirect injection	In-line pump	428 x 433 x 564 (16.9 x 17.0 x 22.2)	—	81 (179)
	Z482-E4 (1800 rpm)	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	4.2 (5.6) / 1800	3.8 (5.1) / 1800	Indirect injection	In-line pump	428 x 433 x 564 (16.9 x 17.0 x 22.2)	—	81 (179)
KUBOTA 05 SERIES	D1005-E2-BG	EPA/CARB Tier 2 level	3	76.0 x 73.6 (2.99 x 2.90)	1.001 (61.08)	Naturally aspirated	—	9.8 (13.1) / 1800	8.7 (11.7) / 1800	Indirect injection	In-line pump	516 x 391 x 605 (20.3 x 15.4 x 23.8)	—	110 (243)
	D1005-E3-BG	EPA/CARB Tier 4 level	3	76.0 x 73.6 (2.99 x 2.90)	1.001 (61.08)	Naturally aspirated	—	9.8 (13.1) / 1800	8.7 (11.7) / 1800	Indirect injection	In-line pump	516 x 391 x 605 (20.3 x 15.4 x 23.8)	—	110 (243)
	D1005-E4-BG	EPA/CARB Tier 4 (NRTC/NTE test mode)	3	76.0 x 73.6 (2.99 x 2.90)	1.001 (61.08)	Naturally aspirated	—	9.8 (13.1) / 1800	8.7 (11.7) / 1800	Indirect injection	In-line pump	516 x 391 x 605 (20.3 x 15.4 x 23.8)	—	110 (243)
	D1105-E2-BG	EPA/CARB Tier 2 level	3	78.0 x 78.4 (3.07 x 3.09)	1.123 (68.53)	Naturally aspirated	—	11.5 (15.4) / 1800	10.1 (13.5) / 1800	Indirect injection	In-line pump	516 x 391 x 605 (20.3 x 15.4 x 23.8)	—	110 (243)
	D1105-E3-BG	EPA/CARB Tier 4 level	3	78.0 x 78.4 (3.07 x 3.09)	1.123 (68.53)	Naturally aspirated	—	11.5 (15.4) / 1800	10.1 (13.5) / 1800	Indirect injection	In-line pump	516 x 391 x 605 (20.3 x 15.4 x 23.8)	—	110 (243)
	D1105-E4-BG	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	3	78.0 x 78.4 (3.07 x 3.09)	1.123 (68.53)	Naturally aspirated	—	11.5 (15.4) / 1800	10.1 (13.5) / 1800	Indirect injection	In-line pump	516 x 391 x 605 (20.3 x 15.4 x 23.8)	—	110 (243)
	D1305-E3-BG	EPA/CARB Tier 4 level	3	78.0 x 88.0 (3.07 x 3.46)	1.261 (76.95)	Naturally aspirated	—	13.1 (17.6) / 1800	11.6 (15.6) / 1800	Indirect injection	In-line pump	516 x 396 x 590 (20.3 x 15.6 x 23.2)	—	112 (247)
	D1305-E4-BG	EPA/CARB Tier 4 (NRTC/NTE test mode)	3	78.0 x 88.0 (3.07 x 3.46)	1.261 (76.95)	Naturally aspirated	—	13.1 (17.6) / 1800	11.6 (15.6) / 1800	Indirect injection	In-line pump	516 x 396 x 590 (20.3 x 15.6 x 23.2)	—	112 (247)
	V1505-E2-BG	EPA/CARB Tier 2 level	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Naturally aspirated	—	15.1 (20.2) / 1800	13.4 (18.0) / 1800	Indirect injection	In-line pump	601 x 391 x 607 (23.7 x 15.4 x 23.9)	—	127 (280)
	V1505-E3-BG	EPA/CARB Tier 4 level	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Naturally aspirated	—	15.1 (20.2) / 1800	13.4 (18.0) / 1800	Indirect injection	In-line pump	601 x 391 x 607 (23.7 x 15.4 x 23.9)	—	127 (280)
	V1505-E4-BG	EPA/CARB Tier 4 (NRTC/NTE test mode) + EU Stage V	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Naturally aspirated	—	15.1 (20.2) / 1800	13.4 (18.0) / 1800	Indirect injection	In-line pump	601 x 391 x 607 (23.7 x 15.4 x 23.9)	—	127 (280)
KUBOTA 03 SERIES	D1503-M-E4-BG	EPA/CARB Tier 4 (NRTC/NTE test mode)	3	83.0 x 92.4 (3.27 x 3.64)	1.499 (91.47)	Naturally aspirated	—	16.2 (21.7) / 1800	15.1 (20.2) / 1800	Indirect injection	In-line pump	574 x 481 x 643 (22.6 x 18.9 x 25.3)	—	170 (374)
	D1703-E2-BG	EPA/CARB Tier2 level	3	87.0 x 92.4 (3.43 x 3.64)	1.647 (100.5)	Naturally aspirated	—	18.1 (24.3) / 1800	15.1 (20.2) / 1800	Indirect injection	In-line pump	574 x 547 x 643 (22.6 x 21.5 x 25.3)	—	164 (361)
	D1703-M-E3-BG	EPA/CARB interim Tier 4 level	3	87.0 x 92.4 (3.43 x 3.64)	1.647 (100.5)	Naturally aspirated	—	18.1 (24.3)/1800	15.1 (20.2) / 1800	Indirect injection	In-line pump	574 x 481 x 643 (22.6 x 18.9 x 25.3)	—	170 (374)
	D1803-CR-TI-E4-BG	EPA/CARB Tier 4	3	87.0 x 102.4 (3.43 x 4.031)	1.826 (111.4)	Turbocharged + Turbo after cooler	DOC*5	24.2 (32.4) / 1800	20.2 (27.1) / 1800	Direct injection	Common rail system	574 x 536 x 728 (22.6 x 21.1 x 28.7)	746 x 536 x 745 (29.4 x 21.1 x 29.3)	213 (469)
	V2003-T-E2-BG	EPA/CARB Tier2 level	4	83.0 x 92.4 (3.27 x 3.64)	1.999 (122.0)	Turbocharged	—	27.1 (36.3) / 1800	24.5 (32.8) / 1800	Indirect injection	In-line pump	669 x 547 x 674 (26.3 x 21.5 x 26.5)	—	208 (458)
	V2003-M-E3-BG	EPA/CARB interim Tier 4 level	4	83.0 x 92.4 (3.27 x 3.64)	1.999 (122.0)	Naturally aspirated	—	21.8 (29.2) / 1800	18.2 (24.2) / 1800	Indirect injection	In-line pump	699 x 481 x 633 (26.3 x 18.9 x 24.9)	—	200 (441)
	V2003-M-T-E3-BG	EPA/CARB interim Tier 4 level	4	83.0 x 92.4 (3.27 x 3.64)	1.999 (122.0)	Turbocharged	—	27.1 (36.3) / 1800	24.5 (32.8) / 1800	Indirect injection	In-line pump	699 x 484 x 674 (26.3 x 19.1 x 26.5)	—	208 (458)
	V2203-E2-BG	EPA/CARB Tier2 level	4	87.0 x 92.4 (3.43 x 3.64)	2.197 (134.1)	Naturally aspirated	—	24.2 (32.5) / 1800	20.2 (27.1) / 1800	Indirect injection	In-line pump	669 x 547 x 633 (26.3 x 21.5 x 24.9)	—	195 (430)
	V2203-M-E3-BG	EPA/CARB interim Tier 4 level	4	87.0 x 92.4 (3.43 x 3.64)	2.197 (134.1)	Naturally aspirated	—	24.2 (32.5) / 1800	20.2 (27.1) / 1800	Indirect injection	In-line pump	669 x 481 x 633 (26.3 x 18.9 x 24.9)	—	200 (441)
	V2403-M-E3-BG	EPA/CARB interim Tier 4 level	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Naturally aspirated	—	26.5 (35.5) / 1800	22.1 (29.6) / 1800	Indirect injection	In-line pump	669 x 484 x 684 (26.3 x 19.1 x 26.9)	—	204 (449)
	V2403-CR-TI-E4-BG	EPA/CARB Tier 4	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Turbocharged + Turbo after cooler	DOC	33.6 (45.1) / 1800	30.6 (41.0) / 1800	Direct injection	Common rail system	669 x 549 x 728 (26.3 x 21.6 x 28.7)	842 x 549 x 745 (33.1 x 21.6 x 29.3)	250 (551)
	V2403-CR-TI-E4-BG	EPA/CARB Tier 4	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Turbocharged + Turbo after cooler	DOC	33.6 (45.1) / 1800	30.6 (41.0) / 1800	Direct injection	Common rail system	669 x 549 x 728 (26.3 x 21.6 x 28.7)	842 x 549 x 745 (33.1 x 21.6 x 29.3)	250 (551)
KUBOTA V3 SERIES	V3300-E2-BG	EPA/CARB Tier2 level	4	98.0 x 110.0 (3.86 x 4.331)	3.318 (202.5)	Naturally aspirated	—	35.3 (47.3) / 1800	32.1 (43.0) / 1800	Indirect injection	In-line pump	738 x 536 x 746 (29.1 x 21.1 x 29.4)	—	280 (617)
	V3300-E3-BG	EPA/CARB interim Tier 4 level	4	98.0 x 110.0 (3.86 x 4.331)	3.318 (202.5)	Naturally aspirated	—	33.6 (45.1) / 1800	30.6 (41.0) / 1800	Indirect injection	In-line pump	738 x 536 x 746 (29.1 x 21.1 x 29.4)	—	280 (617)
	V3300-T-E2-BG	EPA/CARB Tier2 level	4	98.0 x 110.0 (3.86 x 4.331)	3.318 (202.5)	Turbocharged	—	43.1 (57.8) / 1800	39.1 (52.5) / 1800	Indirect injection	In-line pump	738 x 537 x 800 (29.1 x 21.1 x 31.5)	—	289 (637)
	V3600-T-E3-BG	EPA/CARB interim Tier 4 level	4	98.0 x 120.0 (3.86 x 4.724)	3.620 (220.9)	Turbocharged	—	43.1 (57.8) / 1800	39.2 (52.6) / 1800	Indirect injection	In-line pump	738 x 537 x 800 (29.1 x 21.1 x 31.5)	—	284 (626)
	V3800DI-T-E2-BG	EPA/CARB Tier2 level	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	—	49.5 (66.4) / 1800	44.9 (60.2) / 1800	Direct injection	In-line pump	738 x 544 x 797 (29.1 x 21.4 x 31.4)	—	290 (639)
	V3800DI-T-E3-BG	EPA/CARB Tier3 level	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	—	52.3 (70.1) / 1800	47.5 (63.7) / 1800	Direct injection	In-line pump	738 x 544 x 797 (29.1 x 21.4 x 31.4)	—	290 (639)
	V3800DI-T-E3-BG	EPA/CARB interim Tier 4 level	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	—	50.8 (68.1) / 1800	46.2 (61.9) / 1800	Direct injection	In-line pump	738 x 544 x 797 (29.1 x 21.4 x 31.4)	—	290 (639)
KUBOTA EPA MARINE ENGINE	V2403-M-E4-BG	EPA Marine 2014 Tier 3	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Naturally aspirated	—	24.9 (33.4) / 1800	20.8 (27.9) / 1800	Indirect injection	In-line pump	699 x 484 x 684 (26.3 x 19.1 x 26.9)	—	204 (449)
	V3300-E4-BG	EPA Marine 2014 Tier 3	4	98.0 x 110.0 (3.86 x 4.331)	3.318 (202.5)	Naturally aspirated	—	33.6 (45.1) / 1800	30.6 (41.0) / 1800	Indirect injection	In-line pump	738 x 536 x 746 (29.1 x 21.1 x 29.4)	—	280 (617)

Specifications are subject to change without notice. Dimensions and dry weight are according to Kubota's standard specification. Dimensions and weight depend on completed specifications.

*1 : SAE J1349 Net stand-by *2 : SAE J1349 Net continuous *3 : Exclude cooling fan and exclude aftertreatment unit *4 : Exclude cooling fan and include aftertreatment unit on engine *5 : Diesel Oxidation Catalyst (DOC)

KUBOTA GENERATOR ENGINES

GENERATOR ENGINES

50Hz

2-4 cylinder, 4-cycle liquid-cooled diesel engines with the maximum output rating from 3.6 to 42.9 kW.

Series	Engine model	Emission regulation	Cylinders	Bore and stroke	Displacement	Aspiration	Aftertreatment	Stand-by output / speed*1	Continuous output / speed*2	Combustion system	Fuel system	Length x Width x Height*3 (without aftertreatment unit)	Length x Width x Height*4 (with aftertreatment unit)	Dry weight
				mm (in)	L (cu.in)			kW (HP) / rpm	Nm (lb-ft) / rpm			mm (in)	mm (in)	kg (lb)
KUBOTA SUPER MINI SERIES	Z482-E2 (3000 rpm)	—	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	7.5 (10.1) / 3000	6.9 (9.2) / 3000	Indirect injection	In-line pump	413 x 386 x 564 (16.3 x 15.2 x 22.2)	—	78 (172)
KUBOTA SUPER MINI SERIES	Z482-E3 (3000 rpm)	EPA/CARB Tier 4 level + EU Stage V	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	7.5 (10.1) / 3000	6.9 (9.2) / 3000	Indirect injection	In-line pump	413 x 386 x 564 (16.3 x 15.2 x 22.2)	—	78 (172)
KUBOTA SUPER MINI SERIES	D722-E2 (3000 rpm)	EPA/CARB Tier 2 level	3	67.0 x 68.0 (2.64 x 2.68)	0.719 (43.88)	Naturally aspirated	—	11.3 (15.1) / 3000	10.3 (13.8) / 3000	Indirect injection	In-line pump	485 x 386 x 564 (19.1 x 15.2 x 22.2)	—	88 (194)
KUBOTA SUPER MINI SERIES	D722-E3 (3000 rpm)	EPA/CARB Tier 4 level + EU Stage V	3	67.0 x 68.0 (2.64 x 2.68)	0.719 (43.88)	Naturally aspirated	—	11.3 (15.1) / 3000	10.3 (13.8) / 3000	Indirect injection	In-line pump	485 x 386 x 564 (19.1 x 15.2 x 22.2)	—	88 (194)

Series	Engine model	Emission regulation	Cylinders	Bore and stroke	Displacement	Aspiration	Aftertreatment	Stand-by output / speed*1	Continuous output / speed*2	Combustion system	Fuel system	Length x Width x Height*3 (without aftertreatment unit)	Length x Width x Height*4 (with aftertreatment unit)	Dry weight
				mm (in)	L (cu.in)			kW (HP) / rpm	Nm (lb-ft) / rpm			mm (in)	mm (in)	kg (lb)
KUBOTA SUPER MINI SERIES	Z482 (1500 rpm)	EU Stage V	2	67.0 x 68.0 (2.64 x 2.68)	0.479 (29.23)	Naturally aspirated	—	3.6 (4.8) / 1500	3.4 (4.6) / 1500	Indirect injection	In-line pump	428 x 433 x 564 (16.9 x 17.0 x 22.2)	—	81 (179)
KUBOTA 05 SERIES	D1105-BG2	EU Stage V	3	78.0 x 78.4 (3.07 x 3.09)	1.123 (68.53)	Naturally aspirated	—	9.5 (12.7) / 1500	8.4 (11.3) / 1500	Indirect injection	In-line pump	516 x 391 x 605 (20.3 x 15.4 x 23.8)	—	110 (243)
KUBOTA 05 SERIES	V1505-BG2	EU Stage V	4	78.0 x 78.4 (3.07 x 3.09)	1.498 (91.41)	Naturally aspirated	—	12.5 (16.8) / 1500	11.1 (14.9) / 1500	Indirect injection	In-line pump	601 x 391 x 607 (23.7 x 15.4 x 23.9)	—	127 (280)
KUBOTA 03 SERIES	D1703-E2-BG2	—	3	87.0 x 92.4 (3.43 x 3.64)	1.647 (100.5)	Naturally aspirated	—	15.0 (20.1) / 1500	12.8 (17.2) / 1500	Indirect injection	In-line pump	574 x 547 x 643 (22.6 x 21.5 x 25.3)	—	164 (361)
KUBOTA 03 SERIES	D1703-M-BG2	—	3	87.0 x 92.4 (3.43 x 3.64)	1.647 (100.5)	Naturally aspirated	—	15.0 (20.1) / 1500	12.8 (17.2) / 1500	Indirect injection	In-line pump	574 x 481 x 643 (22.6 x 18.9 x 25.3)	—	170 (374)
KUBOTA 03 SERIES	D1703-M-E4-BG2	EU Stage V	3	87.0 x 92.4 (3.43 x 3.64)	1.647 (100.5)	Naturally aspirated	—	14.5 (19.4) / 1500	13.2 (17.7) / 1500	Indirect injection	In-line pump	574 x 481 x 643 (22.6 x 18.9 x 25.3)	—	170 (374)
KUBOTA 03 SERIES	V2003-M-E3-BG2	—	4	83.0 x 92.4 (3.27 x 3.64)	1.999 (122.0)	Naturally aspirated	—	18.1 (24.3) / 1500	15.5 (20.8) / 1500	Indirect injection	In-line pump	669 x 481 x 633 (26.3 x 18.9 x 24.9)	—	200 (441)
KUBOTA 03 SERIES	V2003-T-E2-BG2	EU Stage IIIA level	4	83.0 x 92.4 (3.27 x 3.64)	1.999 (122.0)	Turbocharged	—	22.5 (30.2) / 1500	20.4 (27.4) / 1500	Indirect injection	In-line pump	669 x 547 x 674 (26.3 x 21.5 x 26.5)	—	208 (458)
KUBOTA 03 SERIES	V2203-E2-BG2	EU Stage IIIA level	4	87.0 x 92.4 (3.43 x 3.64)	2.197 (134.1)	Naturally aspirated	—	20.1 (27.0) / 1500	17.2 (23.1) / 1500	Indirect injection	In-line pump	669 x 547 x 633 (26.3 x 21.5 x 24.9)	—	195 (430)
KUBOTA 03 SERIES	V2203-M-E3-BG2	EU Stage IIIA level	4	87.0 x 92.4 (3.43 x 3.64)	2.197 (134.1)	Naturally aspirated	—	20.1 (27.0) / 1500	17.2 (23.1) / 1500	Indirect injection	In-line pump	669 x 481 x 633 (26.3 x 18.9 x 24.9)	—	200 (441)
KUBOTA 03 SERIES	V2203-M-E4-BG2	EU Stage V	4	87.0 x 92.4 (3.43 x 3.64)	2.197 (134.1)	Naturally aspirated	—	17.0 (22.8) / 1500	15.5 (20.8) / 1500	Indirect injection	In-line pump	669 x 481 x 633 (26.3 x 18.9 x 24.9)	—	200 (441)
KUBOTA 03 SERIES	V2403-M-E3-BG2	EU Stage IIIA level	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Naturally aspirated	—	22.0 (29.5) / 1500	18.8 (25.2) / 1500	Indirect injection	In-line pump	669 x 484 x 684 (26.3 x 19.1 x 26.9)	—	204 (449)
KUBOTA 03 SERIES	V2003-M-T-E3-BG2	EU Stage IIIA level	4	83.0 x 92.4 (3.27 x 3.64)	1.999 (122.0)	Turbocharged	—	22.5 (30.2) / 1500	20.4 (27.4) / 1500	Indirect injection	In-line pump	669 x 484 x 674 (26.3 x 19.1 x 26.5)	—	208 (458)
KUBOTA 03 SERIES	V2403-CR-TE5-BG	EU Stage V	4	87.0 x 102.4 (3.43 x 4.031)	2.434 (148.5)	Turbocharged	DOC*5 + DPF*6	28.1 (37.7) / 1500	25.5 (34.2) / 1500	Direct injection	Common rail system	689 x 552 x 762 (27.1 x 21.7 x 30.0)	—	241 (531)
KUBOTA V3 SERIES	V3300-E2-BG2	EU Stage IIIA level	4	98.0 x 110.0 (3.86 x 4.331)	3.318 (202.5)	Naturally aspirated	—	28.9 (38.8) / 1500	26.3 (35.3) / 1500	Indirect injection	In-line pump	738 x 536 x 746 (29.1 x 21.1 x 29.4)	—	280 (617)
KUBOTA V3 SERIES	V3300-T-E2-BG2	EU Stage II level	4	98.0 x 110.0 (3.86 x 4.331)	3.318 (202.5)	Turbocharged	—	35.3 (47.3) / 1500	32.1 (43.0) / 1500	Indirect injection	In-line pump	738 x 537 x 800 (29.1 x 21.1 x 31.5)	—	289 (637)
KUBOTA V3 SERIES	V3800DI-T-E2-BG2	EU Stage II level	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	—	42.7 (57.2) / 1500	38.8 (52.0) / 1500	Direct injection	In-line pump	738 x 544 x 797 (29.1 x 21.4 x 31.4)	—	290 (639)
KUBOTA V3 SERIES	V3800DI-T-E3-BG2	EU Stage IIIA level	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	—	42.9 (57.5) / 1500	39.0 (52.3) / 1500	Direct injection	In-line pump	738 x 544 x 797 (29.1 x 21.4 x 31.4)	—	290 (639)
KUBOTA V3 SERIES	V3800-CR-TE5-BG	EU Stage V	4	100.0 x 120.0 (3.937 x 4.724)	3.769 (230.0)	Turbocharged	DOC + DPF	42.8 (57.4) / 1500	38.9 (52.2) / 1500	Direct injection	Common rail system	738 x 581 x 855 (29.1 x 22.9 x 33.7)	—	300 (661)

Specifications are subject to change without notice.
Dimensions and dry weight are according to Kubota's standard specification.
Dimensions and weight depend on completed specifications.

*1 : SAE J1349 Net stand-by *2 : SAE J1349 Net continuous *3 : Exclude cooling fan and exclude aftertreatment unit *4 : Exclude cooling fan and include aftertreatment unit on engine
*5 : Diesel Oxidation Catalyst (DOC) *6 : Diesel Particulate Filter(DPF)

KUBOTA Corporation

Head Office: 2-47, Shikitsuhigashi 1-chome, Naniwa-ku, Osaka, Japan Fax: 06-6648-3521 **https://global.engine.kubota.co.jp/en/**
Kubota Engine America Corporation: 505 Schelter Road, Lincolnshire, IL 60069 Phone: 847-955-2500 Fax: 847-955-2699 **http://www.kubotaengine.com**
Kubota Europe S.A.S.: 19-25, rue Jules Vercruysse BP 50088 95101 Argenteuil cedex France Phone: 33-1-34-26-34-34 Fax: 33-1-34-26-34-66 **https://www.kubota-eu.com**
Kubota (Deutschland) GmbH: Senefelder Str., 3-5, 63110 Rodgau/Nieder-Roden, Germany Phone: (0) 6106-873-113 Fax: (0) 6106-873-196 **https://www.kubota-eu.com**
Kubota (U.K.) Ltd.: Dormer Road, Thame Oxfordshire, OX9 3UN United Kingdom Phone: 01844-214-500 Fax: 01844-216-685 **https://www.kubota-eu.com**
Kubota Engine (Shanghai) Co.,Ltd.: 6F, Tower 1, Kerry Everbright City, No.128 Tian Mu Road West, Jingan District, Shanghai, China, 200070 Phone: (86)-21-6236-0606 Fax: (86)-21-6236-0637 **http://www.kubota.com.cn/kesco**
Kubota Agricultural Machinery India Pvt.,Ltd.: 94, TVH BELICIAA TOWERS-1, 8th floor, MRC Nagar, Chennai, 600028, India Phone: (91)-44-6104-1500 Fax: (91)-44-6104-1600 **https://www.kubota.co.in/**
Kubota Australia Pty Ltd.: 25-29 Permas Way, Truganina 3029, Victoria, Australia Freecall: 1800 334 653 Email: sales@kubota.com.au **https://www.kubota.com.au/**

10 MILLION AND COUNTING

Cummins eclipses operating hours milestone with Tier 4 final high horsepower engines.

By **Mike Brezonick**

Cummins recently exceeded 10 million operating hours for its Tier 4 final high horsepower diesel engines. One of the earliest and highest-hour applications for the company was the QSK50 engine in hydraulic fracturing rigs.

Ten million is a lot of anything. Jamming 10 million hours into the space of five years – chronologically just short of 44,000 hours – is an accomplishment in itself.

But when you're talking 10 million operating hours for engines that meet the EPA's stringent Tier 4 final exhaust emissions standards, that's where it becomes remarkable.

That's the benchmark that Indiana-based engine manufacturer Cummins recently exceeded with its Tier 4 final high horsepower engines.

"That's cumulative across that engine range," said Gary Johansen, executive director – Power Systems Engineering at Cummins. "We just recently eclipsed that with the Tier 4 product.

"Some are in low-hour applications and some are in very high-hour applications. We think however you look at it, it's a lot of hours."

It's a lot of hours in a lot of different types of machines and equipment. The Cummins high horsepower product line begins at 19 L displacement and ranges to 95 L with the QSK95 launched in 2011 *(see related chart)*. The engines are used in a diverse array of machines and equipment, everything from generator sets to locomotives, large mine haul trucks and marine vessels.

"It was 2015 when we really got started," said Johansen. "We had some engines in field test before that, but frankly the hours rack up a lot faster when you get more units in the field."

FRAC RIGS COME FIRST

One of the first Tier 4 final high horsepower applications was the Tier 4 QSK50 engine for frac rigs. "The frac rig engines probably have the most hours." Johansen said. "They run them long and hard and there's a pretty good-sized installed base that's clocking a lot of hours."

In developing its Tier 4 final engines, Johansen said that Cummins tried to take a fresh look how they could improve and enhance the various subsystems used to make up the modern diesel engine. One advantage that the company has is the fact that Cummins is among the most vertically integrated engine manufacturers in the world, with in-house expertise in critical areas like turbocharging, fuel injection, engine controls, filtration and aftertreatment.

"In many cases, we didn't just optimize the combustion system or optimize the aftertreatment to meet emissions," he said. "We actually went deeper into the engine and asked ourselves, where can we continue our relentless push on improving the diesel engine? What can we do to improve cylinder heads, improve power cylinders, improve bearings, improve geartrains and any other systems?

"We went through each of those systems and said these are all places where we want to continue to push to improve the reliability of our solutions. And we're really pleased with how they're looking right now. Some of them have been out there five years, some of them less than a year, and we're seeing really good results."

As with all engine developments, key design targets included reliability, durability and fuel economy and critically, making sure the Tier 4 final package could work in the same machine spaces as the earlier engines. "One of the things we wanted to make sure we did as we went to Tier 4 was minimize the machine integration impact for OEM customers," Johansen said. "It was very important to essentially make it so that, for example, the aftertreatment could fit wherever the muffler was before. We didn't want to take up a bigger space claim."

IN-HOUSE TECHNOLOGY

As it has in many situations, Cummins leveraged the in-house capabilities of its components group, specifically Cummins Emission Solutions, to find an answer. It came in the form of the company's Single Module Aftertreatment system, a next-generation technology that combines advanced DPF and SCR catalyst technologies with the liquid-only urea dosing system (UL2) to deliver an aftertreatment module that is up to 60% smaller and 40% lighter than previous systems.

"Our Single Module aftertreatment system is just another evolutionary approach to continually improving the packaging, the simplicity, the conversion efficiency and the system level reliability," Johansen said. "Those are the kinds of things we're continuing to push on.

"We have a mix of external suppliers for example in fuel systems, for but we have our own our air handling, electronics and controls. Those are some of the things that we feel you have to do yourself if you're going to have the best in class. If you look at turbomachinery and how we're able to match the compressors and the turbine stages, how we're able to integrate how the engine behaves with what the exhaust aftertreatment needs.

"If you think about what comes out of the cylinders of an engine, that's the feed gas for your exhaust aftertreatment system. So you need to be able to not only just have high conversion in the exhaust after treatment, but you need to be able to optimize what's coming out of the engine so that you can minimize your fluid consumption. You can maximize the life of the aftertreatment, you can improve fuel economy, and a lot of that capability is within Cummins.

"We have some important outside suppliers, but I would not want to go into battle without some of our own integrated technologies. They are very, very important and I would argue they are game changers for us."

Yet Johansen stressed that when engineering the Tier 4 engines, Cummins looked well beyond emissions compliance. "One of the things we did in optimizing the Tier 4 solution was think a lot about the responsiveness of the engine," he said. "The ability to pick up the load in a frac rig, to accelerate in a rail application or to climb out of the pit in a mine – we really looked at all of that."

LOCOMOTIVE POWER

The company has expanded in the rail market, where the QSK95 was selected by Siemens Mobility to power its high-speed diesel-electric Charger locomotive with 85 units currently in revenue service. In 2018, Amtrak announced it had selected the Siemens Charger powered by the QSK95, to replace its aging fleet of locomotives. Engine deliveries started last year.

"That's a really important application for us," Johansen said. "If you look inside the locomotive, you can see there is a lot to manage in terms of the thermal loads inside the engine compartment and the electrical integration to the drive system. Working very closely with Siemens, we were able to accomplish a lot of great integration work there.

"One of the things we've heard back from both the locomotive engineers as well as passengers is the really low vibration and low noise of the QSK95. It's been very noticeable and it's something they really like."

Cummins continues to invest in Tier 4 solutions and is currently developing the QST30 for switcher locomotives.

Mining is another important high horsepower application for Cummins, Johansen said.

"These trucks can spend 45 minutes climbing out of a pit with 400 tons of ore in the back at a 15,000 ft. altitude in extremely dusty applications where it's -40° C in the winter and plus 40° C in the summer," he said. "And they just keep running.

"We launched our 78 L Tier 4 engine for mining and the feedback from the haul truck drivers has been phenomenal."

Cummins has also continued to

THE CUMMINS HIGH HORSEPOWER ENGINE LINEUP

ENGINE	DISP. (L)	HORSEPOWER	TORQUE (LB. FT.)
QSK95	95	3000 – 5100	11,641 – 17,802
QSK78	78	3500	10,175
QSK60	60	1875 – 1398	6169 – 8274
QSK50	50	1478 – 2500	1800 – 7080
QSK45	45	1200 – 2000	4425 –5805
QST30	30	760 – 1500	1800 – 4877
QSK23	23 L	760 – 950	2410 – 2897
QSK19	19	506 – 800	1775 – 2032

expand its Tier 4 high horsepower marine business, particularly with the QSK95. Most notably, the engine is being used by Seacor Marine in some of its newest fast supply vessels. Built by Spanish shipbuilder Astilleros Armon, the Secor Puma and Secor Panther are 187.8 ft. catamarans, each powered by four 4000 hp QSK95 diesels that drive Hamilton HT-810 water jets through Twin Disc MGX-62500SC-H marine transmissions.

"It has is two QSK95s in each hull," Johansen said. "It's really a high-performing vessel and it's a sight to behold. We've also delivered some engines for some passenger ferries around the world, so we have a good bit of variation in the marine market.

"Marine is just a different market compared to what might be a more typical OEM market, like a mining truck OEM or a locomotive OEM. In marine, there is just not that monolithic OEM base. But we are fortunate that especially through our distribution business, we've been able to establish some great relationships with some of the leading vessel designers and naval architects who are looking for high performance, high speed diesels. If you look at the power density we're delivering for the weight and for the package size, the QSK95 is

Rail has been an key segment for Cummins Tier 4 high horsepower diesels. A QSK95 diesel has been in test with the Indiana Rail Road and Amtrak is using the engine in new Siemens Charger locomotives.

really well suited for marine and we're getting more first fit opportunities there."

POWER FOR POWER GEN

The very first application for the QSK95 was in power generation and that continues to be a prime market. "We have standby generators with the QSK95 in data centers, hospitals and banks all over the world," Johansen said. "We also have prime power gen-sets that never turn off. They're the only source of power and they're running 9000 hours a year. We have applications running in the Arctic Circle where they are the only source of electrical power at the site. If the gen-sets go down, that's it. We are supporting life, health and safety."

That, Johansen said, points to another key target of Cummins' Tier 4 final development program – reliability.

"You can't be in the equation unless you're at 98.5%, 99%," he said. "If you talk to a data center customer, they talk about 'five nines' availability. It's all based on the application, but that's where you have to be or the customer is not going to be happy."

Finally, along with improved performance and high reliability, Johansen said the engines have demonstrated a noticeable improvement in perhaps the most important aspect in any engine application, fuel economy.

"We've learned that our solution is saving our customers a lot of fuel and saving a lot of money," Johansen said. "That was really an important element of us delivering our Tier 4 final solution. We had to deliver value to the customer, alongside meeting the challenge of the 80% particulate reduction and a 45% NOx reduction that the regulations called for."

BETTER THAN EXPECTED

Overall, Johansen said that the engines are delivering about a 5% fuel economy improvement over their predecessors, depending on the application.

"When we started, we estimated we'd be at parity, or would be 1 or 2% better," he said. "In some cases, we thought that could be a lot higher – up to 10%. Because there are so many variants and variant factors and so may qualifiers concerning the duty cycle, the use case, the load profiles, all of those things, we were nervous about just saying one number because if you do, you know it's going to be remembered forever. And if you know us at Cummins, we try to underpromise and overdeliver.

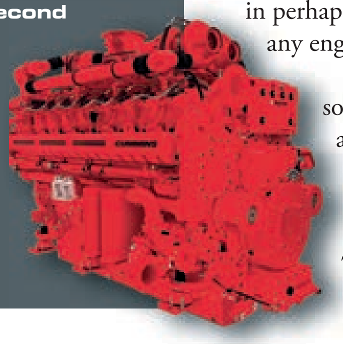
"Our Tier 4 four engines are averaging dependent on the duty cycle - about 5%, more fuel efficiency than their Tier 2 predecessors. We've learned that over a wide range of applications and duty cycles, we're seeing a pretty solid fuel economy advantage. We've done quite a bit of calculation and as near as we can tell, we've saved customers about $30 million in fuel going from Tier 2 to Tier 4.

"You have to bring those kinds value offsets when you when you're bringing a more expensive solution to the market, which of course, we did with Tier 4. But in most cases, our high horsepower customers have been very satisfied." ■

www.cummins.com

FAST FACTS

- Engines above 19 L in displacement are part of the company's Power Systems segment, which accounts for approximately 15% of the company's overall revenue.
- Within the Power Systems segment, Industrial applications are second to Power Generation in sales, accounting for about 35% of the unit's overall sales, which was $4.5 billion in 2019.



Over the years Lister Petter has become a household name for many companies worldwide. In some places an engine is not just an engine, its a 'Lister'. Our engines and generating sets can be found on every continent and in almost every country in the world. This has been the back bone of the company and has pushed everybody involved in Lister Petter to achieve more and deliver nothing but the best.

Lister Petter engines are adapted to a diverse range of applications including generating sets, pumps, agricultural machinery, construction plant and emergency equipment operating reliably in all conceivable ambient conditions. From the freezing sub-zero temperatures of China and Northern Russia, to the scorching heat of the deserts in the Middle East, India and the vast plains of Africa. Over recent years Lister Petter has changed ownership but it is proud to remain a 100% British owned business with all of its manufacturing and assembly still within its home county of Gloucestershire.

The engines are capable of continuous operation at prime, not standby power. As a result, the engines with proper planned maintenance and overhaul can be operated 24/7.

The engines are designed to help the operator with service intervals from 250-2000hrs reducing the time and expense required to travel to remote locations for planned maintenance, with all the service parts on one side enabling easier access when fitted to equipment, and a wide range of accessories to support the majority of applications.

T SERIES	ALPHA SERIES
TR1 | TR2 | TR3	LPW2 | LPW3 | LPW4 | LPWT4
air cooled	liquid cooled
5.5 - 28.5 kW	6.8 - 37.5 kW
7.4 - 38.0 bhp	9.1 - 50.3 bhp
fixed speed 1500 | 1800 r/min	fixed speed 1500 | 1800 | 3000 | 3600 r/min
variable speed 1500-2500 r/min	variable speed 1500-3600 r/min
1, 2 or 3 cylinders	2, 3 or 4 cylinders
ALPHA MAX SERIES	**GAMMA SERIES**
LPWX2 | LPWX3 | LPWX4	GW3 | GWT3 | GW4 | GWT4 | GW6-1A | GW6-2A | GWTA6
liquid cooled	liquid cooled
7.9 - 32.4 kW	17.0 - 158.5 kW
10.6 - 43.4 bhp	22.8 - 212.4 bhp
fixed speed 1500 | 1800 | 3000 | 3600 r/min	fixed speed 1500 | 1800 r/min
variable speed 1500-3000 r/min	variable speed 1000-2200 r/min
2, 3 or 4 cylinders	3, 4 or 6 cylinders

BRITISH ENGINEERING AT ITS BEST

LISTER PETTER
POWER SYSTEMS

LAT GENSETS	LWA GENSETS
LAT8(A) LAT15(A) LAT24(A)	LWA10(A) | LWA15(A) LWA20(A) | LWA27(A) LWA14(A) | LWA22(A) LWA30(A) | LWA41 (A)
air cooled	liquid cooled
50 Hz, 1500 r/min 4.4 - 20.2 kVA	50 Hz, 1500 | 3000 r/min 5.8 - 39.2 kVA
60 Hz, 1800 r/min 5.4 - 24.9 kVA	60 Hz, 1800 | 3600 r/min 7.1 - 31.3 kVA
1, 2 or 3 cyl engine	2, 3 or 4 cyl engine
LWX GENSETS	**GAMMA GENSETS**
LWX13(A) | LWX20(A) LWX27(A) | LWX16(A) LWX25(A) | LWX34(A)	LLG30(A) | LLG45(A) LLG60(A) | LLG90(A) LLG100(A) | LLG135(A) LLG150(A) | LLG160(A) LLG180(A)
liquid cooled	liquid cooled
50 Hz, 1500 | 3000 r/min 6.5 - 33.9 kVA	50 Hz, 1500 r/min 30.0 - 180.0 kVA
60 Hz, 1800 | 3600 r/min 8.0 - 34.1 kVA	60 Hz, 1800 r/min 34.0 - 150.0 kVA
2, 3 or 4 cyl engine	3, 4 or 6 cyl engine

Stage V CERTIFIED

LPP PETROL GENSETS	
LPP2.5RE | LPP2.8RE | LPP6.0RE LPP6.6RE | LPP7.0RE | LPP8.3RE	
single cylinder, air cooled engine	
50 Hz | 3000 r/min 2.5 - 7.0 kVA	60 Hz | 3600 r/min 2.8 - 8.3 kVA

Lister Petter has been supplying durable and hard working engines into different market sectors for decades. Over the years, we have carefully configured our engines for each individual sector. Our flexible and nimble team are able to respond quickly to different customer specifications, whilst keeping lead times short. This ensures your engine is configured for your application before it leaves our factory, meaning it is ready to be put to work immediately.

Lister Petter has pre-configured engines for the following sectors:

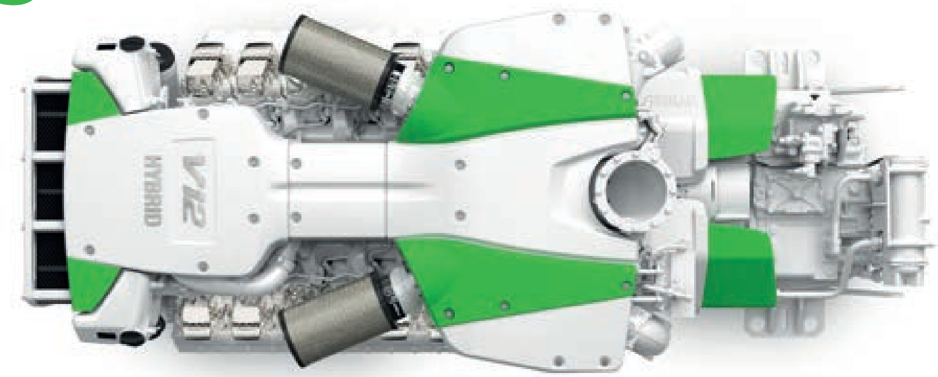
- ✓ POWER GENERATION
- ✓ INDUSTRIAL APPLICATIONS
- ✓ WATER PUMPING
- ✓ MARINE
- ✓ AGRICULTURE
- ✓ TELECOM

MADE IN BRITAIN

Lister Petter Power Systems
Broadmeadow Industrial Estate, Teignmouth, TQ14 9AE
United Kingdom
+44 (0) 1285 702211 | sales@listerpetter.com

www.listerpetter.com

MAN Engines' new marine hybrid system



MAN yacht engines are available in the range 12.4 to 24.2-L displacement, with power ratings from 537 to 1397 kW (730 to 2000 hp).

System combines engine, electric motors and batteries with applications in pleasure boats and commercial vessels

MAN Engines has launched the modular MAN Smart Hybrid Experience which the company said flexibly combines conventional marine engines, electric motors with batteries and onboard units.

Different degrees of power

MAN Engines said that this solution opens up countless opportunities for incorporating different degrees of hybrid power in leisure craft as well as commercial applications. Based on the desired operating modes, the MAN hybrid system can focus the driving profiles on performance, comfort or efficiency. "MAN Engines offers each and every customer a tailored solution for their specific hybrid needs," said Dr Matthias Schreiber, Head of MAN Engines.

Different operating modes

MAN Engines uses different operating modes to configure the driving profiles ranging from battery-electric mode, diesel-electric mode, cross-over mode, hotel mode to boost mode. These include economical driving styles in order to boost the range, as well as the ability to call up more power as a power-boost option. The hybrid system enables emissions to be reduced down to zero and even allows for a zero-emission power supply when the boat is anchored; noise emissions are completely eliminated as well. In battery-electric mode, boats will be able to access future Marine Protected Areas.

Comprehensive support

MAN Engines supports customers along the entire process chain, from the planning and concept phase to the development work and on to the technical implementation of complex drive components as well as batteries and power electronics. When it comes to servicing and maintenance work, MAN Engines has an extensive network including service stations in all major ports across the globe.

The MAN Smart Hybrid Experience won two prestigious international awards, the 2021 Red Dot Award for product design and the German Innovation Award 2021.

MAN Engines certified yacht engines

MAN Engines completed the certification of its range of diesels for yacht applications for major emissions standards worldwide, including EPA Tier 3, China Marine Recreational Stage 2, IMO Tier 2 and RCD 2013/53/EC (EU Recreational Craft Directive).

The latest homologation obtained is for China Marine Recreational Stage 2 standards (with limit values of 5.8 g/kWh NOx and 0.12 g/kWh particulate matter) and covers MAN's twelve-, eight- and six-cylinder engines that also satisfy the limit values of the EU and the USA.

The China Marine Recreational Stage 2 engine emission standard comes into force on 1 July 2022. "Customers who decide today in favour of MAN Engines are certainly investing in the future!" said Claus Benzler, head of Marine MAN Engines. The company added that with this last homologation step, shipyards and yacht builders choosing MAN Engines can offer their products in sales markets throughout the world, while owners can have maximum flexibility in the use and resale of their boats.

MAN Engines' range for yacht applications includes six-cylinder inline units and eight- and 12-cylinder vee configuration engines. The engines are designed to meet all major emissions standards.


SUCCESS TAKES MORE THAN JUST A STRONG ENGINE.
Reliable. Modern. Adaptable.
Our engines are legendary thanks to their inventor and namesake Rudolf Diesel.That's been true since 1897. But today, they're distinguished not only by their top-class, state-of-the-art technology. They also stand out as the lowest in fuel consumption and highest in reliability. So, MAN Engines offers decades of industry experience and the specialist knowledge for a wide range of assembly situations and custom load profiles. Along with sophisticated components and expertise from the large-scale commercial vehicle series. At our International Engine Competence Center, we work exclusively on engines. See the results in countless real-world applications. And at www.man-engines.com
MAN Engines
MAN

Yanmar America has made a number of changes over the last year. One significant addition is the Yanmar//Repower program, through which new engines are provided for repower applications.

YANMAR'S YEAR OF CHANGE

New structure, leadership and focus on distribution position company for the future.

By **Mike Brezonick**

As if anybody needed to be reminded of it in these pandemic times, change is the only constant in the universe. Yet while changes are often borne of crises – COVID-19 being a prime example – others are planned with specific aims in mind.

Yanmar America, the North American headquarters of Japan's Yanmar Power Technology Co. Ltd., has quietly made several significant changes over the last year, taking on a new structure, leadership, personnel and programs. All of the moves are intended to position the company to take advantage of opportunities now and when the pandemic fades to memory.

First, the major changes. Last spring, Yanmar America consolidated its Industrial Engine and Commercial Marine businesses into a single group, Yanmar Power Solutions, which will focus on the company's industrial and marine engine businesses, including sales, application engineering and R&D. Ron Adams, who had been senior engineering manager, was appointed director of the new group.

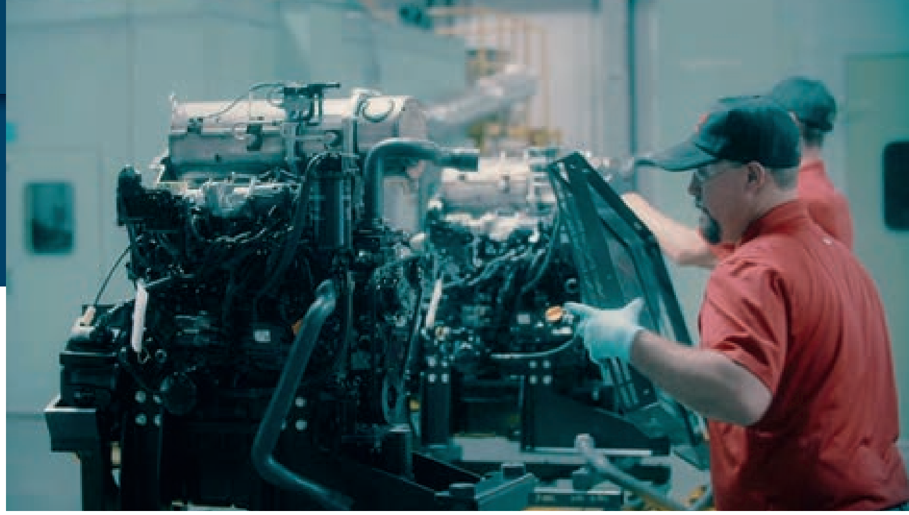
Adams is reporting to Jeff Albright, who became the president of Yanmar America in late spring. Albright has extensive experience in engines, having at one time been president of Briggs & Stratton's business in Asia, as well as president of Briggs' joint venture with Daihatsu.

FOCUS ON DISTRIBUTION

Another significant change is Yanmar's focus on enhancing its distribution organization. Like many engine manufacturers over the last decade, Yanmar experimented with alternatives to the classical engine distribution model, with middling results.

Thus, in mid-2020, the company put

Yanmar has expanded its range of PowerPack power units, which now spans 39 models.



a new strategy into place to re-energize and refocus its Yanmar Industrial Distributor network in North America. It has since reached new agreements with all of its U.S. and Canadian distributors, defining territories and service dealer responsibilities. With the return of Cascade Engine Center as an authorized Yanmar distributor, the company now has 15 distributors in North America, 13 in the U.S. and two in Canada.

Yanmar America has also empowered its distributors to register service dealers within each assigned territory. "Distributors and their dealers are key in providing engines and parts stock, which allows for quicker lead times to Yanmar customers," said Adams. "Yanmar recognizes the added value that a regional OEM may need in Canada's northern territory can be different from one that is in the southern United States.

"By empowering our distributors to have localized responsibilities for the service dealers in their area, Yanmar is establishing closer relationships with its customers."

With the renewed focus on distribution, Yanmar also sought to elevate the experience and capabilities of its sales team. Arley Bedillion, former industrial sales manager at Mastry Engine Center, a Yanmar distributor in St. Petersburg, Fla., was named industrial sales manager. With Bedillion's addition, the industrial sales team has more than 100 years of combined industry experience.

NEW REPOWER PROGRAM

The company also changed its engine remanufacturing program. "We found that most customers preferred a new replacement engine over a remanufactured one," said Adams. "The new Yanmar Repower business model offers new replacement engines only.

"Yanmar Repower gives end users the options to keep their older equipment up and running at peak performance, adding to the overall life of the machine."

As part of the Yanmar Repower introduction, the company also launched Yanmar//One, which provides distributors a more streamlined way to order Yanmar Repower products online which in turn has helped the company expand its repower business to record levels. "Repowering a machine requires engine expertise and guidance," Adams said. "We greatly depend on our distributor network for support in this critical aspect of our business."

Additionally, Yanmar America continues to invest in its development and manufacturing capabilities. A $4 million expansion, including an emission testing bench and a cold-start chamber in Adairsville, Ga., were recently completed. The investment was also critical to the manufacturing of the company's PowerPack line of engine power units, which now spans 39 models. The most recent are based on Yanmar's newest Tier 4 final engines, including the 4TNV94FHT – at 118 hp, the company's first SCR-equipped engine – as well as the 3TNV80FT engine, which was a nominee for Engine of the Year Under 175 hp at the 2020 Diesel Progress Summit.

"The diesel engine business went through major changes when Tier 4 final engines entered the marketplace," Bedillion said. "Many engines have gone fully electronic with the addition of aftertreatment technologies and this has created challenges and opportunities in the industry.

"Going forward, Yanmar has put our distributor network at the center of our strategic growth plan. With larger manufacturers equipped to handle EPA Tier 4 final solutions, we have recognized that smaller OEMs need more dedicated local support. Yanmar has invested resources in the distribution network regarding that training and support. Yanmar offers online and in-person training through its online Power//Train website. The distributors in turn are taking that training to the local service dealership level insuring the highest level of support for the end user."

RISING TO CHALLENGES

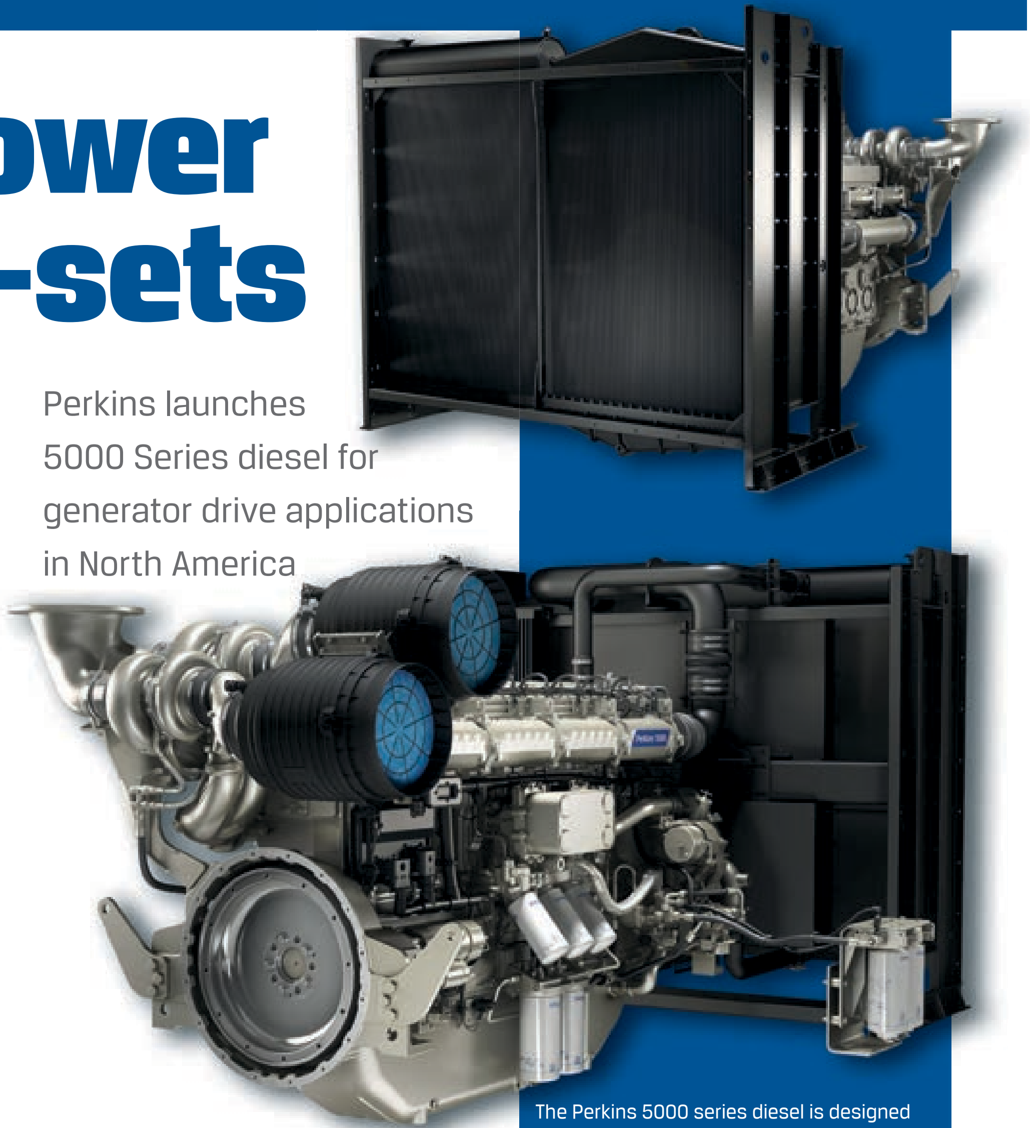
Yanmar also holds an annual engineering workshop, led by Engineering Manager Aaron Engels, to train each distributor's engineering team on engine analysis, latest trends, and provide general updates. "Because of COVID-19, the workshop was held virtually in 2020 and it turned out to be the best workshop yet," said Adams. "Within the past year, given reduced global travel, Yanmar America's engineering team has risen to the challenge by performing engine installation reviews at our facility to maintain OEM production launch schedules. Our customers have really taken advantage of this, and we see this value-add opportunity growing in demand. Smaller OEMs have responded positively to the assistance."

Adams said distributors and OEMs have responding well to the moves Yanmar has made and more are coming, notably an expansion of its lineup over the next 12 months, including its largest displacements yet. "Be on the lookout," Adams said, "for bigger power." ■

www.yanmarengines.com

More power for gen-sets

Perkins launches 5000 Series diesel for generator drive applications in North America



The Perkins 5000 series diesel is designed to deliver up to 1500 kWe emergency standby power for a range of critical applications including data centers, hospitals and commercial buildings.

Perkins Engines Co. Limited has announced the North American launch of the Series 5000 diesel, its most powerful line of electronic engines to date designed to deliver up to 1500 kWe emergency standby power for a range of critical applications including data centers, hospitals and commercial buildings.

"With multiple engine models offering a substantial power output of up to 1500 kWe – ideal for a 1.5 MWe generator set – every aspect of the new 5000 Series engine range, from its load acceptance capabilities to custom-created components and innovative engineering techniques, has been designed to optimize our customers' needs for quick, reliable and cost-effective power," said Americas Sales Director Bill Giunta.

The first engine available, the 5008C-E30TAG, is an inline eight-cylinder diesel with bore and stroke dimensions of 160 x 190 mm and a total displacement of 30.56 L. Engineered to meet EPA Tier 2 standards for 60 Hz emergency standby applications, the engine has a gross mechanical output of 907 to 1107 kWm (1216 to 1485 hp) and are targeted toward 900 and 1000 kWe standby nodes.

Twin turbocharged and air-to-air charge-air cooled, the 5000 Series engines incorporate optimized turbochargers that provide load acceptance meeting ISO 8528-5 G2 and G3 standards and the ability to accept NFPA 100% block load. All of this means that the 5000 Series achieves full recovery after first load step within 13 seconds, the company said.

"The engine's ability to very quickly deliver stable backup power is a vital requirement for critical applications," said 5000 Series Product Manager Steve Chesworth. "Drawn on nearly nine decades of engine-design and manufacturing expertise, the 5000 Series is the culmination of many years of research, development and rigorous testing. Throughout that time, we've focused on delivering what our customers have asked for – cost-effective and reliable power – and we're confident this engine will exceed their expectations."

Full authority electronics

The 5000 Series utilizes advanced technology, with full authority electronics designed to easily integrate into the customer's chosen telematic solutions. Perkins said it also offers high power density from a 32.7 kWe/L footprint, and incorporates electronic sensors with wireless communication capability, allowing operators to remotely monitor the generator and engine.

Maintenance issues have been addressed through a single-side servicing design and an oil service interval of 750 hours and a three-year, 1500-hour warranty for standby applications.

As with all Perkins engines, the 5000 Series will be supported by Perkins' global network of 92 distributors covering 183 countries.

"In many areas in the world Perkins has long been regarded as the engine of choice for power generation – a reputation we're rightly very proud of," said Jaz Gill, vice president of global sales, marketing, service and support. "I'm very excited about the opportunities the 5000 Series will create for us to extend that brand reputation and further grow our business in North America."

ADVANCED DRIVE SYSTEMS **FOR PROFESSIONALS**

G 2.2 L3 | G 2.9 L4

- 26–54 kW | 35–72 hp at 2600 min^{-1}/rpm
- EU Stage V | US EPA Tier 2

TCD 2.2 L3

- max. 55,4 kW | 74 hp at 2600 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

TCD 4.1 L4 | TCD 6.1 L6

- 80–180 kW | 108–241 hp at 2300 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

TCD 7.8 L6

- max. 260 kW | 339 hp at 2200 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

DEUTZ

TCD 2.9 L4

- max. 55,4 kW | 74 hp at 2200 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

TCD 3.6 L4

- max. 105 kW | 141 hp at 2300 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

TCD 5.2 L4

- max. 170 kW | 228 hp at 2200 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

TCD 12.0 V6 | TCD 16.0 V8

- 220–500 kW | 295–671 hp at 2100 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

TCD 9.0 L4 | 12.0 L6 | 13.5 L6

- 220–454 kW | 295–609 hp at 2100 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

TCD 18.0 L6

- 565–623 kW | 758–836 hp at 1900 min^{-1}/rpm
- EU Stage V | US EPA Tier 4 | CN4

The engine company.

DEUTZ ENGINE PORTFOLIO.

ENGINES FOR INDUSTRIAL AND AGRICULTURAL APPLICATIONS

ENGINES UP TO EU STAGE V / US-EPA TIER 4 / CN4

Engine Type	Cyl. and config.	Industrial ratings ISO 3046/1 and ISO 14396 TIER 4			Max. Torque	Bore / Stroke	Displace-ment	Dimensions			Weight
		kW	HP	rpm	Nm/rpm	mm	l	Length mm	Width mm	Height mm	kg
D 1.2 L3	3 IL	17,9	24	2800	65/2200	78/82	1,18	500	416	647	120
G 2.2 L3	3 IL	42,0	56	2600	160/1600	92/110	2,19	617	480	711	208
D 2.2 L3	3 IL	18,4	25	2600	125/1400	92/110	2,19	576	550	708	200
TD 2.2 L3	3 IL	44,5	60	2600	200/1600	92/110	2,19	576	600	708	215
TCD 2.2 L3	3 IL	55,4	74	2600	280/1600	92/110	2,19	576	576	708	215
G 2.9 L4	4 IL	54,0	72	2600	215/1600	92/110	2,92	719	498	719	220
D 2.9 L4	4 IL	36,4	49	2600	150/1600	92/110	2,92	648	483	685	220
TD 2.9 L4	4 IL	55,4	74	2600	260/1800	92/110	2,92	648	560	685	237
TCD 2.9 L4	4 IL	55,4	74	2600	300/1600	92/110	2,92	648	560	685	237
TCD 2.9 L4 HT	4 IL	55,4	74	2600	375/1600	92/110	2,92	648	560	685	237
TCD 2.9 L4 HP	4 IL	82,0	110	2200	420/1600	92/110	2,92	648	560	685	237
TCD 2.9 L4 HP (A)	4 IL	82,0	110	2200	420/1600	92/110	2,92	478	522	952	340
TD 3.6 L4	4 IL	55,4	74	2600	340/1600	98/120	3,62	733	644	812	350
TCD 3.6 L4	4 IL	100,0	134	2300	500/1600	98/120	3,62	733	644	799	350
TCD 3.6 L4 (A)	4 IL	105,0	141	2200	550/1600	98/120	3,62	717	644	1080	477
TCD 3.6 L4 HT	4 IL	55,4	74	2300	405/1300	98/120	3,62	733	644	799	350
TCD 3.6 L4 HP	4 IL	105,0	141	2300	550/1600	98/120	3,62	733	644	799	350
TCD 4.1 L4	4 IL	115,0	154	2300	610/1600	101/126	4,04	851	617	884	400
TCD 4.1 L4 (A)	4 IL	120,0	161	2100	699/1500	101/126	4,04	778	629	1079	450
TCD 5.2 L4	4 IL	170,0	228	2200	610/1600	110/136	5,2	851	617	884	400
TCD 6.1 L6	6 IL	180,0	241	2300	1000/1450	101/126	6,06	1082	678	946	620
TCD 6.1 L6 (A)	6 IL	174,0	233	2100	1072/1500	101/126	6,06	767	621	1205	676
TTCD 6.1 L6 (A)	6 IL	211,0	283	2100	1229/1450	101/126	6,06	767	643	1071	715
TCD 7.8 L6	6 IL	260,0	349	2200	1400/1450	110/136	7,75	1214	793	1046	725
TTCD 7.8 L6 (A)	6 IL	291,0	390	2100	1565/1600	110/136	7,75	1256	708	1401	1225
TCD 9.0 L4	4 IL	304,0	402	2100	1747/1400	135/157	9,0	1015	838	1116	755
TCD 12.0 L6	6 IL	404,0	536	2100	2527/1350	130/150	12,0	1390	853	1156	1115
TCD 13.5 L6	6 IL	454,0	604	2100	2783/1400	135/157	13,50	1390	853	1156	1115
TCD 12.0 V6	6 V	390,0	523	2100	2130/1400	132/145	11,91	980	853	1156	1115
TCD 16.0 V8	8 V	500,0	671	2100	2890/1400	132/145	15,90	1150	945	1170	1260
TCD 18.0 L6	6 IL	623,0	831	1900	3650/1300	148/174	17,96	1554	985	1680	1950

(A) = Agricultural machinery

ENGINES EU STAGE IIIA / US-EPA TIER 3

Engine Type	Cyl. and config.	Industrial ratings ISO 3046/1 and ISO 14396 TIER 3			Max. Torque	Bore / Stroke	Displace-ment	Dimensions			Weight
		kW	HP	rpm	Nm/rpm	mm	l	Length mm	Width mm	Height mm	kg
D 2011 L2 o	2 IL	23,1	31	2800	90/1700	94/112	1,6	601	544	683	169
D 2011 L2 i	2 IL	22,5	30	2800	90/1700	94/112	1,6	501	544	683	175
D 2011 L3 o	3 IL	36,4	49	2800	137/1700	94/112	2,3	710	563	678	210
D 2011 L3 I	3 IL	36,3	49	2800	137/1700	94/112	2,3	612	543	677	217
D 2011 L4 W	4 IL	50,0	67	2600	210/1700	96/125	3,6	745	534	724	270
D 2011 L4 I	4 IL	47,5	64	2600	190/1700	96/125	3,6	732	535	724	270
TD 2011 L4 I	4 IL	57,6	77	2600	240/1600	96/125	3,6	722	553	724	267
TD 2011 L4 W	4 IL	68,0	91	2600	280/1600	96/125	3,6	736	561	709	269
TCD 2011 L4 W	4 IL	79,4	107	2600	350/1600	96/125	3,6	736	560	711	269
D 914 L4	4 IL	58,0	78	2300	273/1500	102/132	4,3	826	668	800	307
D 914 L6	6 IL	86,5	116	2300	375/1500	102/132	6,5	1082	680	885	420
TCD 914 L6 ecAGR	6 IL	129,9	174	2300	650/1600	102/132	6,5	1224	732	1024	510
D 2.9 L4	4 IL	36,4	49	2600	147/1600	92/110	2,9	648	483	685	220
TD 2.9 L4	4 IL	55,4	74	2600	260/1800	92/110	2,9	648	560	685	237
TCD 2.9 L4	4 IL	55,4	74	2600	300/1800	92/110	2,9	648	560	685	237
TD 3.6 L4	4 IL	55,4	74	2600	340/1600	98/120	3,62	733	644	797	350
TCD 3.6 L4	4 IL	100,0	134	2300	550/1600	98/120	3,62	733	644	797	350

ENGINES EU STAGE IIIA / US-EPA TIER 3

Engine Type	Cyl. and config.	Industrial ratings ISO 3046/1 and ISO 14396 TIER 3			Max. Torque	Bore / Stroke	Displace-ment	Dimensions			Weight
		kW	HP	rpm	Nm/rpm	mm	l	Length mm	Width mm	Height mm	kg
TCD 4.1 L4	4 IL	115,0	154	2300	609/1600	101/126	4,04	808	617	884	385
TCD 6.1 L6	6 IL	160,0	215	2300	1000/1450	101/126	6,06	1044	678	946	520
TCD 7.8 L6	6 IL	250,0	335	2300	1400/1450	110/136	7,75	1172	793	1046	705
TD 2012 L4 2V	4 IL	66,0	88,5	2300	350/1600	101/126	4,0	847	645	743	400
TCD 2012 L4 2V	4 IL	88,0	118	2400	420/1600	101/126	4,0	866	706	825	400
TCD 2012 L4 2V	4 IL	103,0	138	2400	520/1600	101/126	4,0	805	695	845	400
TCD 2012 L6 2V	6 IL	155,0	208	2400	810/1600	101/126	6,1	1041	705	893	510
TCD 2013 L4 2V	4 IL	129,0	173	2300	670/1600	108/130	4,8	896	645	965	500
TCD 2013 L6 2V	6 IL	200,2	269	2300	1050/1500	108/130	7,2	1215	705	991	610
TCD 2013 L6 4V	6 IL	238,0	319	2200	1311/1450	108/130	7,2	1319	750	947	660
TCD 2015 V6	6V	360,0	483	2100	2080/1300	132/145	11,9	985	932	1141	1020
TCD 2015 V8	8V	500,0	671	2100	2890/1400	132/145	15,9	1141	932	1172	1245
TCD 12.0 V6	6V	360,0	483	2100	2080/1300	132/145	11,9	985	932	1141	1020
TCD 16.0 V8	8V	500,0	671	2100	2890/1400	132/145	15,9	1141	932	1172	1245

ENGINES ≤ EU STAGE II AND US-EPA TIER 2

Engine Type	Cyl. and config.	Industrial ratings ISO 3046/1 and ISO 14396 TIER 2			Max. Torque	Bore / Stroke	Displace-ment	Dimensions			Weight
		kW	HP	rpm	Nm/rpm	mm	l	Length mm	Width mm	Height mm	kg
F 4 L 912	4 IL	54,0	72	2500	238/1600	102/132	4,3	860	668	800	307
F 6 L 912	6 IL	82,0	110	2500	364/1600	102/132	6,5	1118	680	819	430
F 3 L 914	3 IL	48,0	64	2500	207/1500	102/132	3,2	730	694	800	277
F 4 L 914	4 IL	64,0	89	2500	275/1500	102/132	4,3	843	668	800	307
BF 4 L 914	4 IL	85,7	115	2500	363/1600	102/132	4,3	877	690	808	350
F 6 L 914	6 IL	96,0	129	2500	414/1500	102/132	6,5	1128	680	885	430
BF 6 L 914	6 IL	140,9	189	2500	624/1600	102/132	6,5	1262	715	934	485
BF 6 L 914 C	6 IL	148,5	199	2500	700/1600	102/132	6,5	1258	715	1000	510
F 12 L 513	12 V	235,0	315	2300	1112/1400	128/130	20,0	1483	1090	985	1130
BF 8 L 513	8 V	243,0	326	2300	1170/1500	125/130	12,8	1404	1144	1078	920
BF12 L 513 C	12 V	386,0	518	2300	1900/1500	125/130	19,1	1599	1164	1070	1300
BF 4 M 2012	12 V	74,9	100	2500	390/1500	101/126	4,0	860	701	751	391
BF 4 M 2012 C	4 IL	103,0	138	2500	493/1500	101/126	4,0	866	701	836	391
BF 6 M 2012 C	6 IL	155,0	208	2500	743/1500	101/126	6,0	1183	723	807	509
BF 4 M 1013 EC	4IL	118,0	158	2300	577/1400	108/130	4,8	1547	732	1151	432
BF 6 M 1013 EC	4 IL	174,0	233	2300	854/1400	108/130	7,2	1249	762	1036	432
BF 6 M 1015 C	4 IL	300,0	402	2100	1978/1200	108/130	11,9	1574	1111	1300	572
BF 6 M 1015 CP	6 IL	330,0	443	2100	1875/1400	108/130	11,9	1046	933	1182	572
BF 8 M 1015 C	6 V	400,0	536	2100	2637/1200	132/145	15,9	1154	940	1163	850
BF 8 M 1015 CP	6 V	440,0	590	2100	2500/1300	132/145	15,9	1154	938	1163	850
TCD 12.0 V6	8 V	400,0	536	2100	2637/1200	132/145	15,87	1151	932	1170	1060
TCD 16.0 V8	8 V	440,0	590	2100	2500/1300	132/145	15,87	1151	932	1170	1060

DEUTZ AG
Ottostr. 1
51149 Cologne, Germany
Phone: +49 (0) 221 822-0
Fax: +49 (0) 221 822-3525
E-mail: info@deutz.com
www.deutz.com

DEUTZ Corporation
3883 Steve Reynolds Blvd.
Norcross, GA 30093, USA
Phone: +1 770 564 7100
Fax: +1 770 564 7222
E-mail: engines@deutzusa.com
www.deutzamericas.com

DEUTZ (Beijing) Engine Co., Ltd.
1102 CITIC Building, 19, Jian Wai Dajie
Beijing 100004, China
Phone: +86 10 65 25 41 86
Fax: +86 10 65 12 00 42
E-mail: dbj@deutz.com.cn
www.deutz.com.cn

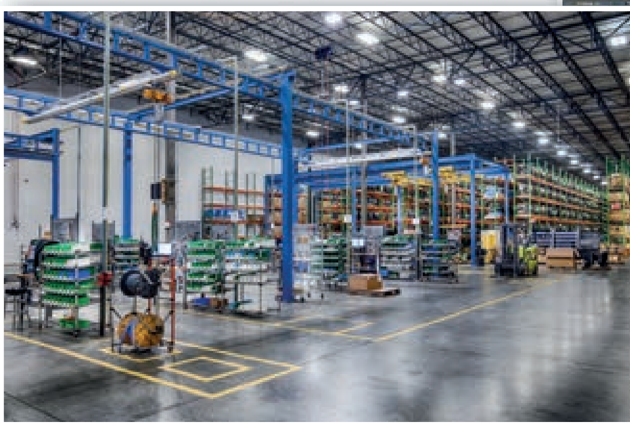
DEUTZ Asia-Pacific (Pte) Ltd.
10 Gul Crescent
Singapore 629523
Phone: +65 66 72 7800
Fax: +65 62 64 1779/62 65 3007
E-mail: dap@deutz.com
www.deutz.com.sg

DEUTZ Australia Pty. Ltd.
Unit 4, 13-15 Brough Street
Springvale, Vic, 3195, Australia
Phone: +61 3 9549 8400
Fax: +61 3 9549 8490
E-mail: deutzoz@deutz.com
www.deutz.com.au

EXPANSION FOR DEUTZ WITH NEW FACILITY

Expanded engine remanufacturing, packaging capabilities and application engineering.

By **Mike Osenga**



With the opening of its new 160,000 sq. ft. Sequence Center in Pendergrass, Ga., Deutz Corp. has expanded its engine remanufacturing capacity and engine packaging capabilities.

In a series of moves in and near its headquarters operation in Norcross, Ga., Deutz Corp. has expanded its engine remanufacturing capacity, increased its packaging capabilities, and expanded its applications engineering, package development, prototyping and parts kitting operations.

The centerpiece of these recent moves was the opening of a new 160,000 sq. ft. Sequence Center in Pendergrass, Ga., about one mile from the Deutz Xchange engine remanufacturing facility.

REMAN SUPPORT

The opening of the Sequence Center will support the reman production facility as well as assembling an expanded range of engine packages. The Sequence Center stores all of the parts and engines for Deutz engine packages, as well as Xchange cores and components in one central location. The Sequence Center also batches together parts by engine specification and sends them over as needed to the reman facility.

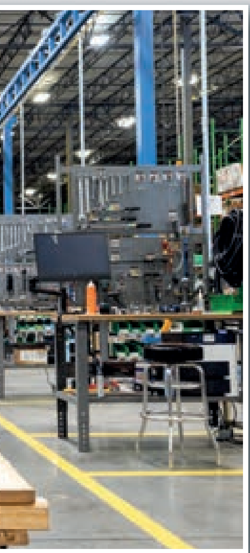
The Sequence Center also has its own production capabilities, building and shipping kits and customized Deutz Power Packs to OEMs and distributors. This production was previously done in the Norcross operations, which is now completely dedicated to engineering activities and aftermarket operations.

According to Deutz Corp CEO and President Bob Mann and Christian Vorspel-Rueter, executive vice president and chief financial officer, opening the Sequence Center frees up floor space to expand the remanufacturing operations including adding more reman engine assembly capacity and expanding disassembly and cleaning capabilities with the addition of new pass-through washing machines, soak tanks and ultrasonic cleaning equipment.

The expansion also allows Deutz to add two engines, as the 2.9 and 3.6 L models now join the Xchange program. The new center also enables Deutz to restructure and improve aftermarket operations in Norcross.

"This," Vorspel-Rueter said, "is

certainly the result of the growth in our Xchange business, but also the growth in our aftermarket. We were doing much more kitting of complete kits for the aftermarket, so it gives us more capacity to do that." Mann and Vorspel-Rueter said Deutz was targeting as much as a 25% growth in its aftermarket business, "in more normal times."



In turn, it also opens up capacity for what Deutz calls its value-added packaging where it adds various components to engine packages going to OEMs, as well as packages that go to market through the company's distribution network.

"We now have the capability to build more OEM packages as well as power packs," said Mann. "But we also end up being the lead buyer for certain other components for our OEM customers, because we can buy things like radiators and other parts in volumes, where we can leverage that purchasing power and sell to smaller OEMs at a better price than they can buy." He listed components such as steel fabrications, hydraulic pumps, radiators, hoses, and air filters as value-added components.

The opening of the new facility frees up the Deutz Norcross, Ga., operation to focus on application engineering.

EXPANDING PORTFOLIO

The opening of the Sequence Center also lays the groundwork for an expansion of Deutz' overall engine packaging portfolio. Later this year Deutz will be adding two larger engine models to its range and the Sequence Center will allow those engines to be packaged for OEMs, distribution, and power packs.

The new Deutz Sequence Center stores all of the parts and engines for Deutz engine packages, as well as Xchange cores and components in one central location.

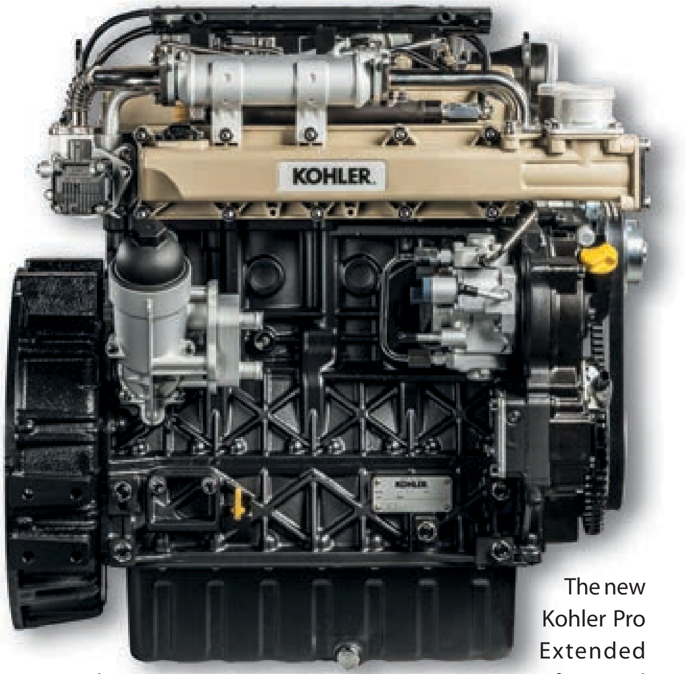
Currently, Deutz is able to efficiently package engines up through its 3.6 L family. The Sequence Center, Vorspel-Rueter said, will allow production of packages above that size, especially more complex and larger packages when the new engines join the line.

"It will not be a large, volume packaging operation, but these are higher complexity, bigger and more extensive builds than we can handle in the kind of small packages we are currently running down the track line," Vorspel-Rueter said. "As we move into larger engines, we needed more custom types of value-added packaging. With these products ready to launch over the next few months we are now able to series produce these in a customized packaging setting."

The third piece of the puzzle involves Deutz' Norcross headquarters, which previously handled many of the aftermarket parts and parts kitting, which is now part of the Sequence Center.

"What we'll do in Norcross," Mann said, "is more of the application engineering and package development work, so that we'll have the workshop right next to the engineering group. And especially, as our E-Deutz programs grow, we'll be able to bring a machine in, and if we want to put a hybrid drive in it, or a full electric system, that's where we'll build the prototype system or machines." ■

Kohler engines ready for China Tier 4



Kohler said its KDI diesels are ready for the upcoming China Tier 4 emissions regulations.

China Tier 4 emissions regulation will come into force Dec. 1, 2022, for industrial engines below 560 kW (750 hp). And Kohler engine said it is ready, as its engines will meet that standard and other low-emissions regulations around the world. Kohler also offers support and expertise to OEMs to design a China 4 compliant product line.

"The new China Tier 4 emission standard for non-road mobile machinery sets highly demanding requirements on particulate matter emissions," said Li Shaoqi, director of Commerce, Kohler Engines Asia Pacific. "Kohler has already upgraded the traditional engine fuel system, intake and exhaust systems and control system, to provide OEMs with fully compliant engines.

"The upgrade from China 3 to China 4 is much more challenging if compared to the previous from China 2 to China 3, but Kohler, leveraging the experience gained in highly regulated markets, is able to offer enhanced performance, a smart exhaust aftertreatment strategy, heavy-duty design, as well as guarantee low cost of ownership."

Important to note is also that the China Tier 4 emission standard has raised China Tier 5 standard prospectively, which reflects EU Stage 5. Therefore, as Chinese users opt for Kohler engines to upgrade to China Tier 4, they would save the laborious development when China Tier 5 will come into force over the next few years, the company said.

Kohler Pro 300-hour oil change kits

Kohler has developed new Kohler Pro 10W-50 oil and Kohler Pro Extended Life oil filters which, when paired

New emissions regulations to take effect in 2022

together, triple the oil change interval from 100 to 300 hours in Kohler gasoline engines. The company is offering three Kohler Pro 300 Hour Oil Change Kits, consisting of Kohler Pro 10W-50 full synthetic oil and Kohler Pro Extended Life oil filter, to service most Kohler engines.

Kohler Pro 10W-50 is a full synthetic oil engineered specifically for extended oil change intervals on Kohler gas engines. The proprietary formulation is shear-stable with high-film-strength to provide extended wear protection, with a more durable fluid film than conventional oils, the company said.

Kohler's 300-hour oil change kits.

The new Kohler Pro Extended Life oil filters are a durable construction for longer life. They incorporate 10-micron fiberglass media supported by wire backing to provide extra capacity with improved filtration, metal end caps and an anti-drain back valve to ensure oil flow in all conditions. The filter is available in two sizes, depending on the Kohler engine model.

Kohler has also upgraded its CheckApp smartphone application for the monitoring and maintenance of Kohler engines with the addition of a digital shop for Kohler genuine parts. The app is free and available for iOS and Android.

When an engine is registered in CheckApp, the app creates a profile that includes the engine's characteristics and its documentation, including video tutorials and user and maintenance handbooks. The app also sends information concerning scheduled maintenance intervals.

The app also runs general engine diagnostics via Bluetooth to Check Plus, a device available for engines with Deutsch connectors that communicates directly with the engine control unit on fuel injected engines.

CONFERENCE-NETWORKING-AWARDS
DPS 2021
DIESEL PROGRESS SUMMIT
THE EVENT FOR THE GLOBAL ENGINE AND POWERTRAIN TECHNOLOGY INDUSTRY
SAVE THE DATE
OCTOBER 25 & 26, 2021
LOEWS CHICAGO O'HARE HOTEL, CHICAGO, USA
WHAT TO EXPECT
• Keynote speeches from industry leaders
• Innovative off-road electric vehicle applications
• New developments in fuel cells
• Managing the transition from diesel to new power technologies
• Battery technologies of the future
• E-Mobility: managing a fleet of new power vehicles
• Diesel fights back: innovations in traditional engines
• Awards evening with dinner and networking drinks, celebrating excellence and achievements in the field of engine and powertrain technology.
AWARDS OPEN FOR ENTRIES : DEADLINE FOR ENTRIES: Tuesday July 27, 2021
GOLD SPONSORS
HATZ DIESEL
LIEBHERR
SILVER SPONSORS
DANA
JCB POWER SYSTEMS
ISUZU
DRINKS RECEPTION SPONSOR
KOHLER
IN POWER. SINCE 1920.
SUPPORTING SPONSORS
LAWSONS
Off-Highway RESEARCH
CREATED AND ORGANIZED BY
DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
NPP NEW POWER PROGRESS
khl
FIND OUT MORE AT
www.dieselprogresssummit.com


THE POWER
TO BUILD HERE.
We are not afraid of heights or confined spaces. We work on the tallest buildings and in the deepest quarries. And we love it. KOHLER® KDI engines were designed to guarantee safety and durability. Our engines will not be retiring anytime soon.
The power to bring you here.


KOHLERENGINES.COM
KOHLER®
IN POWER. SINCE 1920.


Sampo-Rosenlew HR86 is powered
by AGCO POWER HD74 Engine
HR86
SAMPO ROSENLEW
Regardless of application, AGCO Power delivers extreme power and durability for off-road, construction machinery and power generation, even in the most demanding conditions.
Designed and manufactured in Finland.


AGCO POWER
POWER IS OUR BUSINESS
Valtra T Series is powered by the
AGCO POWER HD66 or HD74 Engine
Interested? Contact us!
Tel. +358 20 786 3600 | sales.agcopower@agcocorp.com | www.agcopower.com
AGCO
Your Agriculture Company


POWER IS
OUR BUSINESS
CONTINUOUS
DRIVE
STAGE V
TIER 4 FINAL
AGCO
POWER
High-tech diesel engines with Sisu from Finland.
Extreme power and durability for construction machinery and
power generation, even in the most demanding conditions.
AGCO Power Tel. +358 20 786 3600, sales.agcopower@agcocorp.com
AGCO
Your Agriculture Company

AGCO POWER'S ENGINE MANUFACTURING UPGRADE

Company making significant investments and improvements in Linnavuori facility.

AGCO said it is progressing with significant upgrade to the manufacturing capabilities of its engine subsidiary AGCO Power in Linnavuori, Finland.

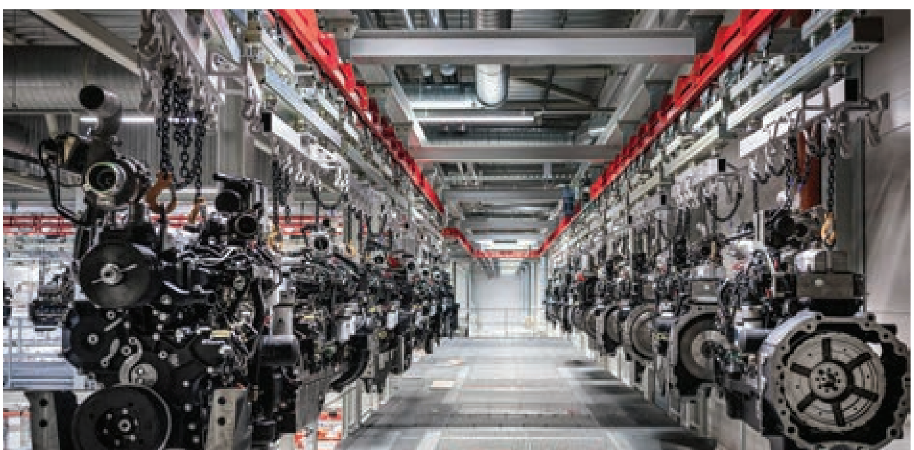
AGCO, the worldwide manufacturer and distributor of agricultural equipment and products, announced that it is progressing with significant upgrade to the manufacturing capabilities of its engine subsidiary, AGCO Power. The company initiated a €100 million-plus investment program in 2019 to strengthen the manufacturing capabilities at its engine manufacturing site in Linnavuori, Finland.

The company said a new and expanded assembly plant and a logistics center have been constructed in record time at Linnavuori, both of which are intended to help AGCO Power make its engine manufacturing process more modern and efficient.

"Despite a tight schedule and the global COVID-19 pandemic, the investment project has progressed as planned," said Juha Tervala, CEO of AGCO Power. "The investments at the Linnavuori plant enable a more efficient and streamlined production process.

"Upgrades such as the automated logistics center and state-of-the-art robotics support improved quality, cleanliness and work ergonomics. In addition, the investment paves way for the launch of production of a new engine family by the end of 2022."

Part of the investment was a multi-million Euro overhaul to the plant's machining line. Once fully operational, the 100% automated machining line will enable flexible manufacturing of components in-house, reducing costs and increasing control over the production process, AGCO Power said.



Part of the investment in AGCO Power's Linnavuori plant included advanced robotic assembly systems.

"The successful completion of the project makes AGCO Power's position in the global powertrain market better than ever," Tervala said. "The new engine product family that is being developed will serve AGCO brands (Valtra, Fendt and Massey Ferguson) more effectively and offer future solutions to customers in the off-road machinery market."

AGCO Power operates globally and manufactures engines at four plants: Linnavuori, Changzhou, China, Mogi das Cruzes, Brazil, and General Rodriguez, Argentina. The company, which turns 80 in 2022, has an overall engine capacity of over 100,000 engines per year. ■

Reprinted from June 2021 **Diesel Progress**

New range launched

JCB Power Systems has unveiled a new range of EU Stage 5-compliant engines.

Stage 5-compliant diesels rated 81 to 129 kW designed for mobile and stationary industrial equipment and generator set applications.

JCB Power Systems has unveiled a new range of EU Stage 5-compliant engines to power OEM equipment designed for off-highway applications in both static and mobile industrial equipment and generators.

The engines are available in four power nodes spanning from 81 kW to 129 kW and boost peak torque outputs from 516 Nm to 690 Nm.

The engine packages have been engineered to be as small as possible while featuring engine mounted aftertreatment – a diesel oxidation catalyst with a selective catalytic reduction urea injection system for NOx reduction as standard - to simplify engine integration. Exhaust aftertreatment can also be supplied loose for bespoke installations where height limitations call for an alternative to the engine-mounted arrangement, said JCB.

JCB Power Systems OEM Engine Sales and Applications manager, Daniel Jackson, said: “Not only have we introduced a high performance, ultra-efficient and low emissions engine solution,

JCB extends axle range

New is the recently introduced SD120 which has a 15-tonne dynamic load whilst the SD40 with a 5.5 tonne load, already used in JCB equipment, is to be made available externally.

“We are extending our offerings both at the top and bottom of our range” said John Snodin, general manager at the company which is based in Wrexham, Wales.

Previously the maximum dynamic rating in the axle range was 12 tonnes and the 5.5 tonne axle extends the company’s product range at the bottom end.

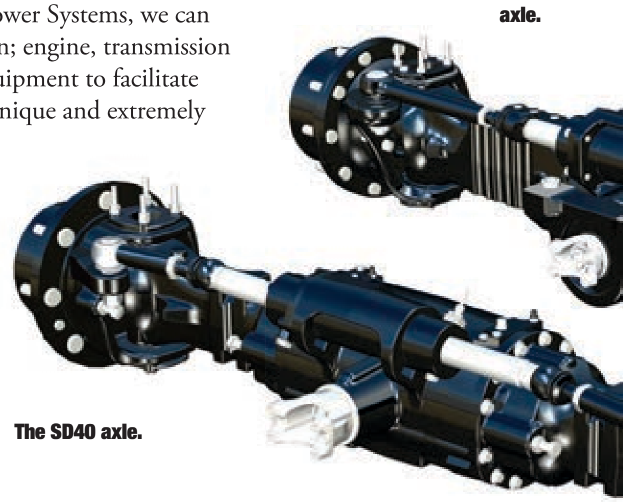
JCB DSL is a sister division to JCB Power Systems – the engine arm of JCB based in Derbyshire, England.

Although the SD40 has been used in JCB machines, the newer SD120 has only been supplied to one external OEM customer. As well as both rigid and steering axles, DSL is able to offer power-shift and power-shuttle transmissions from the plant in Wales.

POWERFUL OFFER

Snodin added: “Just as JCB Power Systems sells engines to independent OEMs, we do the same thing with axles and transmissions but in addition, by working closely with Power Systems, we can offer a complete powertrain; engine, transmission and axles plus auxiliary equipment to facilitate the installation. This is a unique and extremely

> “This is a unique and extremeley powerful offer.”
>
> **JOHN SNODIN, General manager, JCB drivetrain systems**



The SD120 axle.

The SD40 axle.

Reprinted from March-April & May-June 2021
Diesel Progress Interntional

# of engines by JCB

but we have done so in a way that makes life much easier for our OEM customers. Making integration with their equipment as seamless as possible and providing full support before, during and after manufacture."

BUILDS ON PREDECESSOR

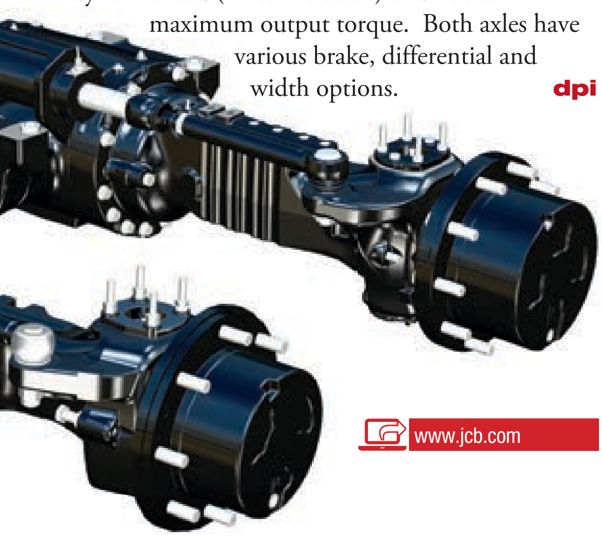
JCB said the development of the Stage 5 448 units will enable it to support new and existing customers in off-highway applications across the Stage 5-emissionised markets and then further territories as emissions legislation evolves. The new Stage 5 range builds upon its predecessor, the 448 JCB engine, said JCB.

The engines are suitable for a range of uses, from propulsion of off-highway equipment to the mechanical power behind a variety of stationary equipment. **dpi**

for OEMs

powerful offer. The OEM can focus on the machine's application leaving the powertrain to JCB."

The SD120 has a 15-tonne dynamic load capacity (30 tonne static) with a maximum output torque of 65000Nm. The SD40 has a 5.5 tonne dynamic load (11 tonne static) and 20000Nm maximum output torque. Both axles have various brake, differential and width options. **dpi**



www.jcb.com

JCB develops hydrogen-fueled engine

JCB has developed a hydrogen-fueled engine and also set up a specialist development team as the company believes the technology offers the quickest way to reach carbon dioxide emissions targets.

The team is based at the company's engine factory at Foston, Derbyshire, where a re-engineered JCB 4.8 L engine is running on hydrogen.

A JCB 4.8 L hydrogen engine, producing 70 kW, has been fitted into this JCB backhoe loader and is currently undergoing testing at a nearby proving ground in Staffordshire.

Another JCB 4.8 L hydrogen engine, producing 70 kW, has been fitted into a JCB backhoe loader and is currently undergoing testing at a nearby proving ground in Staffordshire.

The company believes that, ultimately, hydrogen engines could be used in a variety of its machines although it is understood that production of the engines would not be until the end of 2022 at the earliest.

It follows the writing into law of the UK's Climate Change Act which set out emission reduction targets. It stated that the UK must achieve an 80% reduction of carbon dioxide emissions by 2050. This was amended in June 2019 to change the target from 80% to 100%, net zero, by 2050.

JCB chairman Lord Bamford told Diesel Progress: "We accept that the days of fossil fuels are numbered. However, we don't believe that the only way to achieve zero carbon emissions is by the use of fuel cells or batteries which are more costly and complex.

"We can use our existing, proven engine technology and existing supply base to ensure that internal combustion engines, powered by hydrogen, remain a key part of the drive to achieving zero carbon emissions.

"Hydrogen is a clean, renewable and transportable fuel capable of powering larger, heavier equipment."

The company said that there are several other advantages associated with hydrogen engines, including the fact that a hydrogen engine is approximately the same price as a diesel engine and that it can be implemented into traditional powertrains.

Also, there is no requirement for charging stations and, unlike electric and battery options, it does not require expensive electric motors, JCB added.

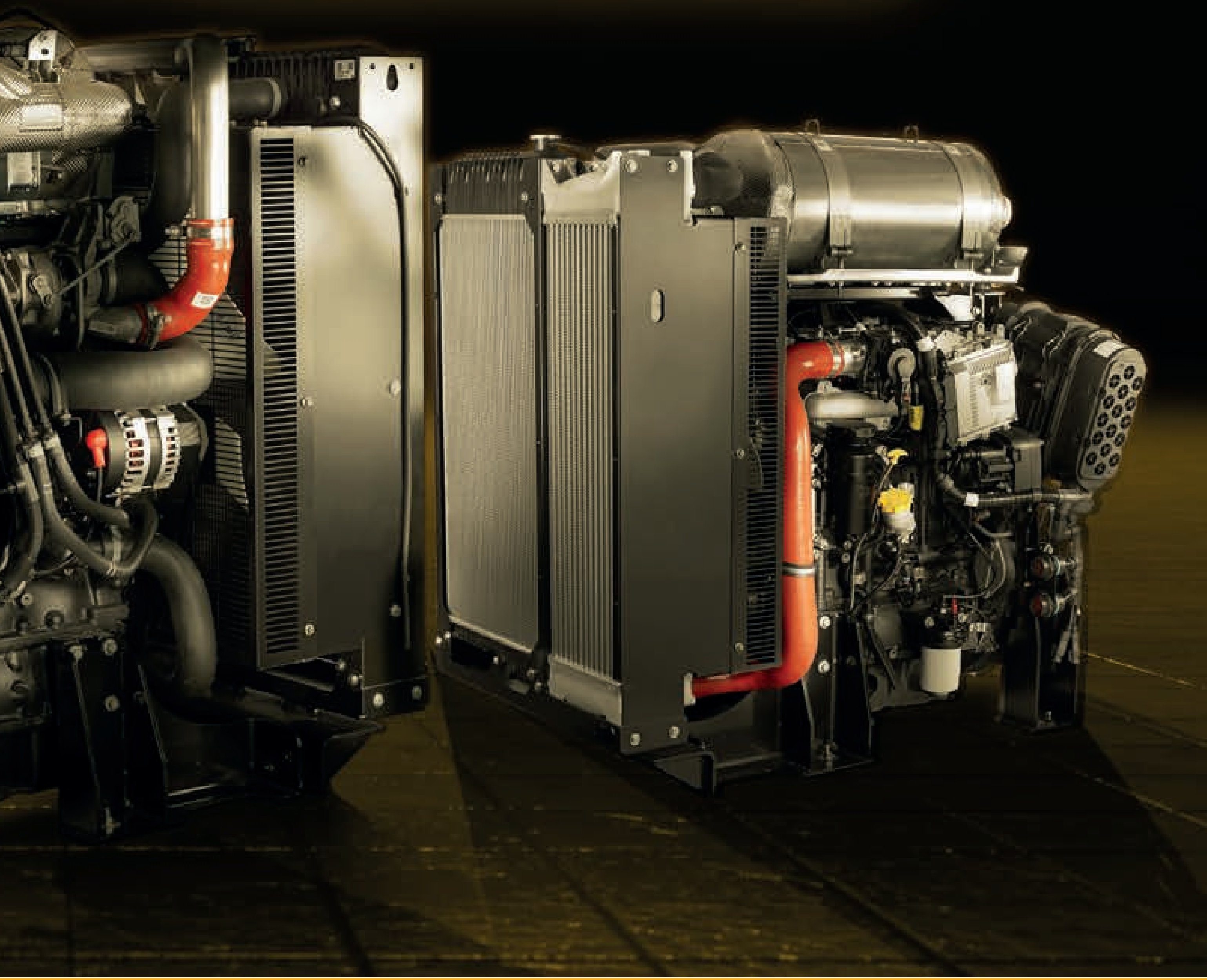
Tim Burnhope, JCB's chief innovation and growth officer, said: "Whilst there is much discussion about the merits of using battery and fuel cell technology in machinery, we believe that the use of hydrogen internal combustion engines will provide the quickest way to reach the target of zero carbon dioxide emissions, especially from high use, high energy equipment such as larger excavators, backhoes and loadalls."

Earlier this year JCB said it had developed the construction industry's first ever hydrogen powered excavator.

The 20-tonne 220X excavator, powered by a hydrogen fuel cell, has been undergoing testing at JCB's quarry proving grounds for more than a year.

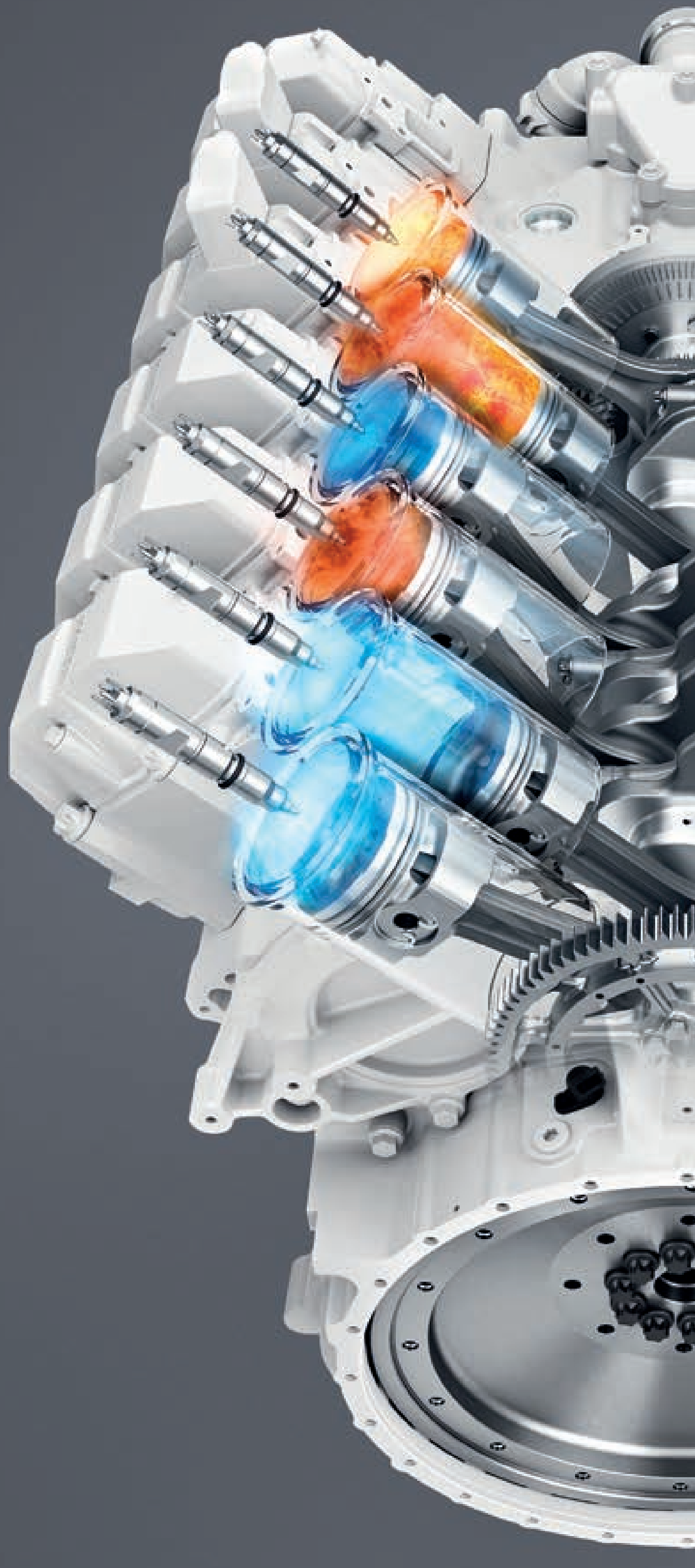

New Powerful
HVO
COMPATIBLE

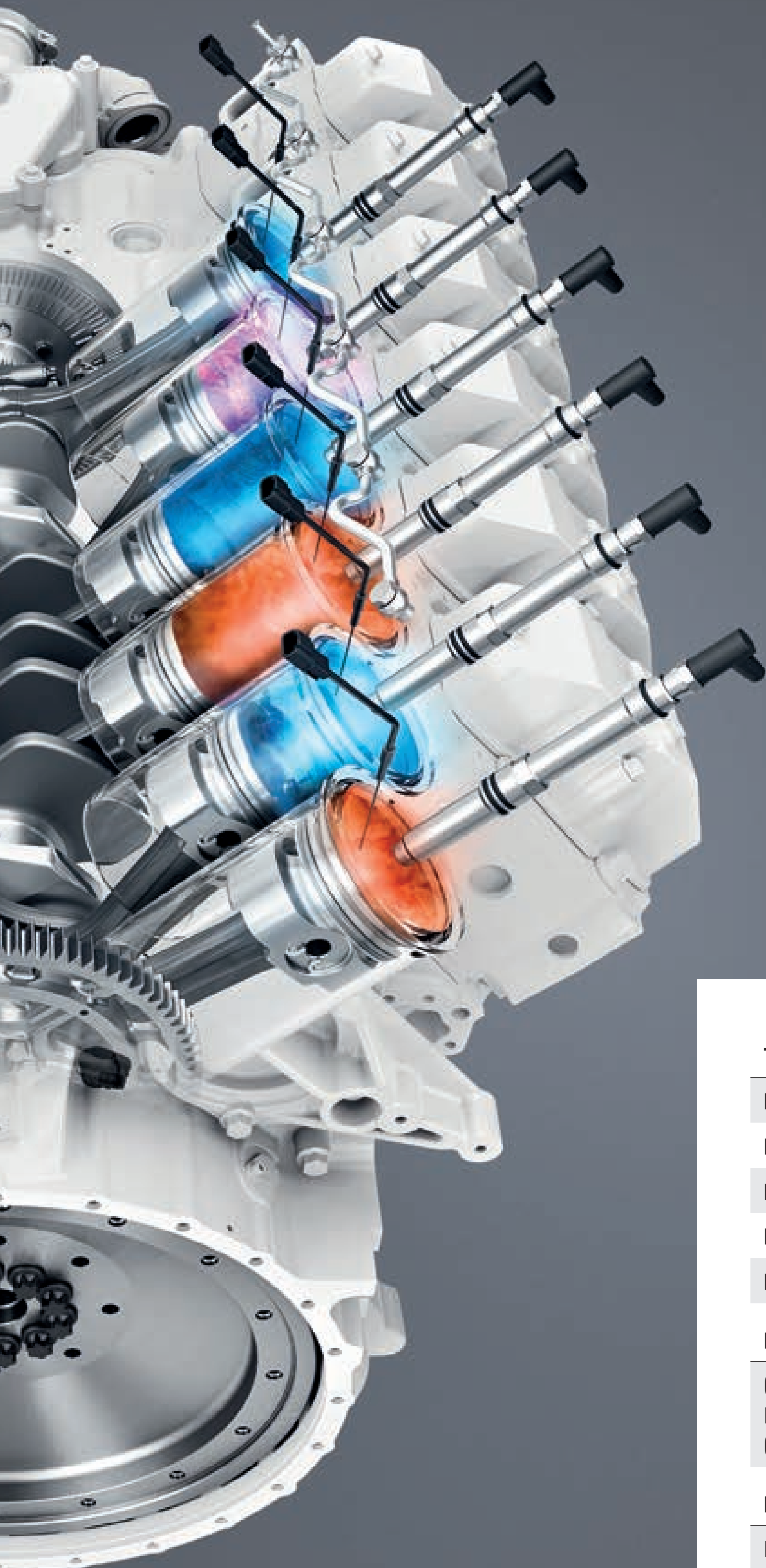
Possibilities



JCB POWER SYSTEMS

Powerful Possibilities





Types of engines from in-line 4 to V20

Fuels	diesel and gas
Displacement	7 – 103.4 l
Power rating	120 – 4,250 kW
Rated speed	from 1,200 to 1,900 rpm
Max. torque	1,245 – 23,550 Nm

Emission standards

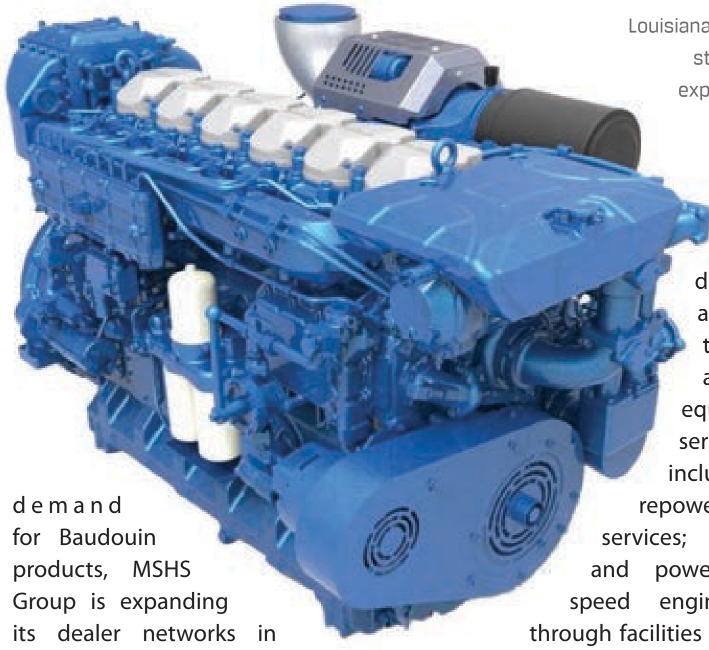
(EU) 2016/1628 Stage V, USA EPA CARB Tier 4f, ECE R96, H (IIIA equivalent), IMO III, IMO II, USA EPA Tier 2 (or equivalent), Fuel Consumption Optimised (Tier 0)

Exhaust gas aftertreatment

EGR / SCRonly / SCR filter

Baudouin donates engines to technical college

Distributor Motor Services Hugo Stamp helped with project aimed toward helping students gain valuable marine engine knowledge



Louisiana's Fletcher Trade School students to get hands-on experience thanks to Motor Services Hugo Stamp (MSHS), Baudouin marine diesel engine donation.

Engine manufacturer Baudouin, through its master distributor Motor Services Hugo Stamp (MSHS Group), has donated four engines to the Marine Diesel Engine Technical Program at Louisiana's Fletcher Technical Community College.

The four 6M26.3 Baudouin engines donated to the school will enable Fletcher students to gain needed skills by working on the same engines currently in use by four nearby Louisiana shipyards engaged in building vessels, the companies said.

"Operations of this size incorporate a sizable workforce of highly skilled and paid trade jobs," MSHS Group Territory Manager Dual Yelverton said. "The value to students of being able to work on these engines is much more than just nominal. These engines will enable them to expand their knowledge of innovators in the industry in terms of electronic engine components, hybrid systems and alternative fuels."

Louisiana's Fletcher Trade School students to get hands-on experience thanks to Motor Services Hugo Stamp (MSHS), Baudouin marine diesel engine donation.

Working with customers

The companies said the Baudouin brand is becoming increasingly popular in the United States because of its efficiency and emissions compliance. MSHS Group and Baudouin regularly work closely with customers, manufacturers, shipyards and naval architects in Louisiana. To supply the demand for Baudouin products, MSHS Group is expanding its dealer networks in specific regions to provide local companies with entrance into new and repowering applications.

Based in southern France, Baudouin has been an original equipment manufacturer of marine engines for over 100 years. With the goal of expanding its product offerings and building its brand in the U.S. market, Baudouin plans to make its involvement with marine diesel engine trade schools a central component of its community outreach.

"As an engine manufacturer, our investment in STEM projects is a key aspect of our strategy," Baudouin's Americas Sales Director Mehdi Kebaili said. "Baudouin is thrilled to be participating in this exciting initiative to shape the next generation of maritime engineers."

Baudouin is currently offering 16L and 32L displacement engines at 450-815 hp and 1100-1650 hp respectively, as well as onboard generating sets up to 1MW.

Founded in 1983 in Ft. Lauderdale, Florida, MSHS Group delivers a full range of engine services including diesel engine repair and maintenance; turbocharger sales and service; auxiliary equipment sales and service; yacht services including electrical, repower, and waterjet services; and propulsion and power including high-speed engines and waterjet through facilities in Florida, Louisiana, Washington State and Brazil.

Baudouin was founded in 1918 by Charles Baudouin in Marseille, France, and later moved its headquarters and manufacturing to Cassis. In April of 2009, Chinese manufacturer Weichai Power acquired Baudouin for $3.8 million, and has since consolidated its European operations under the Baudouin name.

For much of its history, Baudouin specialized in the design and manufacture of low-speed diesel engines, primarily for use in fishing vessels, but following the Weichai acquisition it began to develop high-speed engines for use in a wider range of marine power applications.

In 2017, Baudouin introduced a range of stationary engines for power generation applications and in 2020, the company began production of its first LNG-powered engines, initially for stationary use, and also began development of a new diesel/LNG marine engine design. The new gas engines offer robust performance, even when drawing from fuel sources of variable quality, the company said.


MOTEURS
Baudouin
A WEICHAI COMPANY

MAN Energy Solutions launches low-speed dual-fuel engine

Launched in live-streamed ceremony from MAN Energy Solutions' Research Center in Denmark

MAN Energy Solutions unveiled its new low-speed, dual-fuel engine – an MAN B&W ME-GA type designed for LNG/fuel-oil running – during a live-streamed ceremony from its Copenhagen Research Centre, Danmark, where the engine's operation has been demonstrated for the first time to the public.

The new engine is an Otto-cycle variant of the company's ME-GI engine that uses the diesel cycle, and is compliant with IMO Tier 2 and Tier 3 emissions regulations in gas mode thanks to its pre-mixed combustion that results in low NOx emissions.

The engine was designed in close cooperation with MAN Energy Solutions' licensee Hyundai Heavy Industry and answered a specific demand from the market of LNG carriers using boil-off gas from the cargo as a fuel for the engine.

MAN Energy Solutions' Principal Promotion Manager, Peter H. Kirkeby said that the market for LNG carriers shows a very good trend with new liquefaction trains coming online, creating more request for carrier ships. MAN Energy Solutions forecasted that 70 ships per year can be commissioned in the coming years.

Integrated EGR system

The ME-GA engine is already specified in LNG carrier newbuilds but more details cannot be communicated at this time.

Thomas S. Hansen, head of Two-Stroke Promotion & Customer Support, explained some of the engine's technical characteristics, saying that to fully utilize the engine's dual-fuel potential in IMO Tier 3 areas, the engine is also being offered with an integrated Exhaust Gas Recirculation (EGR) that ensures compliance when in diesel mode.

According to MAN Energy Solutions, EGR will enable the ME-GA to reduce specific gas consumption by about 3%, and specific fuel-oil consumption by 5%. It will also significantly reduce methane slip by 30 to 50%, and improve the stability of the Otto-cycle combustion process. EGR will enable the ME-GA to meet IMO Tier 3 requirements in both fuel oil and gas modes without additional aftertreatment.

Hansen explained that the ME-GA EGR solution is a high-pressure system, integrated into the engine in a very compact solution – the EGR unit itself actually does not change the engine footprint.

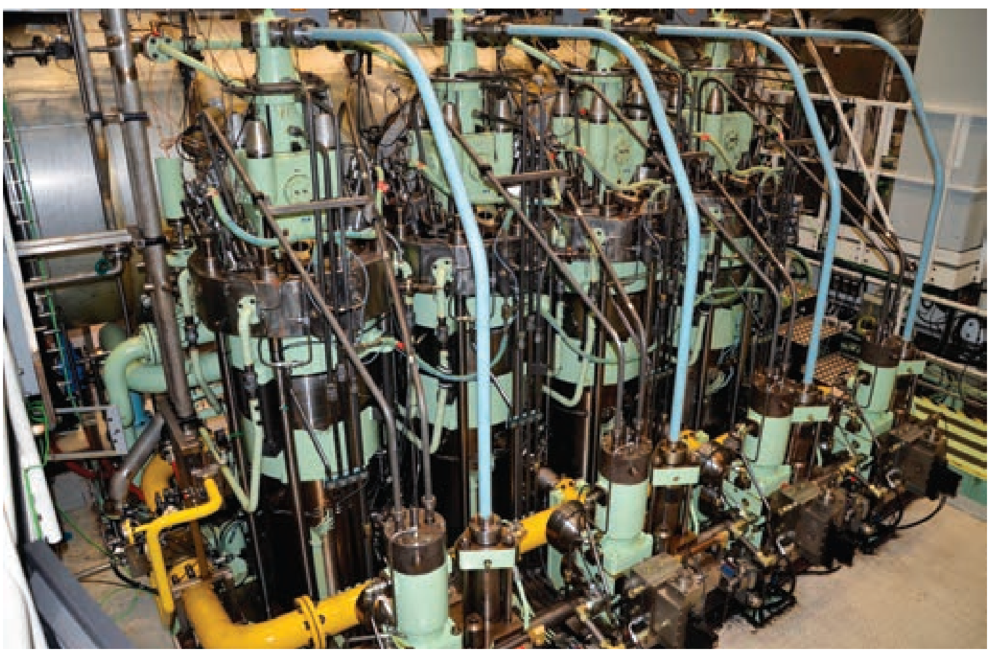
The volume requirements of the ME-GA EGR system are significantly lower with, for example, less pipework required than for low-pressure EGR solutions. Its design-similarity to that of ME-C engines' EGR systems will lower its price point as the supply chain and components are mature.

The MAN B&W ME-GA uses an efficient ignition concept with pre-mixed Otto principle and a gas-admission system that delivers safe and reliable operation. "A specially developed Safe Gas Admission Valve (SGAV) insures an enhanced engine operation; it features a window valve that offers a double safety function," added Hansen. "The gas admission system has a double-wall pipe installation with bi-directional flow.

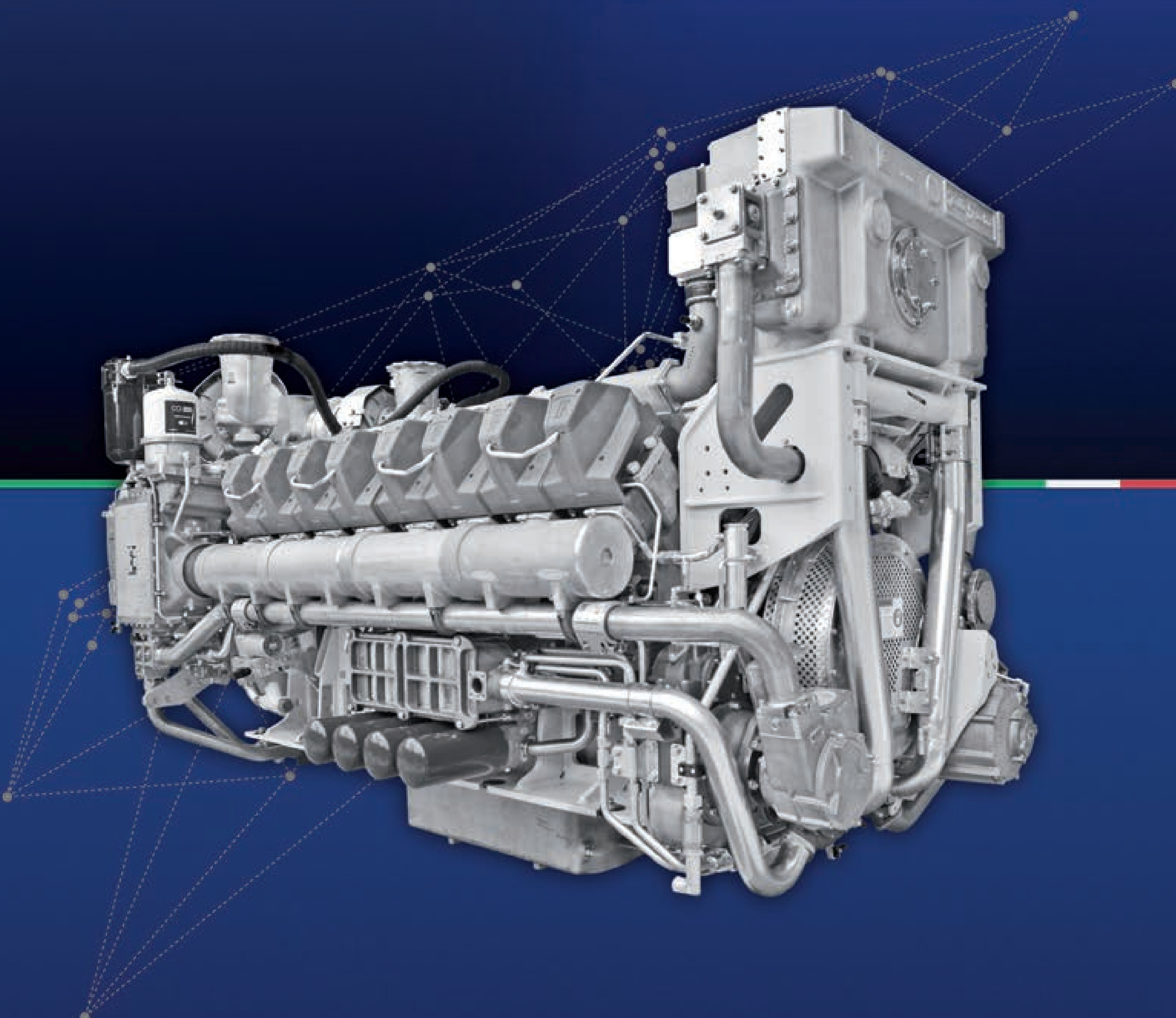
"One other key characteristic of this engine is the robust piston/ring pack, taken from MAN's experience with ME-GE engines, featuring three piston rings and insuring a uniform pressure drop."

The ME-GA engine is available in 60- and 70-cm cylinder bore versions (G60ME-C10.5-GA and G70ME-C10.5-GA) with a 50-cm bore version coming soon.

MAN Energy Solutions aims to start testing the first, commercial ME-GA design by the end of this year, with the first engine delivery following in early 2022.

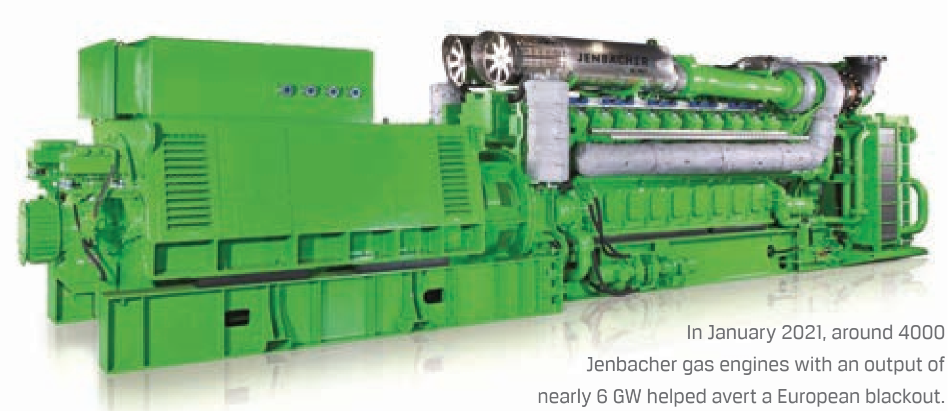


The new MAN B&W ME-GA low-speed dual fuel engine was demonstrated live at the MAN Research Center in Copenhagen.



Jenbachers help avoid European blackout

In January of 2021, about 4000 Jenbacher gas engines helped provide stability after power grid experienced critical frequency drop



In January 2021, around 4000 Jenbacher gas engines with an output of nearly 6 GW helped avert a European blackout.

In January 2021, around 4000 Jenbacher gas engines with an output of nearly 6 GW helped avert a European blackout.

A stable frequency was regained within a few minutes of the event Jan. 8. An active part in the operation was played by around 4000 flexible, fast-start, dispatchable Jenbacher gas engines, according to INNIO, Jenbacher's parent company.

A frequency deviation from the normal 50 Hz is a highly precarious situation and can, in extreme cases, lead to a large-scale and lengthy power failure known as a "total blackout." To prevent this from happening, automated security systems have been put in place that can be enabled at short notice and, in this particular instance, these backup systems successfully swung into action, according to INNIO.

Thanks to a coordinated approach that quickly ramped up reserve capacities, for example through gas-powered plants, in addition to the deployment of stabilizing measures, the frequency was quickly restabilized and the worst-case scenario was avoided.

"Because of the recordings made by our myPlant Asset Performance Management System, we know that at the time of the near-blackout in January 2021, almost 4000 Jenbacher gas engines played a role in stabilizing the European grid," said Andreas Kunz, chief technology officer at INNIO.

The engines responded to the frequency change within a few milliseconds and were able to help avert a damaging blackout by feeding around 6 GW into the European grid, the company said.

The continuous expansion of renewable generating capacity in Europe also places increasing demands on energy supply systems. To prevent blackouts from occurring, the grid therefore needs reliable power sources – namely centralized large-scale power plants and decentralized power plants – that can be called upon at any time to make up any shortfalls, INNIO said.

Playing a key role

"The decentralized supply of energy based on cogeneration systems has a key role to play in securing the electricity and heat supply across Europe in the decades ahead and in putting the energy supply on a more sustainable footing," Kunz said. "In the short and medium term, that means gas power plants that operate on natural gas. In the long term, these plants must also be made CO_2 neutral by running them on biomethane or even CO_2-free through the use of hydrogen, for example."

Gas engines that form part of a decentralized supply system are particularly well-suited to rapid start-up and load balancing in the event of fluctuations in consumption levels, a factor that will continue to gain importance with ever-advancing electrification (e.g. through electric vehicles and heat pumps).

While the technology may not be changing as the world moves toward a greener energy supply, the fuel is. And this is something that highly efficient INNIO Jenbacher gas engines are already prepared for since they can run on fossil fuel gases (natural gas or liquefied petroleum gas), on renewable gases (biogas or biomethane), or on up to 100% green hydrogen. The prerequisites for the flexibility for INNIO's efficient gas engines in terms of fuel choice, has been set in a cooperative development with the Large Engine Competence Center (LEC) in Graz.

INNIO is a global solutions provider of gas engines, power equipment, digital platforms and related services for power generation and gas compression. The company also provides lifecycle support to more than 53,000 delivered gas engines worldwide, backed by a service network in more than 100 countries. Headquartered in Jenbach, Austria, INNIO also maintains has primary operations in Welland, Ontario, Canada, and Waukesha, Wisconsin, USA.


JENBACHER
Waukesha
THOSE WHO BUILD
STRONG ENGINES
CAN DRIVE THE FUTURE.

INNIO's power generation and gas compression solutions

INNIO is a leading provider of renewable gas, natural gas, and hydrogen-based solutions and services for power generation and gas compression at or near the point of use. With our Jenbacher and Waukesha gas engines, INNIO helps to provide communities, industry and the public access to sustainable, reliable and economical power ranging from 200 kW to 10 MW. We also provide life-cycle support and digital solutions to the more than 53,000 delivered gas engines globally, through our service network in more than 100 countries. We deliver innovative technology driven by decarbonization, decentralization, and digitalization to help lead the way to a greener future. Headquartered in Jenbach, Austria, the business also has primary operations in Welland, Ontario, Canada, and Waukesha, Wisconsin, U.S.

Available Jenbacher* gas engines products 2021

1) ISO standard output, at 1,500 rpm/1,800 rpm and standard reference conditions according to ISO 3046at p.f. = 1.0 according to VDE 0530 REM

2) Heat recovery with a tolerance +/- 8%

3) NOx @ 5% O_2 dry

Requirements for technical data: All data according to full load, and subject to technical development and modification

*Indicates a trademark

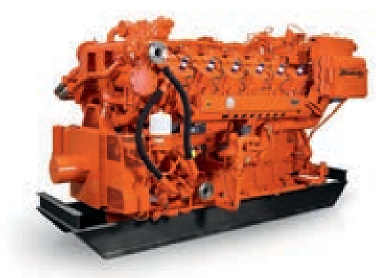
Power Generation

Fuel	Engine Types	Electrical output[1]		Thermal output[2]	
		50 Hz	60 Hz	50 Hz	60 Hz
		kWe	kWe	kW therm.	kW therm.
Natural gas NOx < 500 mg/Nm[3] (NOx < 1.1 g/bhp.hr)	J208	330	336	371	424
	J312	635	633	791	835
	J316	851	847	1,081	1,113
	J320	1,067	1,062	1,241	1,391
	J412	901	851	945	980
	J416	1,202	1,141	1,252	1,307
	J420	1,497	1,429	1,563	1,633
	J612	2,001	1,979	1,930	1,941
	J616	2,676	2,654	2,527	2,541
	J620	3,360	3,334	3,172	3,186
	J624	4,498	4,478	4,161	4,179
	J920 FleXtra	10,380	9,350	8,600+	7,510+
Biogas NOx < 500 mg/Nm[3] (NOx < 1.1 g/bhp.hr)	J208	330	336	413	410
	J312	635	633	709	785
	J316	851	847	935	1,046
	J320	1,067	1,062	1,179	1,307
	J412	901	851	913	956
	J416	1,202	1,141	1,214	1,274
	J420	1,497	1,429	1,515	1,594
	J612	1,817	1,798	1,668	1,727
	J616	2,433	2,411	2,225	2,305
	J620	3,044	3,022	2,782	2,878
Hydrogen NOx < 100 mg/Nm[3] (NOx < 0.3 g/bhp.hr)	J412	531	528	630	674
	J416	710	707	838	899
	J420	889	890	1,049	1,124

Waukesha

INNIO

Available Waukesha* gas engines products 2021



INNIO manufactures Waukesha spark ignited gaseous fueled 275GL+* VHP* and VGF* engines as well as Enginator* systems for gas compression, electric power generation, cogeneration and mechanical drive applications – ranging in output from 200 to 5,000 bhp (150 – 3,729 kWb).

Notes:

- Additional Ratings at speeds not shown are available.
- Rating Standard: All models: Ratings conform to ISO 3046/1 (latest version) with a mechanical efficiency of 90% and auxiliary water temperature, Tcra, as specified in the Power Ratings 18900 (latest version) limited to ±10° F (±5.5° C). Ratings are also valid for SAE J1349, BS 5514, DIN 6271 and API 7B-11C standard atmospheric reference conditions.
- For intermittent, reduced speed, alternate fuel, and other site condition power ratings, see Power Ratings 18900 or consult INNIO's Waukesha team.

*Indicates a trademark

Gas compression & mechanical drive

Lean-burn engines

Engine Types	rpm	bhp	kWb
275GL+			
16V275GL+	1,000	5,000	3,729
12V275GL+	1,000	3,750	2,796
VHP			
L5794LT	1,200	1,450	1,081
L5774LT	1,200	1,280	954
VGF			
P48GL	1,800	1,175	880
L36GL	1,800	880	660
H24GL	1,800	585	440
F18GL	1,800	440	330

Rich-burn engines

Engine Types	rpm	bhp	kWb
VHP			
P9394GSI S5	1,200	2,500	1,864
L7044GSI	1,200	1,680	1,253
L7044GSI S5	1,200	1,900	1,417
L7042GSI S4	1,200	1,480	1,104
L7042GSI S5	1,200	1,500	1,119
L7044G	1,200	920	686
L5794GSI	1,200	1,380	1,029
F3524GSI	1,200	840	626
F3514GSI	1,200	740	552
F3524G	1,200	460	343
VGF			
P48GSI	1,800	1,065	800
L36GSI	1,800	800	600
H24SE	1,800	530	400
H24SE-EPA	1,800	530	400
F18SE	1,800	400	300
F18SE-EPA	1,800	400	300

Power Generation

Lean-burn engines

Engine Types	Hz/rpm	kWe	Hz/rpm	kWe
275GL+				
16V275GL+	60/900	3,215	50/1,000	3,605
12V275GL+	60/900	2,415	50/1,000	2,705
VHP				
5904LT	60/1,200	1,025	50/1,000	900
VGF				
48GL	60/1,800	830	50/1,500	685
36GL	60/1,800	620	50/1,500	515
24GL	60/1,800	415	50/1,500	340
18GL	60/1,800	310	50/1,500	250

Rich-burn engines

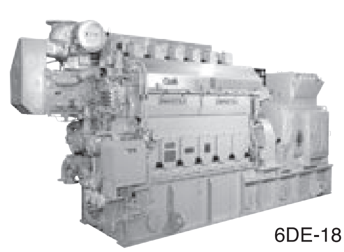
Engine Types	Hz/rpm	kWe	Hz/rpm	kWe
VHP				
9504GSI S5	60/1,200	1,770	50/1,000	1,600
7104GSI	60/1,200	1,200	50/1,000	1,100
7104GSI S5	60/1,200	1,350	50/1,000	1,240
7104GSI-EPA	60/1,200	1,200	-	-
7104GSI-MOB	-	-	50/1,000	1,100
7100GSI S4	60/1,200	1,050	50/1,000	875
7100GSI S5	60/1,200	1,065	50/1,000	1,005
5904GSI	60/1,200	980	50/1,000	900
5904GSI-EPA	60/1,200	980	-	-
5904GSI-MOB	-	-	50/1,000	900
3604GSI	60/1,200	600	50/1,000	540
VGF				
48GSI	60/1,800	750	50/1,500	625
36GSI	60/1,800	560	50/1,500	475
24SE	60/1,800	375	50/1,500	310
24SE-EPA	60/1,800	375	50/1,500	310
18SE	60/1,800	280	50/1,500	230
18SE-EPA	60/1,800	280	50/1,500	230

INNIO Waukesha Gas Engines Inc. (Pimary operation) Waukesha, WI 53188, USA T: +1 262 547 3311 F: +1 262 549 2759 www.innio.com

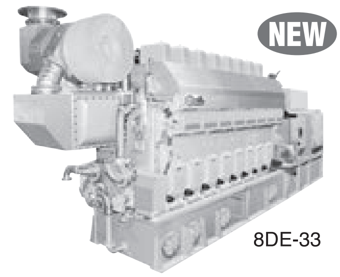
DAIHATSU DIESEL

Marine Gensets & Land Engines

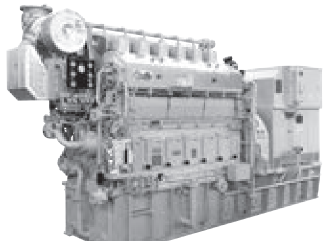
- Reliability and durability
- Compact, light weight
- Environmentally-friendly
- Lower operating costs



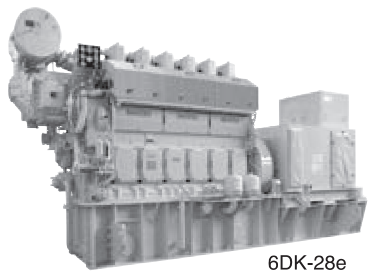
6DE-18



8DE-33



6DK-20e



6DK-28e

6DC-32e

DE Series

Models	No. of Cylinders	min⁻¹	kW	Bore × Stroke (mm)	Method of Starting A: air / E: electric	Total Weight (ton)	Length (mm)	Height (mm)	Width (mm)
6DE-18	6	720~900	680~860	185 × 280	A	12.0	4,850	2,400	1,540
6DE-23	6	720~900	1,280~1,500	230 × 320	A	23.0	6,100	2,840	1,780
6DE-33	6	720	3,600	330 × 440	A	69.1	9,110	3,950	2,410
8DE-33	8	720	4,800	330 × 440	A	83.7	10,390	4,150	2,410

Dimensions: Including generator and common bed

DC Series

Models	No. of Cylinders	min⁻¹	kW	Bore × Stroke (mm)	Method of Starting A: air / E: electric	Total Weight (ton)	Length (mm)	Height (mm)	Width (mm)
5DC-17Ae	5	900 / 1000	490	170 × 270	A	10.0	4,070	2,250	1,350
6DC-17Ae	6	900 / 1000	610	170 × 270	A	11.0	4,510	2,250	1,350
6DC-32e	6	720 / 750	3,000	320 × 400	A	58.00	8,295	3,820	2,345
8DC-32e	8	720 / 750	4,000	320 × 400	A	67.00	9,580	4,020	2,345

Dimensions: Including generator and common bed

DL・DK Series

Models	No. of Cylinders	min⁻¹	kW	Bore × Stroke (mm)	Method of Starting A: air / E: electric	Total Weight (ton)	Length (mm)	Height (mm)	Width (mm)
6DL-16Ae	6	1,200	530	165 × 210	A or E	5.9	3,700	1,800	1,230
5DK-20e	5	720~900	610~800	200 × 300	A	13.5	4,850	2,670	1,670
6DK-20e	6	720~900	800~1,040	200 × 300	A	16.0	5,480	2,890	1,800
8DK-20e	8	720~900	1,065~1,360	200 × 300	A	22.0	6,350	2,890	1,800
5DK-26e	5	720 / 750	1,280	260 × 380	A	24.0	5,770	3,250	1,990
6DK-26e	6	720 / 750	1,840	260 × 380	A	30.0	6,465	3,310	1,990
6DK-28e	6	720 / 750	2,100	280 × 390	A	35.0	6,825	3,710	2,235
8DK-28e	8	720 / 750	2,800	280 × 390	A	45.5	7,865	3,830	2,235
6DK-36e	6	600	3,500	360 × 480	A	73.0	7,500	3,818	3,360
8DK-36e	8	600	4,500	360 × 480	A	95.0	9,430	3,818	3,360
12DK-36e	12V	600	6,600	360 × 460	A	101.0	11,728	4,280	2,500

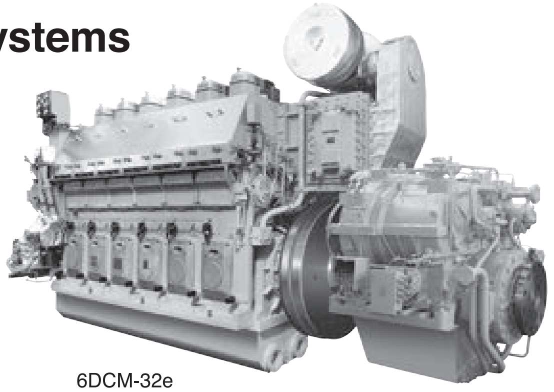
Dimensions: Including generator and common bed

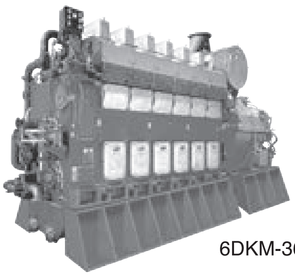
DAIHATSU DIESEL

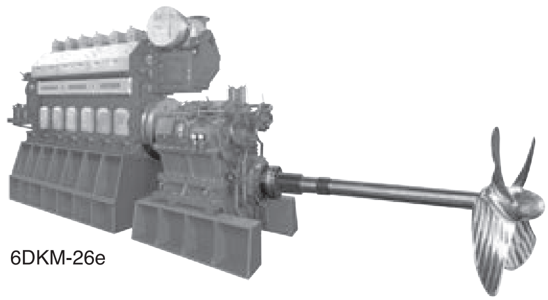
Marine Propulsion Engines

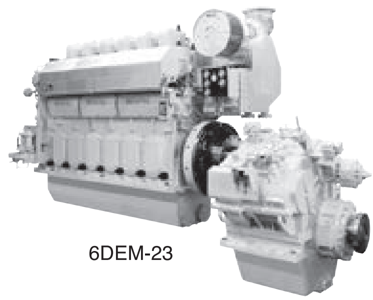
Creating next-generation propulsion systems

Our clean and powerful "e-Diesel" is packed with top-level quality and technologies that Daihatsu Diesel has accumulated and refined over many years since the foundation of the company in 1907. Daihatsu Diesel's history is marked by relentless challenges toward achieving the engine performance demanded by the changing times and meeting new needs. This challenging spirit is unchanged today and will continue into the future.
Daihatsu's e-Diesel is constantly advancing in order to deliver the ultimate performance that only the continually evolving company can attain.


6DCM-32e


6DKM-36e

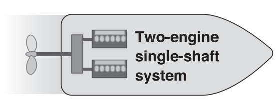

6DKM-26e

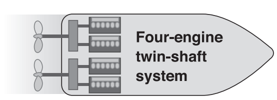

6DEM-23

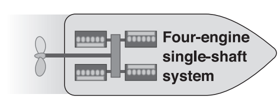
Models	No. of Cylinders	min⁻¹	Output (kWm)	Bore × Stroke (mm)	Propeller Revolution (min⁻¹)	Total Weight (ton)	Length (mm)	Height (mm)	Width (mm)
6DEM-18(750min⁻¹)	6	750	680	185 × 280	343 / 349	10.0 / 9.8	4,529 / 4,524	2,250	1,590
6DEM-18(900min⁻¹)	6	900	850	185 × 280	344 / 335	10.0 / 9.8	4,529 / 4,524	2,250	1,590
6DKM-20e	6	900	1,060	200 × 300	298 / 306	13.8 / 13.3	4,620 / 4,390	2,305	1,737
6DEM-23(750min⁻¹)	6	750	1,236	230 × 320	264 / 277	17.8 / 17.0	5,328 / 5,053	2,690	1,727
6DEM-23(900min⁻¹)	6	900	1,516	230 × 320	281 / 276	17.8 / 17.9	5,328 / 5,253	2,690	1,727
6DKM-26e	6	750	1,960	260 × 380	264 / 248	23.5 / 23.5	5,459 / 5,439	3,168	1,961
6DKM-28e	6	750	2,260	280 × 390	230 / 228	29.0 / 30.8	5,985 / 5,830	3,407	2,002
8DKM-28e	8	750	3,020	280 × 390	202 / 224	40.0 / 37.0	7,460 / 6,860	3,407	2,018
6DCM-32e	6	750	3,030	320 × 400	202 / 224	47.0 / 44.0	7,054 / 6,454	4,072	1,993
8DCM-32e	8	750	4,020	320 × 400	188 / 252	60.0 / 59.0	8,852 / 8,402	4,107	2,669
6DEM-33	6	720	3,600	330 × 440	212 / 249*	59.0 / 59.0*	9,240 / 8,800	3,980	2,830
8DEM-33	8	720	4,800	330 × 440	176 / 202	70.0* / 70.0*	8,350 / 8,150	3,780	2,680
6DKM-36e	6	600	3,500	360 × 480	198 / 183	63.0 / 62.0	7,675 / 7,095	4,135	1,994
8DKM-36e	8	600	4,500	360 × 480	188 / 202	85.0 / 84.0	9,202 / 8,662	4,332	2,245
12DKM-36e	12V	600	6,600	360 × 460	189 / 198	105.0 / 103.0	11,373 / 10,823	4,677	3,224

Output for all engine given for crank shaft end. Values marked with an asterisk (*) are reference values.

Multiple-Geared Diesel Engines







DAIHATSU DAIHATSU DIESEL MFG.CO.,LTD.
Tokyo Office. 1 2-10, Nihonbashi-Honcho 2-chome, Chuo-ku, Tokyo, 103-0023 Japan TEL:+81-3-3279-0827 FAX:+81-3-3245-0359


ROLLS
ROYCE


FISHING VESSELS
POWER PLANTS
DREDGERS
COASTERS
NAVY VESSELS
POWER GENERATION
LOCOMOTIVE


CONTAINERIZED GENSETS
TUGBOATS
FERRIES
WORKBOATS
HYBRID POWER PLANTS

Overall data

			Engine power (ISO 3046 – I)			Nominal power of gensets							
						50 Hz electric - 3 phase				60 Hz electric - 3 phase			
			kW		HP	P_w (kW)		P_n (kVA)		P_w (kW)		P_n (kVA)	
	Engine	rpm	mdo/hfo/bio	dual fuel **	mdo/hfo/bio	mdo/hfo/bio	dual fuel **	mdo/hfo/bio	dual fuel **	mdo/hfo/bio	dual fuel **	mdo/hfo/bio	dual fuel **
DV36	16 DV36	750	10547	—	14340	10125	—	12656	—	—	—	—	—
	16 DV36	720	10125	—	13766	—	—	—	—	9720	—	12150	—
	16 DV36	600	8438	—	11472	8100	—	10125	—	8100	—	10125	—
	12 DV36	750	7910	—	10755	7594	—	9493	—	—	—	—	—
	12 DV36	720	7594	—	10325	—	—	—	—	7290	—	9113	—
	12 DV36	600	6328	—	8604	6075	—	7594	—	6075	—	7594	—
DL36	8 DL36	750	5274	—	7166	5063	—	6328	—	—	—	—	—
	8 DL36	720	5063	—	6879	—	—	—	—	4860	—	6075	—
	8 DL36	600	4219	—	5732	4050	—	5063	—	4050	—	5063	—
	6 DL36	750	3955	—	5374	3797	—	4746	—	—	—	—	—
	6 DL36	720	3797	—	5159	—	—	—	—	3645	—	4556	—
	6 DL36	600	3164	—	4299	3038	—	3797	—	3038	—	3797	—
16 (V) DZC	*16 DZC*	*1000*	*4000 **	—	*5435*	*3840*	—	*4800*	—	—	—	—	—
	16 DZC	*900*	*3600 **	—	*4891*	—	—	—	—	*3456*	—	*4320*	—
	16 DZC	1000	3536	2670	4804	3395	2537	4244	3171	—	—	—	—
	16 DZC	900	3184	2400	4326	—	—	—	—	3057	2280	3821	2850
	16 DZC	800	2944	—	4000	—	—	—	—	—	—	—	—
	16 DZC	750	2840	2000	3859	2726	1900	3408	2375	—	—	—	—
	16 DZC	720	2752	1920	3739	—	—	—	—	2642	1824	3302	2280
12 (V) DZC	*12 DZC*	*1000*	*3000 **	—	*4076*	*2880*	—	*3600*	—	—	—	—	—
	12 DZC	*900*	*2700 **	—	*3668*	—	—	—	—	*2592*	—	*3240*	—
	12 DZC	1000	2652	2000	3603	2546	1900	3183	2375	—	—	—	—
	12 DZC	900	2388	1800	3245	—	—	—	—	2292	1710	2866	2138
	12 DZC	800	2208	—	3000	—	—	—	—	—	—	—	—
	12 DZC	750	2130	1500	2894	2045	1425	2556	1781	—	—	—	—
	12 DZC	720	2064	1440	2804	—	—	—	—	1981	1368	2477	1710
8 DZC	*8 DZC*	*1000*	*2000 **	—	*2717*	*1920*	—	*2400*	—	—	—	—	—
	8 DZC	*900*	*1800 **	—	*2446*	—	—	—	—	*1728*	—	*2160*	—
	8 DZC	1000	1768	1335	2402	1697	1268	2122	1585	—	—	—	—
	8 DZC	900	1592	1200	2163	—	—	—	—	1528	1140	1910	1425
	8 DZC	800	1472	—	2000	—	—	—	—	—	—	—	—
	8 DZC	750	1420	1000	1929	1363	950	1704	1188	—	—	—	—
	8 DZC	720	1376	960	1870	—	—	—	—	1321	912	1651	1140
6 DZC	*6 DZC*	*1000*	*1500 **	—	*2038*	*1440*	—	*1800*	—	—	—	—	—
	6 DZC	*900*	*1350 **	—	*1834*	—	—	—	—	*1296*	—	*1620*	—
	6 DZC	1000	1326	1000	1802	1273	950	1591	1188	—	—	—	—
	6 DZC	900	1194	900	1622	—	—	—	—	1146	855	1433	1069
	6 DZC	800	1104	—	1500	—	—	—	—	—	—	—	—
	6 DZC	750	1065	750	1447	1022	713	1278	891	—	—	—	—
	6 DZC	720	1032	720	1402	—	—	—	—	991	684	1238	855

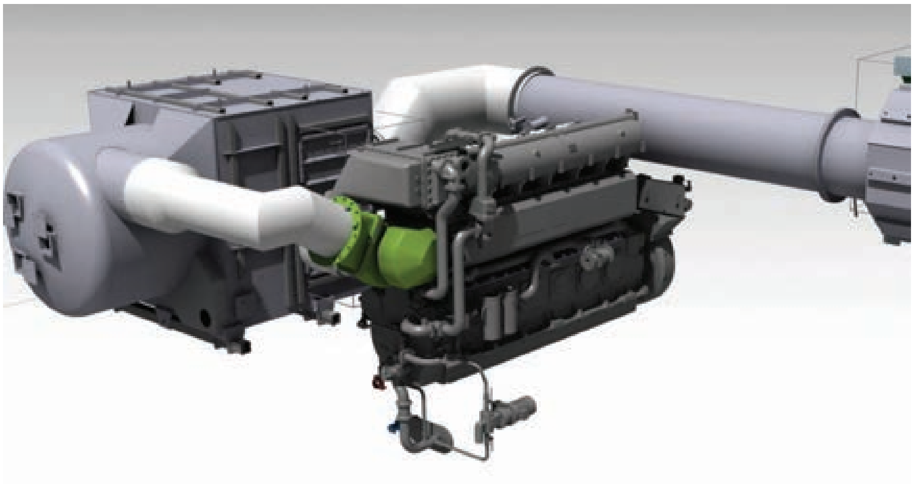
Conversion factors used: 1 metric HP = 0,736 kW → Generator efficiency: η_G = 0,96 → Power factor: cos φ = 0,8

* For special applications, contact ABC for more information

** Natural gas with Methane Index = 73 → Lower Calorific Value gas = 39.000 kJ/Nm³ → Lower Calorific Value diesel = 42.700 kJ/kg
Possible gases: natural gas, waste gas, landfill gas (the ability to burn other gases should be done in consultation with ABC)

DZC engine family approved

Anglo Belgian Corp. has first medium-speed engine to receive EU Stage 5 emissions certification



Anglo Belgian Corp. (ABC) received the official EU Stage 5 certificate for its DZC engines, making the company is the first medium-speed engine manufacturer to get Stage 5 certified.

Anglo Belgian Corp. (ABC) received the official EU Stage 5 certificate for its DZC engines, making the company is the first medium-speed engine manufacturer to get Stage 5 certified.

The EU Stage 5 standard limits the emission of nitrogen oxides and particles (soot) to very low values. This applies to all Non Road Mobile Machinery (NRMM) including vessels used for inland navigation.

For new main and auxiliary engines with a power above 300 kW, the Stage 5 emission requirement came into force on Jan. 1, 2020. This applies to all inland navigation engines for new builds as well as for repowering. The EU stage 5 engines for inland navigation are divided into several categories: IWP and IWA.

ABC said it has a Stage 5 solution for both categories in an engine range up to 4000 kW. Because the engine and the aftertreatment system are perfectly aligned, the outcome is a strong emission reduction and a considerable additional fuel saving.

ABC said the certification positions the company as a forerunner in the market. This market is not limited to inland shipping, as seagoing vessels can also make use of this development. These ships are currently regulated by less strict emission standards, but some operators consciously choose to further reduce their emissions.

As a result of this development, they can meet the stricter ULEV (Ultra Low Emission Vessel) standards, the company said.

"As a Belgian company, we are very proud of being the first in this segment to obtain a Stage 5 certificate," said Yannick Loulidi, development engineer EATS at ABC. "It was a challenge to go through the entire project.

"For EU Stage 5 we do not only have to meet certain emission requirements, but there are also very specific standards for monitoring the system. On top of that, there is also a follow-up of the engines during the production and implementation process.

"Our big advantage is that we combine the entire production, development and testing phase at the same facility in Ghent. This ensures a very short chain that allows us to monitor directly if necessary. This project has been carried out by the whole of ABC, from the people on the assembly line to the test engineers. Everyone within ABC helped to ensure that we achieved this fabulous result."

Anglo Belgian Corp. manufactures medium-speed engines between 600 and 10,400 kW. The company's engines are designed for energy and transport applications, including propulsion engines and generating sets for marine applications and diesel-hydraulic or diesel-electric engines for locomotive traction applications. More than 90% of its products are exported.

ABC has developed hybrid solutions designed to offer a flexible range of propulsion and power generation solutions. For this, ABC concluded cooperation agreements with several partners such as Bureau Veritas. ABC also offers turnkey solutions for power stations and special projects such as floating cranes, emergency generators for nuclear power plants and pump sets.

ABC said its flexible and modular engine aftertreatment (EAT) solutions are manufactured and assembled according to European standards, guaranteeing business reliability, service and short delivery times.

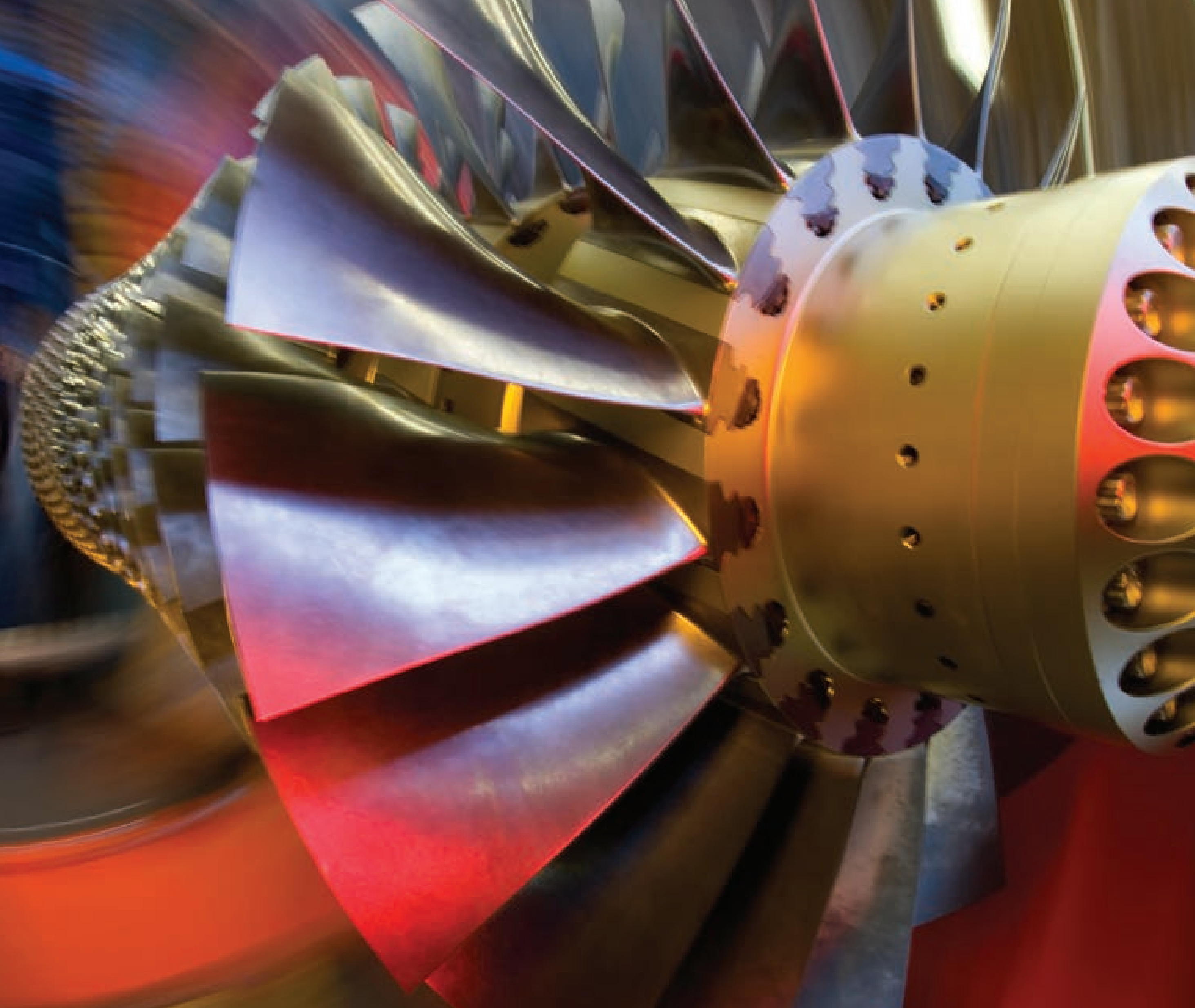
For IMO Tier III, ABC said it has type approval of its engines with the EAT system, which allows it to navigate in ECA zones. When leaving the ECA zone, the selective catalytic reduction (SCR) system can be switched off and the engine will comply with IMO Tier II limits, the company said.

The company's EAT solution to meet the stringent Stage 5 regulations according to EU2016/1628 emissions limits consists of a diesel particulate filter (DPF) and SCR, which allows the engine to meet ultralow levels of particles and NOx, the company said.

For seagoing vessels, ABC said it can offer a similar EAT system which meets ULEV standards. ABC was originally established in 1912 by a group of industrialists that included the inventor of the diesel engine, Rudolf Diesel.

An important step in the company's long history was its 1985 acquisition by OGEPAR. Also headquartered in Belgium, OGEPAR is a financial company whose holdings also include Kompressorenbau Bannewitz Gmbh (KBB), a manufacturer of turbochargers for diesel and gas engines.


DOOSAN
Powered by Innovation
The best performance and fastest response
The lowest total cost of ownership
D24
2.4L, 74hp
Tier 4 Final & Stage V
DOOSAN
DX50
www.doosanengine.com



Manufacturer	Page Reference	Model Number	Type (EG=Electric Generator GG=Gas Generator MD=Mechanical Drive MN=Marine Propulsion)	Fuel (L=Liquid G=Gaseous)	Continuous Output at ISO Conditions (bhp)	Continuous Output at ISO Conditions (kW)	Heat Rate (btu/hph)	Heat Rate (kJ/kWh)	Pressure Ratio	Mass Flow (lb/s)	Mass Flow (kg/s)	Turbine Inlet Temp (°C)	Exhaust Temp (°C)	Output Shaft Speed (r/min) min	Output Shaft Speed (r/min) max
ANSALDO ENERGIA	238	AE64.3A	EG	L/G		80000		9890	18.3	474	215		580	3000	3600
		AE94.2	EG	L/G		190000		9917	12	1224	555		550	3000	3000
		AE94.2K	EG	L/G		170000		9863	12	1190	540		545	3000	3000
		AE94.3A	EG	L/G		340000		8933	19.5	1664	755		593	3000	3000
		GT26	EG	L/G		370000		8780	35	1634	741		625	3000	3000
		GT36-S5	EG	L/G		538000		8411	26	2249	1020		621	3000	3000
		GT36-S6	EG	L/G		369000		8511	24	1565	710		630	3600	3600
		AE-T100	EG	G		100		12000	4.5	1.8	0.8		270	70000	70000
BAKER HUGHES	*	NovaLT5	EG	L/G	7510	5600	11127	11740	14.5	43	20		574		16630
		NovaLT16	EG	G	21460	16000	7067	10000	19	145	54		490		7800
CAPSTONE	*	C1000	GG	G	1341	1000	7700	10900		14.7	6.7	50	280	30000	61000
		C200 CARB High Pressure	GG	G	268	200	7700	10900		2.9	1.3	50	280	30000	61000
		C600 Low Pressure	GG	G	764	570	8200	11600		8.8	4	50	280	30000	61000
		C600 High Pressure	GG	G	805	600	7700	10900		8.8	4	50	280	30000	61000
		C800 Low Pressure	GG	G	1019	760	8200	11600		11.7	5.3	50	280	30000	61000
		C800 High Pressure	GG	G	1073	800	7700	10900		11.7	5.3	50	280	30000	61000
		C1000 Low Pressure	GG	G	1274	950	8200	11600		14.7	6.7	50	280	30000	61000
		C1000 High Pressure	GG	G	1341	1000	7700	10900		14.7	6.7	50	280	30000	61000
		C30	GG	L	39	29	10200	14400		0.7	0.3	50	275	45000	96000
		C65	GG	L	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		C65 ICHP	GG	L	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		C200	GG	L	255	190	7700	10900		2.9	1.3	50	280	30000	61000
		CR30	GG	G	40	30	9800	13800		0.7	0.3	50	275	45000	96000
		CR65	GG	G	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		CR65 ICHP	GG	G	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		CR200	GG	G	268	200	7700	10900		2.9	1.3	50	280	30000	61000
		CR600	GG	G	805	600	7700	10900		8.8	4	50	280	30000	61000
		CR800	GG	G	1073	800	7700	10900		11.7	5.3	50	280	30000	61000
		CR1000	GG	G	1341	1000	7700	10900		14.7	6.7	50	280	30000	61000
		C30	GG	G	40	30	9800	13800		0.7	0.3	50	275	45000	96000
		C30 Hazloc	GG	G	40	30	9800	13800		0.7	0.3	50	275	45000	96000
		C65	GG	G	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		C65 ICHP	GG	G	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		C65 Hazloc	GG	G	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		C200	GG	G	268	200	7700	10900		2.9	1.3	50	280	30000	61000
continued		C200 Hazloc	GG	G	268	200	7700	10900		2.9	1.3	50	280	30000	61000

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Model Number	Type (EG=Electric Generator, GG=Gas Generator, MD=Mechanical Drive, MN=Marine Propulsion)	Fuel (L=Liquid, G=Gaseous)	Continuous Output at ISO Conditions (bhp)	Continuous Output at ISO Conditions (kW)	Heat Rate (btu/hph)	Heat Rate (kJ/kWh)	Pressure Ratio	Mass Flow (lb/s)	Mass Flow (kg/s)	Turbine Inlet Temp (°C)	Exhaust Temp (°C)	Output Shaft Speed (r/min) min	Output Shaft Speed (r/min) max
CAPSTONE	*	C600	GG	G	805	600	7700	10900		8.8	4	50	280	30000	61000
		C800	GG	G	1073	800	7700	10900		11.7	5.3	50	280	30000	61000
		C30 Low Pressure	GG	G	38	28	10200	14400		0.7	0.3	50	275	45000	96000
		C30 High Pressure	GG	G	40	30	9800	13800		0.7	0.3	50	275	45000	96000
		C65 High Pressure	GG	G	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		C65 ICHP High Pressure	GG	G	87	65	8800	12400		1.1	0.5	50	309	45000	96000
		C65 CARB High Pressure	GG	G	87	65	9100	12900		1.1	0.5	50	311	45000	96000
		C200 Low Pressure	GG	G	255	190	8200	11600		2.9	1.3	50	280	30000	61000
		C200 High Pressure	GG	G	268	200	7700	10900		2.9	1.3	50	280	30000	61000
		C200 CARB Low Pressure	GG	G	255	190	8200	11600		2.9	1.3	50	280	30000	61000
CENTRAX GAS TURBINES	*	501-KB5	EG	G		3947		12391			15.7		555		
		501-KN5	EG	L		3852		12530			15.7		559		
		501-KB7	EG	G		4495		11661			16.3		553		
		501-KB7	EG	G		5334		11232			20.9		503		
		501-KN7	EG	L		5198		11348			21		494		
		501-KN7	EG	G		5954		10599			21.8		490		
		CX 300	EG	G		7900		11773			29.8		537		
		CX 300	EG	L		7574		11910			30.2		535		
		CX 400	EG	G		12900		10355			39.4		555		
		CX 400	EG	L		11428		10559			37.4		549		
		CX 400	EG	G		14400		10084			44.3		546		
		RB211 - DLE	EG	G		32070		9364			94.3		503		
		TRENT 60 - DLE	EG	G		53049		8499			155.1		434		
		TRENT 60 - WLE	EG	G		60493		8830			171		424		
		TRENT 60 - WLE (ISI)	EG	G		66000		8715			178.1		425		
DAIHATSU DIESEL MFG. CO. LTD.	214, 245	DT-4	EG	L		441		18110	8.0	6.6			570		1800
		DT-4W	EG	L		883		18110	8.0	13			570		1800
		DT-6	EG	L		662		17890	8.0	11			610		1800
		DT-10	EG	L		1103		19190	8.0	18			520		1800
		DT-10A	EG	L		1324		17890	8.0	18			560		1800
		DT-14	EG	L		1546		17890	8.0	23			580		1800
		DT-20	EG	L		2206		17890	8.0	33			570		1800
		DT-10AW	EG	L		2648		17890	8.0	37			560		1800
		DT-14W	EG	L		3089		17890	8.0	45			580		1800
		DT-20W	EG	L		4412		17890	8.0	66			570		1800
GE OIL & GAS	*	LMS100	EG	L/G	131683	98196	5885	8327	40	456	207		417		3600
		NovaLT16	EG	G	21460	16000	7067	10000	19	145	54		490		7800
		NovaLT5	EG	L/G	7510	5600	11127	11740	14.5	43	20		574		16630
		PGT20 SAC	EG	L/G	23450	17487	7227	10225	19.7	138	63		479		6500
continued		PGT20 DLE	EG	L/G	24055	17937	7238	10240	19.8	137	62		491		6500

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Model Number	Type (EG=Electric Generator, GG=Gas Generator, MD=Mechanical Drive, MN=Marine Propulsion)	Fuel (L=Liquid, G=Gaseous)	Continuous Output at ISO Conditions (bhp)	Continuous Output at ISO Conditions (kW)	Heat Rate (btu/hph)	Heat Rate (kJ/kWh)	Pressure Ratio	Mass Flow (lb/s)	Mass Flow (kg/s)	Turbine Inlet Temp (°C)	Exhaust Temp (°C)	Output Shaft Speed (r/min) min	Output Shaft Speed (r/min) max
GE OIL & GAS	*	PGT25 SAC	EG	L/G	30113	22456	7002	9906	17.9	152	69		522		6500
		PGT25 DLE	EG	L/G	30103	22448	7040	9960	17.9	151	69		529		6500
		PGT25+SAC	EG	L/G	40598	30274	6412	9072	21.5	186	84		500		6100
		PGT25+DLE	EG	L/G	40215	29988	6432	9101	21.5	185	84		507		6100
		PGT25+G4 SAC	EG	L/G	43901	32737	6434	9103	23	198	90		512		6100
		PGT25+G4 DLE	EG	L/G	43584	32500	6432	9101	23	197	90		513		6100
		LM6000 PC SAC FIXED IGV	EG	L/G	58197	43397	6094	8621	27.9	277	126		454		3600
		LM6000 PC SAC OPEN IGV	EG	L/G	58368	43525	6098	8628	28.2	279	127		452		3600
		LM6000 PC SAC VARIABLE IGV	EG	L/G	58470	43601	6089	8615	28.1	278	126		454		3600
		LM6000 PD	EG	L/G	57633	42977	6107	8641	28.3	275	125		455		3600
		LM6000 PF	EG	L/G	57633	42977	6107	8641	28.3	275	125		455		3600
		LM6000 PC SAC FIXED IGV	MD	L/G	59385	44283	5972	8449	27.9	277	126		454		3600
		LM6000 PC SAC OPEN IGV	MD	L/G	59559	44413	5976	8455	28.2	279	127		452		3600
		LM6000 PC SAC VARIABLE IGV	MD	L/G	59663	44491	5968	8443	28.1	278	126		454		3600
		LM6000 PD	MD	L/G	58809	43854	5985	8468	28.3	275	125		455		3600
		LM6000 PF	MD	L/G	58809	43854	5985	8468	28.3	275	125		455		3600
		LM6000 PF+	MD	L/G	72752	54000	6054	8566	31.4	310	142		502		3930
		LM6000 PG	MD	L/G	76885	57300	6179	8743	33.4	319	145		466		3930
		LMS100	MD	L/G	134370	100200	5768	8160	40	456	207		417		3600
		NovaLT16	MD	G	22130	16500	6876	9729	19	145	54		490		7800
		PGT20 SAC	MD	L/G	24300	18121	6974	9867	19.7	138	63		479		6500
		PGT20 DLE	MD	L/G	24927	18588	6985	9882	19.8	137	62		491		6500
		PGT25 SAC	MD	L/G	31206	23270	6756	9559	17.9	152	69		522		6500
		PGT25 DLE	MD	L/G	31195	23262	6793	9611	17.9	151	69		529		6500
		PGT25+SAC	MD	L/G	42071	31372	6187	8754	21.5	186	84		500		6100
		PGT25+DLE	MD	L/G	41674	31076	6207	8782	21.5	185	84		501		6100
		PGT25+G4 SAC	MD	L/G	45493	33924	6209	8784	23	198	90		512		6100
		PGT25+G4 DLE	MD	L/G	45164	33679	6207	8782	23	197	90		513		6100
		MS5001	EG	L/G	36047	26880	8842	12510	10.5	276	125		483		5100
		MS5002E LE	MD	G	43047	32100	6964	9854	17.3	227	103		502		5714
		MS5002E PE	MD	G	45327	33800	6876	9730	17.8	226	103		518		5714
		MS5002E LE	EG	G	41840	31200	7181	10161	17.3	227	103		502		5714
		MS5002E PE	EG	G	43986	32800	7096	10041	17.8	226	103		518		5714
		MS6001B	EG	L/G	57128	42600	7888	11160	12.3	322	146		546		5160
		MS7001EA	EG	L/G	120378	89766	7523	10644	12.9	662	300		544		3600
		MS9001E	EG	L/G	174467	130100	7358	10410	12.8	927	420		538		3000
continued		MS7121(EA)	EG		120378	89766	7523	10644	12.9	662	300		544		3600

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Model Number	Type (EG=Electric Generator, GG=Gas Generator, MD=Mechanical Drive, MN=Marine Propulsion)	Fuel (L=Liquid, G=Gaseous)	Continuous Output at ISO Conditions (bhp)	Continuous Output at ISO Conditions (kW)	Heat Rate (btu/hph)	Heat Rate (kJ/kWh)	Pressure Ratio	Mass Flow (lb/s)	Mass Flow (kg/s)	Turbine Inlet Temp (°C)	Exhaust Temp (°C)	Output Shaft Speed (r/min) min	Output Shaft Speed (r/min) max
GE OIL & GAS	*	MS9171(E)	EG		174467	130100	7358	10410	12.8	927	420		538		3000
		MS5002C	MD	L/G	37951	28300	8701	12310	8.8	274	124		517		4670
		MS5002C POWER CRYSTAL	MD		39520	29470	8714	12330	9.1	270	122		540		4670
		MS5002D	MD	L/G	43717	32600	8411	11900	10.8	312	141		509		4670
		MS5002D POWER CRYSTAL	MD		45553	33980	8413	11904	10.4	308	140		534		4670
		MS5002E	MD	G	42913	32000	7053	9978	17	226	102		508		5714
		MS6001B	MD	L/G	58955	43963	8140	11517	12.3	322	146		546		5160
		MS7001EA	MD	L/G	121362	90500	7584	10730	12.9	662	300		544		3600
		MS9001E	MD	L/G	175272	130700	7358	10410	12.8	927	420		538		3000
		GE10	EG	L/G	15086	11250	8122	11489	15.5	105	48		482		11000
		GE10-1 STANDARD	EG	L/G	15087	11250	8115	11481	15.5	105	48		482		11000
		GE10-1 DLE	EG	L/G	15089	11252	8434	11932	15.8	104	47		481		11000
		GE10-2	MD	L/G	16288	12146	7621	10782	15.6	104	47		483		7900
		GE10-2 DLE	MD	G	15907	11862	7762	10982	15.8	104	47		489		7900
KAWASAKI HEAVY INDUSTRIES LTD.	*	M1A-13A	EG	L/G	1991	1485	10510	14871	9.4	17.7	8		521	1500	1800
		M1A-13D	EG	L/G	1991	1485	10618	15022	9.6	17.5	8		531	1500	1800
		M1A-17D	EG	G	2280	1700	9480	13413	10.5	17.8	8.1		520	1500	1800
		M1T-13A	EG	L/G	3929	2930	10662	15085	9.4	35.4	16.1		521	1500	1800
		M1T-13D	EG	G	3929	2930	10771	15239	9.6	35.1	15.9		531	1500	1800
		M7A-01	EG	L/G	7410	5530	8590	12150	13	48	21.7		545	1500	1800
		M7A-02	EG	L/G	9120	6800	8390	11870	16	59.5	27		516	1500	1800
		M7A-01D	EG	L/G	7340	5470	8610	12190	13	48	21.7		542	1500	1800
		M7A-02D	EG	L/G	9040	6740	8410	11900	16	59.5	27		513	1500	1800
		M7A-03D	EG	L/G	10470	7800	7590	10730	16	59.9	27.2		523	1500	1800
		L20A	EG	G	24838	18522	7418	10496	18.6	131.8	59.8		541	1500	1800
		L30A	EG	G	40391	30120	6340	8970	24.9	195.6	88.7		470	1500	1800
		L30A	MD	G	41546	30980	6164	8720	24.9	195.6	88.7		470		5600
MAN ENERGY SOLUTIONS - TURBO	206	THM 1304-10N	MD	L/G	14080	10500	8370	11840	10	102.5	46.5	-	490	3870	9450
		THM 1304-10N	EG	L/G	13520	10080	8720	12330	10	102.5	46.5	-	490		9000
		THM 1304-12N	MD	L/G	16090	12000	8210	11610	11	106	48.1	-	525	3870	9450
		THM 1304-12N	EG	L/G	15450	11520	8550	12090	11	106	48.1	-	525		9000
		MGT6000	MD	L/G	9250	6900	7480	10590	15	62	28.1	-	460	5400	12600
		MGT6000	MD	L/G	11130	8300	7270	10290	16	66.1	30	-	480	5400	12600
		MGT6000	EG	L/G	8890	6630	7910	11190	15	57.8	26.2	-	505		1500/1800
		MGT6000	EG	L/G	10460	7800	7660	10840	16	64.8	29.4	-	490		1500/1800
SIEMENS ENERGY GLOBAL GMBH & CO. KG	243	KG2-3E	EG	L/G	2588	1930	21005	22160	4.7	33	15		549		1500/ 1800
		KG2-3G	EG	G		2000		14118	7		9.5		583		1500/ 1800
		SGT-50 DLE	EG	G	2682	2000	9978	14118	7	20.9	9.5			1500 / 1800	
continued		SGT-50 Diffusion Flame	EG	L/G	2573	1919	14967	21176	4.7	33.1	15		549	1500 / 1800	

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Model Number	Type (EG=Electric Generator, GG=Gas Generator, MD=Mechanical Drive, MN=Marine Propulsion)	Fuel (L=Liquid, G=Gaseous)	Continuous Output at ISO Conditions (bhp)	Continuous Output at ISO Conditions (kW)	Heat Rate (btu/hph)	Heat Rate (kJ/kWh)	Pressure Ratio	Mass Flow (lb/s)	Mass Flow (kg/s)	Turbine Inlet Temp (˚C)	Exhaust Temp (˚C)	Output Shaft Speed (r/min) min	Output Shaft Speed (r/min) max
SIEMENS ENERGY GLOBAL GMBH & CO. KG	243	SGT-100	EG	L/G	6772	5050	8443	11945	14	43.1	19.5		544	17384	
		SGT-100	EG	L/G	7241	5400	8421	11914	15.3	46.1	20.9		548.8	17384	
		SGT-100	MD	L/G	7700	5742	7607	10832	14.4	43.4	19.7		544	6500	13650
		SGT-300	EG	L/G	10540	7860	7667	10848	13.7	66.6	30.2		533.9	14010	
		SGT-300	MD	L/G	11220	8367	7212	10349	13.5	65	29.5		489	5750	12075
		SGT-300	MD	L/G	12320	9187	7071	10174	14.1	67	30.5		504	5750	12075
		SGT-400	EG	L/G	14027	10460	7310	10342	16.1	75.5	34.3		509	11500	
		SGT-400	MD	L/G	14600	10887	6908	9931	16.1	75.4	34.3		523	5750	12075
		SGT-400	EG	L/G	17299	12900	7319	10355	16.8	86.8	39.4		555	9500	
		SGT-400	MD	L/G	18540	13825	6919	9943	16.9	89.4	40.6		543	4750	9975
		SGT-400	EG	L/G	19230	14340	7194	10178	18.5	98.1	44.6		529	9500	
		SGT-400	MD	L/G	20020	14929	6858	9774	18.5	98.1	44.6		540	4750	9975
		SGT-600	EG	L/G	32828	24480	7577	10720	14	179.2	81.3		543	7700	
		SGT-600	MD	L/G	33847	25240	7344	10390	14	179.2	81.3		543	3850	8085
		SGT-700 (33 MW)	EG	L/G	44012	32820	6838	9675	18.7	209.4	95		533	6500	
		SGT-700 (33 MW)	MD	L/G	45151	33670	6661	9424	18.7	209.4	95		533	3250	6825
		SGT-700 (35 MW)	EG	L/G	47298	35270	6690	9466	20.4	217.6	98.7		531	6500	
		SGT-700 (35 MW)	MD	L/G	48511	36175	6524	9230	20.4	217.6	98.7		531	3250	6825
		SGT-750	EG	L/G	53386	39810	6306	8922	24.3	254.4	115.4		468	6100	
		SGT-750	MD	L/G	54994	41010	6121	8661	24.3	254.4	115.4		468	3050	6405
		SGT-750	MD	L/G	45595	34000	6299	8912	21.9	237	107.5		439	3050	6405
		SGT-800 (50 MW)	EG	L/G	66917	49900	6465	9147	19.8	274.9	124.7		560	6600	
		SGT-800 (54 MW)	EG	L/G	72415	54000	6507	9206	21.6	298.7	135.5		563	6600	
		SGT-800 (56 MW)	EG	L/G	74561	55600	6448	9123	22	303.6	137.7		564	6600	
		SGT-800 (57 MW)	EG	L/G	76438	57000	6340	8970	22	301.1	136.6		565	6600	
		SGT-800 (62 MW)	EG	L/G	83814	62500	6191	8759	21.1	298.7	135.5		596	6600	
		SGT5-2000E	EG	L/G	250800	187000	6971	9863	12.8	1230	558		536	3000	
		SGT5-4000F	EG	L/G	441000	329000	6206	8780	20.1	1596	724		599	3000	
		SGT5-8000H	EG	L/G	603500	450000	<6206	<8780	21	2061	935		630	3000	
		SGT5-8000HL	EG	L/G	645000	481000	5970	8447	24	1874	850		680	3000	
		SGT5-9000HL	EG	L/G	797908	595000	<9517	<8372	24	2314.9	1050		670	3000	
		SGT6-2000E	EG	L/G	156900	117000	7187	10169	12	816	368		532	3600	
		SGT6-5000F	EG	L/G	288320	215000	6442	9114	17	1053.8	478		612	3600	
		SGT6-5000F	EG	L/G	348666	260000	6361	9000	19.5	1291.9	586		592	3600	
		SGT6-8000H	EG	L/G	416000	310000	<6361	<9000	21	1433	650		645	3600	
		SGT6-9000HL	EG	L/G	590050	440000	<5890	<8333	24	1682.1	763		670	3600	
		SGT-A05	EG	L/G	5337	3980	8578	12137	10.3	34	15.4		560	14200	
		SGT-A05	EG	L/G	7215	5380	7882	11152	13,9	47	21.3		494	14600	
		SGT-A05	EG	L/G	7805	5820	7667	10848	14.1	47.2	21.4		522	14600	
continued		SGT-A35 GT62 DLE	EG	L/G	42030	31342	6644	9400	21.7	215.3	97.9		484.4	4800	

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Model Number	Type (EG=Electric Generator GG=Gas Generator MD=Mechanical Drive MN=Marine Propulsion)	Fuel (L=Liquid G=Gaseous)	Continuous Output at ISO Conditions		Heat Rate		Pressure Ratio	Mass Flow		Turbine Inlet Temp (˚C)	Exhaust Temp (˚C)	Output Shaft Speed (r/min)	
					(bhp)	(kW)	(btu/hph)	(kJ/kWh)		(lb/s)	(kg/s)			min	max
SIEMENS ENERGY GLOBAL GMBH & CO. KG	243	SGT-A35 GT62 DLE	MD	L/G	43145	32173	6037	9341	21.7	215.3	97.9		485	3120	5040
		SGT-A35 GT62	EG	L/G	42465	31666	6599	9336	22	217.4	98.8		480.6	4800	
		SGT-A35 GT62	MD	L/G	43593	32507	5996	9336	22	217.4	98.8		481	3120	5040
		SGT-A35 GT61 DLE	EG	L/G	44318	33048	6460	9140	21.6	215.7	98		486.7	4850	
		SGT-A35 GT61 DLE	MD	L/G	45493	33924	5848	8922	21.6	215.7	98		486	3153	5093
		SGT-A35 GT61	EG	L/G	45367	33830	6411	9071	22.1	218.7	99.4		485.6	4850	
		SGT-A35 GT61	MD	L/G	46571	34728	5803	8912	22.1	218.7	99.4		486	3153	5093
SOLAR TURBINES	Gas Turbine Tab, 268, 273	Titan 250	EG	L/G		23100	8775	9260	24.1	150	68.2		465	1500	1800
		Titan 250	MD	L/G	31900	23790	6725	8880	24.1	155.2	68.2		460		
		Titan 130	EG	L/G		16530	9605	10130	17.1	109.6	49.8		490	1500	1800
		Titan 130 Mobile Power Unit	EG	L/G		16530	9605	10130	17.1	109.6	49.8		490	1500	1800
		Titan 130 Modular Power Plant	EG	L/G		16530	9605	10130	17.1	109.6	49.8		490	1500	1800
		Titan 130	MD	L/G	23470	17500	6800	9940	16.1	123.8	50		480		
		Mars 100	EG	L/G		11350	10365	10935	17.7	93.6	42.6		485	1500	1800
		Mars 100	MD	L/G	15900	11860	7395	10465	17.1	93.8	42.2		485		9500
		Mars 90	EG	L/G		9450	10710	11300	16.3	88.4	40.2		465	1500	1800
		Mars 90	MD	L/G	13220	9860	7655	10830	16.3	88.5	40.2		465		9400
		Taurus 70	EG	L/G		8180	9920	10470	17.6	59.1	26.9		520	1500	1800
		Taurus 70	MD	L/G	11110	8290	7190	10195	16.5	59.1	27.8		500		
		Taurus 65	EG	L/G		6500	10295	10860	15	46.4	21.1		540	1500	1800
		Taurus 60	EG	L/G		5670	10830	11430	9.9	47.9	21.8		510	1500	1800
		Taurus 60 Mobile Power Unit	EG	L/G		5670	10830	11430	9.9	47.9	21.8		510	1500	1800
		Taurus 60 Modular Power Plant	EG	L/G		5670	10830	11430	9.9	47.9	21.8		510	1500	1800
		Taurus 60	MD	L/G	7700	5740	7950	11265	12.2	47.8	21.6		510		13950
		Mercury 50	EG	G		4600	8865	9350	9.9	39.2	17.8		365	1500	1800
		Centaur 50	EG	L/G		4600	11630	12270	10.6	42	19.1		510	1500	1800
		Centaur 50	MD	L/G	6150	4590	8485	12030	10.3	41.6	18.8		515		16500
		Centaur 40	EG	L/G		3515	12240	12910	10.1	41.8	19		445	1500	1800
		Centaur 40	MD	L/G	4700	3500	9125	12905	10.3	41.8	18.9		445		15500
		Saturn 20	EG	L/G		1210	14040	14810	6.7	14.4	6.5		505	1500	1800
		Saturn 20	MD	L/G	1590	1185	10370	14670	6.7	14.3	6.5		520		
YANMAR POWER TECHNOLOGY	175, 177	AT360S	EG	L		268								1500	1800
		AT600S	EG	L		450								1500	1800
		AT900S	EG	L		700								1500	1800
		AT1200ES	EG	L		883								1500	1800
		AT1800S	EG	L		1397								1500	1800
		AT2400ES	EG	L		1765								1500	1800
		AT2900	EG	L		2133								1500	1800
continued		AT3600ES	EG	L		2663								1500	1800

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Model Number	Type (EG=Electric Generator, GG=Gas Generator, MD=Mechanical Drive, MN=Marine Propulsion)	Fuel (L=Liquid, G=Gaseous)	Continuous Output at ISO Conditions (bhp)	Continuous Output at ISO Conditions (kW)	Heat Rate (btu/hph)	Heat Rate (kJ/kWh)	Pressure Ratio	Mass Flow (lb/s)	Mass Flow (kg/s)	Turbine Inlet Temp (°C)	Exhaust Temp (°C)	Output Shaft Speed (r/min) min	Output Shaft Speed (r/min) max
ZORYA-MASHPROEKT	*	UGT3000	MN	L	4505	3360	8210	11615	13.5	34	15.5		440		9700
		UGT3000R	MN	L	4505	3360	8775	12415	14	35	16		470		8800
		UGT5000	EG	G	7040	5250	7955	11250	14	47	21.5		480		1500, 1800, 3000
		UGT6000	EG	G	8530	6360	8080	11430	13.5	67	30.5		425		3000
		UGT6000	MD	G	8715	6500	8080	11430	14	68	31		430		8200
		UGT6000	MN	L	9855	7350	7955	11250	14.5	71	32		440		7000
		UGT6000R	MN	L	9855	7350	8485	12000	15	72	32.5		470		4750
		UGT6000+	MN	L	11800	8800	7710	10910	16	75	34		470		7000
		UGT6000R+	MN	L	11800	8800	8210	11615	16.5	76	34.5		500		7300
		UGT8000	MD	G	11130	8300	7665	10845	16.6	73	33		470		8200
		UGT16000	EG	G	21320	15900	8105	11465	12.5	212	96		350		3000
		UGT16000R	MN	L	22195	16550	8485	12000	13.5	220	100		380		3600
		UGT16000	MD	G	22395	16700	7955	11250	13	216	98		360		5300
		UGT15000	EG	G	22665	16900	7270	10285	19.5	157	71		420		3000
		UGT15000	MD	G	22395	16700	7270	10285	19.5	157	71		420		5200
		UGT15000	MN	L	23670	17650	7190	10170	20	161	73		430		5300
		UGT15000R	MN	L	19715	14700	7955	11250	18	154	70		430		4400
		UGT15000+	MN	L	26820	20000	7070	10000	20	169	76.5		450		3500
		UGT25000	EG	G	35135	26200	7010	9915	21.5	196	89		485		3000
		UGT25000	MN	L	38485	28700	6880	9730	22.5	207	94		500		3400
		UGT25000 (DU80)	MD	G	34865	26000	7070	10000	21.5	194	88		485		5000
		UGT25000 (DN80)	MD	G	35805	26700	6975	9865	21.5	196	89		490		3700
		UGT6000R	MN	L	9855	7350	8485	12000	15	72	32.5		470		4750
		UGT6000+	MN	L	11800	8800	7710	10910	16	75	34		470		7000
		UGT6000R+	MN	L	11800	8800	8210	11615	16.5	76	34.5		500		7300
		UGT8000	MD	G	11130	8300	7665	10845	16.6	73	33		470		8200
		UGT16000	EG	G	21320	15900	8105	11465	12.5	212	96		350		3000
		UGT16000R	MN	L	22195	16550	8485	12000	13.5	220	100		380		3600
		UGT16000	MD	G	22395	16700	7955	11250	13	216	98		360		5300
		UGT15000	EG	G	22665	16900	7270	10285	19.5	157	71		420		3000
		UGT15000	MD	G	22395	16700	7270	10285	19.5	157	71		420		5200
		UGT15000	MN	L	23670	17650	7190	10170	20	161	73		430		5300
		UGT15000R	MN	L	19715	14700	7955	11250	18	154	70		430		4400
		UGT15000+	MN	L	26820	20000	7070	10000	20	169	76.5		450		3500
		UGT25000	EG	G	35135	26200	7010	9915	21.5	196	89		485		3000
		UGT25000	MN	L	38485	28700	6880	9730	22.5	207	94		500		3400
		UGT25000 (DU80)	MD	G	34865	26000	7070	10000	21.5	194	88		485		5000
		UGT25000 (DN80)	MD	G	35805	26700	6975	9865	21.5	196	89		490		3700
		GTE-60A	EG	G	85155	63500	6560	9280	18	385	174.5		520		3000

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Combined-Cycle Model Designation	Frequency (50 and/or 60 Hz)	Base Load Rating ISO Conditions, Gas Fuel Lower Heating Value (LHV) of Fuel			Number and Model of Gas Turbines	Gas Turbine Output (kW)	Steam Turbine Output (kW)	Notes
				Continuous Output (kW)	Heat Rate (kJ/kWh)	Efficiency (%)				
ANSALDO ENERGIA S.P.A.	238	1AE643-CC1S	50/60	120000	6463	55.7	1x AE64.3A			
		1AE942-CC1M	50	287000	6452	55.8	1x AE94.2			
		1AE943-CC1S	50	495000	6000	60	1x AE94.3A			
		1GT26-CC1S	50	540000	5902	61	1x GT26			
		1GT36-S5-CC1M	50	760000	5751	62.6	1x GT36-S5			
		1GT36-S6-CC1M	60	520000	5778	62.3	1x GT36-S6			
		2AE643-CC1M	50/60	243000	6383	56.4	2x AE64.3A			
		2AE942-CC1M	50	578000	6406	56.2	2x AE94.2			
		2AE943-CC1M	50	992000	5970	60.3	2x AE94.3A			
		2GT26-CC1M	50	1083000	5882	61.2	2x GT26			
		2GT36-S5-CC1M	50	1525000	5732	62.8	2x GT36-S5			
		2GT36-S6-CC1M	60	1046000	5751	62.6	2x GT36-S6			
GE POWER	*	LM6000 PC	50/60	60300	6932	51.90%	1x	46700	14500	
		LM6000 PC	50/60	121100	6902	52.20%	2x	93400	29600	
		LM6000 PC Sprint	50/60	66500	6971	51.60%	1x	51500	16000	
		LM6000 PC Sprint	50/60	133600	6941	51.90%	2x	103100	32500	
		LM6000 PG	50/60	73900	6966	51.70%	1x	56100	18900	
		LM6000 PG	50/60	148800	6924	52.00%	2x	112300	38700	
		LM6000 PG Sprint	50/60	75500	7037	51.20%	1x	57400	19400	
		LM6000 PG Sprint	50/60	152200	6987	51.50%	2x	114700	39700	(dual pressure no reheat)
		LM6000 PF	50/60	58800	6585	54.70%	1x	44600	15000	(dual pressure no reheat)
		LM6000 PF	50/60	118400	6538	55.10%	2x	89200	30800	(dual pressure no reheat)
		LM6000 PF Sprint	50/60	65200	6653	54.10%	1x	50000	16000	(dual pressure no reheat)
		LM6000 PF Sprint	50/60	131200	6610	54.50%	2x	100000	32900	(dual pressure no reheat)
		LM6000 PF+	50/60	72400	6510	55.30%	1x	53800	19500	(dual pressure no reheat)
		LM6000 PF+	50/60	145600	6472	55.60%	2x	107600	39900	3P no reheat
		LM6000 PF+ Sprint	50/60	76000	6626	54.30%	1x	57100	20000	3P no reheat
		LM6000 PF+ Sprint	50/60	153300	6571	54.80%	2x	114200	41200	3P no reheat
		LM2500 DLE	50	33300	6943	51.90%	1x	22200	11800	3P no reheat
		LM2500 DLE	50	67200	6887	52.30%	2x	44300	24100	3P no reheat
		LM2500+ DLE	50	44200	6795	53.00%	1x	30500	14500	3P no reheat
		LM2500+ DLE	50	89200	6737	53.40%	2x	61000	29600	3P no reheat
		LM2500+G4 SAC	50	49100	7263	49.60%	1x	34500	15500	3P no reheat
		LM2500+G4 SAC	50	99000	7205	50.00%	2x	69000	31700	3P no reheat
continued		LM2500+G4 DLE	50	47900	6719	53.60%	1x	32900	15800	3P no reheat

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Combined-Cycle Model Designation	Frequency (50 and/or 60 Hz)	Base Load Rating ISO Conditions, Gas Fuel Lower Heating Value (LHV) of Fuel			Number and Model of Gas Turbines	Gas Turbine Output (kW)	Steam Turbine Output (kW)	Notes
				Continuous Output (kW)	Heat Rate (kJ/kWh)	Efficiency (%)				
GE POWER	*	LM2500+G4 DLE	50	96700	6662	54.00%	2x	65800	32400	3P no reheat
		LM2500XPRESS+G4 UPT DLE	50	47700	6594	54.60%	1x	33900	14700	3P no reheat
		LM2500XPRESS+G4 UPT DLE	50	96200	6542	55.00%	2x	67700	30000	(dual pressure no reheat)
		LM2500XPRESS+G5 UPT DLE	50	51200	6585	54.70%	1x	36200	15800	(dual pressure no reheat)
		LM2500XPRESS+G5 UPT DLE	50	103300	6533	55.10%	2x	72400	32500	Triple pressure reheat
		TM2500	50	49200	7248	49.70%	1x	34600	15500	Triple pressure reheat
		TM2500	50	99200	7189	50.10%	2x	69100	31800	Triple pressure reheat
		LM9000	50	95700	6648	54.10%	1x	72300	24700	Triple pressure reheat
		LM9000	50	192800	6598	54.60%	2x	144600	50800	Triple pressure reheat
		LMS100 PA+	50	134500	7006	51.40%	1x	113600	23000	Triple pressure reheat
		LMS100 PA+	50	269700	6986	51.50%	2x	227100	46600	Triple pressure reheat
		LMS100 PB+	50	127000	7052	51.00%	1x	107000	21900	Triple pressure reheat
		LMS100 PB+	50	255000	7025	51.20%	2x	213900	44800	(dual pressure no reheat)
		LM2500 DLE	60	33500	6869	52.40%	1x	22900	11300	(dual pressure no reheat)
		LM2500 DLE	60	67700	6802	52.90%	2x	45800	23200	Triple pressure reheat
		LM2500+ DLE	60	44000	6597	54.60%	1x	31200	13500	Triple pressure reheat
		LM2500+ DLE	60	88800	6551	54.90%	2x	62500	27700	Triple pressure reheat
		LM2500+G4 SAC	60	51300	7098	50.70%	1x	37200	15000	Triple pressure reheat
		LM2500+G4 SAC	60	103500	7043	51.10%	2x	74400	30700	Triple pressure reheat
		LM2500+G4 DLE	60	48000	6597	54.60%	1x	34000	14800	Triple pressure reheat
		LM2500+G4 DLE	60	96500	6558	54.90%	2x	67900	30100	Triple pressure reheat
		LM2500XPRESS+G4 UPT DLE	60	47800	6566	54.80%	1x	34200	14400	Triple pressure reheat
		LM2500XPRESS+G4 UPT DLE	60	96400	6514	55.30%	2x	68300	29500	(dual pressure no reheat)
		LM2500XPRESS+G5 UPT DLE	60	51900	6518	55.20%	1x	37000	15700	(dual pressure no reheat)
		LM2500XPRESS+G5 UPT DLE	60	104600	6467	55.70%	2x	73900	32200	(dual pressure no reheat)
		TM2500	60	51100	7125	50.50%	1x	37000	15000	(dual pressure no reheat)
continued		TM2500	60	103100	7067	50.90%	2x	73900	30800	(dual pressure no reheat)

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Combined-Cycle Model Designation	Frequency (50 and/or 60 Hz)	Base Load Rating ISO Conditions, Gas Fuel Lower Heating Value (LHV) of Fuel			Number and Model of Gas Turbines	Gas Turbine Output (kW)	Steam Turbine Output (kW)	Notes
				Continuous Output (kW)	Heat Rate (kJ/kWh)	Efficiency (%)				
GE POWER	*	LM9000	60	95900	6677	53.90%	1x	72500	24700	(dual pressure no reheat)
		LM9000	60	193300	6623	54.40%	2x	145000	50800	(dual pressure no reheat)
		LMS100 PA+	60	135300	7027	51.20%	1x	116700	20500	(dual pressure no reheat)
		LMS100 PA+	60	271300	7007	51.40%	2x	233500	41700	(dual pressure no reheat)
		LMS100 PB+	60	128200	7014	51.30%	1x	107900	22300	(dual pressure no reheat)
		LMS100 PB+	60	257300	6992	51.50%	2x	215700	45300	(dual pressure no reheat)
		6B.03	50/60	70000	6940	51.90%	1x	44500	26200	
		6B.03	50/60	141000	6874	52.40%	2x	89000	53600	
		6F.01	50/60	84000	6309	57.10%	1x	56300	29100	
		6F.01	50/60	170000	6259	57.50%	2x	112700	59400	
		6F.03	50/60	135000	6328	56.90%	1x	87600	49400	
		6F.03	50/60	272000	6271	57.40%	2x	175200	100900	
		9E.03	50	205000	6775	53.10%	1x	130800	76600	
		9E.03	50	412000	6723	53.50%	2x	261500	156200	
		9E.04	50	218000	6545	55.00%	1x	145000	76100	
		9E.04	50	439000	6505	55.30%	2x	290000	154700	
		GT13E2-210	50	305000	6530	55.10%	1x	208000	100800	
		GT13E2-210	50	613000	6492	55.50%	2x	415900	205000	
		GT13E2-190	50	280000	6512	55.30%	1x	193200	90400	
		GT13E2-190	50	563000	6475	55.60%	2x	386400	183700	
		9F.03	50	412000	6096	59.10%	1x	263700	153400	
		9F.03	50	825000	6081	59.20%	2X	527300	308500	
		9F.04	50	443000	5978	60.20%	1X	285600	163600	
		9F.04	50	889000	5960	60.40%	2X	571200	329700	
		9F.05	50	493000	5928	60.70%	1X	-	-	
		9F.05	50	989000	5911	60.90%	2X	625300	374700	
		9HA.01	50	680000	5651	63.70%	1X	-	-	
		9HA.01	50	1363000	5639	63.80%	2X	909700	469100	
		9HA.02	50	838000	5613	64.10%	1X	-	-	
		9HA.02	50	1680000	5598	64.30%	2X	1142400	557600	
continued		7E.03	60	140000	6873	52.40%	1X	89400	52500	

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Combined-Cycle Model Designation	Frequency (50 and/or 60 Hz)	Base Load Rating ISO Conditions, Gas Fuel Lower Heating Value (LHV) of Fuel: Continuous Output (kW)	Heat Rate (kJ/kWh)	Efficiency (%)	Number and Model of Gas Turbines	Gas Turbine Output (kW)	Steam Turbine Output (kW)	Notes
GE POWER	*	7E.03	60	283000	6809	52.90%	2X	178900	107400	
		7F.04	60	309000	6031	59.70%	1X	199200	113800	
		7F.04	60	622000	5987	60.10%	2X	398300	231600	
		7F.05	60	379000	5979	60.20%	1X	242000	142300	
		7F.05	60	762000	5951	60.50%	2X	484000	287400	
		7HA.01	60	438000	5783	62.30%	1X	294100	149000	
		7HA.01	60	880000	5753	62.60%	2X	588200	302500	
		7HA.02	60	573000	5677	63.40%	1X	-	-	
		7HA.02	60	1148000	5660	63.60%	2X	765000	397200	
		7HA.03	60	640000	5636	63.90%	1X	-	-	
		7HA.03	60	1282000	5625	>64.0%	2X	860000	437600	
MAN ENERGY SOLUTIONS SE - TURBO	206	MGT6000	50/60	19210	7860	45.8	2X MGT6000	13260	5950	
		THM 1304-10N	50/60	31560	7772	46.3	2X THM 1304-10N	21160	10400	
		THM 1304-12N	50/60	36800	7483	48.1	2X THM 1304-12N	24000	12800	
PW POWER SYSTEMS	*	FT8 SWIFTPAC 30	50/60	41050	7333	49.1	1X FT8-3	30100	12000	
		FT8 SWIFTPAC 60	50/61	83100	7257	49.6	2X FT8	60500	24600	
		FT4000 SWIFTPAC 60	50/62	84608	7247	49.7	1X FT4000	69347	16752	
		FT4000 SWIFTPAC 120	50/63	170272	7202	50	2X FT4000	139009	34262	
SIEMENS ENERGY GLOBAL GMBH & CO. KG	243	SCC-600 2X1	50/60	73280	7071	50.9	2X SGT-600	47780	26450	
		SCC-600 1X1	50/60	35900	7220	49.9	1X SGT-600	23880	12600	
		SCC-700 2X1	50/60	91620	6778	53.1	2X SGT-700 (33 MW)	62600	30040	
		SCC-700 1X1	50/60	45160	6876	52.3	1X SGT-700 (33 MW)	32300	14410	
		SCC-700 2X1	50/60	99000	6644	54.2	2X SGT-700 (35 MW)	68780	31240	
		SCC-700 1X1	50/60	49200	6684	53.9	1X SGT-700 (35 MW)	34390	15370	
		SCC-750 2X1	50/60	103740	6718	53.6	2X SGT-750	77300	27480	
		SCC-750 1X1	50/60	51550	6760	53.3	1X SGT-750	38650	13480	
		SCC-800 1X1	50/60	71200	6298	57.2	1X SGT-800	48800	23100	
		SCC-800 2X1	50/60	143900	6233	57.8	2X SGT-800	97500	47800	
		SCC-800 3X1	50/60	215700	6228	57.8	3X SGT-800	146300	71600	
		SCC-800 1X1	50/60	77300	6323	56.9	1X SGT-800	52800	25300	
		SCC-800 2X1	50/60	156300	6257	57.5	2X SGT-800	105700	52200	
continued		SCC-800 3X1	50/60	234300	6261	57.5	3X SGT-800	158500	78200	

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Combined-Cycle Model Designation	Frequency (50 and/or 60 Hz)	Base Load Rating ISO Conditions, Gas Fuel Lower Heating Value (LHV) of Fuel			Number and Model of Gas Turbines	Gas Turbine Output (kW)	Steam Turbine Output (kW)	Notes
				Continuous Output (kW)	Heat Rate (kJ/kWh)	Efficiency (%)				
SIEMENS ENERGY GLOBAL GMBH & CO. KG	243	SCC-800 1X1	50/60	80700	6221	57.9	1X SGT-800	55800	25700	
		SCC-800 2X1	50/60	163100	6158	58.5	2X SGT-800	111600	53200	
		SCC-800 3X1	50/60	245000	6154	58.5	3X SGT-800	167400	80100	
		SCC-800 1X1	50/60	88000	6100	59	1X SGT-800	61200	27700	
		SCC-800 2X1	50/60	180000	6000	60	2X SGT-800	122400	59400	
		SCC-800 3X1	50/60	270000	6000	60	3X SGT-800	183800	88900	
		SCC5-2000E 1X1	50	275000	6679	53.9	1X SGT5-2000E	187000	93000	
		SCC5-2000E 2X1	50	551000	6679	53.9	2X SGT5-2000E	374000	186000	
		SCC5-4000F SINGLE SHAFT	50	475000	6030	59.7	1X SGT5-4000F			
		SCC5-4000F 2X1	50	950000	6030	59.7	2X SGT5-4000F	658000	320000	
		SCC5-8000H SINGLE SHAFT	50	665000	5890	61	1X SGT5-8000H			
		SCC5-8000H 2X1	50	1335000	5880	61	2X SGT5-8000H	900000	455000	
		SCC5-8000HL SINGLE SHAFT	50	708000	5 714	>63	1X SGT5-8000HL			
		SCC5-8000HL 2X1	50	1416000	5 714	>63	2X SGT5-8000HL			
		SCC5-9000HL 1X1 / SINGLE SHAFT	50	880000	5 625	>64	1X SGT5-9000HL	595000	285000	
		SCC5-9000HL 2X1	50	1760000	5 625	>64	2X SGT5-9000HL	1190000	570000	
		SCC6-2000E 1X1	60	174000	6893	52.2	1X SGT6-2000E	117000	60000	
		SCC6-2000E 2X1	60	347000	6901	52.2	2X SGT6-2000E	234000	119000	
		SCC6-5000F 1X1	60	325000	6050	59.5	1X SGT6-5000F	215000	115000	
		SCC6-5000F 2X1	60	650000	6040	59.6	2X SGT6-5000F	430000	230000	
		SCC6-5000F 1X1	60	387000	6040	59.6	1X SGT6-5000F	260000	133000	
		SCC6-5000F 2X1	60	775000	6030	59.7	2X SGT6-5000F	520000	267000	
		SCC6-8000H SINGLE SHAFT	60	460000	5920	61	1X SGT6-8000H			
		SCC6-8000H 2X1	60	930000	5910	61	2X SGT6-8000H			
		SCC6-9000HL 1X1 / SINGLE SHAFT	60	655000	5 625	>64	1X SGT6-9000HL	440000	215000	
		SCC6-9000HL 2X1	60	1310000	5 625	>64	2X SGT6-9000HL	880000	430000	
		SGT-A35 DLE 1 × 1	50/60	37700	7175	50.2	1X SGT-A35 G62 DLE	26716	12045	
		SGT-A35 DLE 1 × 1	50/60	39800	7005	51.4	1X SGT-A35 GT62 DLE	28626	12205	
continued		SGT-A35 DLE 1 × 1	50/60	42600	6820	52.8	1X SGT-A35 GT61 DLE	31171	12593	

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Combined-Cycle Model Designation	Frequency (50 and/or 60 Hz)	Base Load Rating ISO Conditions, Gas Fuel Lower Heating Value (LHV) of Fuel			Number and Model of Gas Turbines	Gas Turbine Output (kW)	Steam Turbine Output (kW)	Notes
				Continuous Output (kW)	Heat Rate (kJ/kWh)	Efficiency (%)				
SIEMENS ENERGY GLOBAL GMBH & CO. KG	243	SGT-A65 (INDUSTRIAL TRENT 60) DLE 1 × 1	50	73000	6593	54.6	1X SGT-A65 DLE			
		SGT-A65 (INDUSTRIAL TRENT 60) DLE ISI 1 × 1	50	83000	6648	54.2	1X SGT-A65 DLE ISI			
		SGT-A65 (INDUSTRIAL TRENT 60) DLE 1 × 1	60	73000	6593	54.6	1X SGT-A65 DLE			
		SGT-A65 (INDUSTRIAL TRENT 60) DLE ISI 1 × 1	60	83000	6648	54.2	1X SGT-A65 DLE ISI			
		SGT-A65 (INDUSTRIAL TRENT 60) DLE 2 × 1	50	147000	6546	55	2X SGT-A65 DLE			
		SGT-A65 (INDUSTRIAL TRENT 60) DLE ISI 2 × 1	50	166800	6617	54.4	2X SGT-A65 DLE ISI			
		SGT-A65 (INDUSTRIAL TRENT 60) DLE 2 × 1	60	147000	6546	55	2X SGT-A65 DLE			
		SGT-A65 (INDUSTRIAL TRENT 60) DLE ISI 2 × 1	60	166800	6617	54.4	2X SGT-A65 DLE ISI			
ZORYA-MASHPROEKT	*	UGT15000CC1	50	20600		45.1	1X UGT15000	16,000		
		UGT15000CC2	50	41500		43.4	2X UGT15000	32,000		
		UGT25000CC1	50	33300		46.6	1X UGT25000	25,000		
		UGT25000CC2	50	67000		46.9	2X UGT25000	50,000		
		UGT16000CC1	50	18500		37	1X UGT16000	15,000		
		UGT45000CC1	50	66100		50.8	1X UGT45000	45,000		
		UGT45000CC2	50	132200		50.8	2X UGT45000	90,000		
		UGT60000CC1	50	83800		52.1	1X UGT60000	60,000		
		UGT60000CC2	50	167600		52.1	2X UGT60000	120,000		

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.


INN
WORLD
EFFICI
TOG THE
E


PEOPLE
OVATION
WIDE
ENCY
R
Power Together
Manufacturing and technological capabilities,
design expertise,
innovative spirit and ability to deliver results,
to offer tailor made solutions based on Customers' needs.
ANSALDO ENERGIA
ansaldoenergia.com

An AE64.3A gas turbine by Ansaldo Energia.

Ansaldo Energia to supply gas turbine for CCPP

Ansaldo gas turbine, equipped with the latest generation high-efficiency technologies and controls, will be used in 120 MW combined-cycle plant in Italy

Ansaldo Energia was awarded a contract by Gruppo Arvedi for the supply and refurbishment of the new combined cycle plant in Servola, Trieste, Italy.

The contract includes an AE64.3A gas turbine, equipped with the latest generation technologies already validated to guarantee high efficiency, operational flexibility and low emissions. Also included is the Ansaldo Energia Plant Optimizer management system.

The plant in combined-cycle configuration will have a power output of 120 MW and is expected to be operational by the end of 2021.

Gruppo Arvedi is one of the main European steel companies, reporting a consolidated turnover of €2.9 billion in 2019 and employing 3,600 people.

Meeting strict regulations

With this investment, the Arvedi Group enters the Italian Capacity Market for electricity supply, whose implementation decree was approved by the Italian Ministry of Economic Development in June 2019. The Capacity Market, in line with the situation in other European countries, aims to ensure the adequacy and safety of the national electricity system in the presence of a strong renewable component – non-dispatchable by its very nature – by encouraging investments in efficient, low-polluting and flexible plants.

Ansaldo Energia reported that the proposed solution chosen by the customer is able to ensure full compliance with the most stringent regulations on environmental impact.

With more than 250,000 MW installed in more than 90 countries and 4000 employees,

Ansaldo Energia Group is an international player in the field of electricity generation and provides turnkey plants, components – including gas turbines, steam turbines, generators and microturbines – and support services. Ansaldo

Energia is 88% owned by CDP Equity of the Cassa Depositi e Prestiti Group, a national promotion institution that has been active in the Italian economy since 1850, and 12% by Shanghai Electric, a Chinese specialist in the production of power generation machinery and mechanical equipment.

Two Titan 130 generator sets provide the Ontario, California, USA, facility with 100% of its electrical requirements as well as steam for production.

An environmental upgrade

Containerboard maker chooses Solar Titan 130 gas turbines for mill

New-Indy Containerboard operates four mills producing 750 000 tons of recycled containerboard per year. New-Indy's mills receive more than 100 truckloads of old corrugated cardboard (OCC) daily. This material is cleaned, reduced to a slurry and then reformed to create new containerboard. The recycled paper is then sent to box plants throuout local markets. Each of their California, USA, locations have combined heat and power (CHP) plants that provide all of the mill's electrical power and also supply power to thousands of Southern California homes through its partnership with Southern California Edison.

Powered by natural gas

New-Indy previously owned and operated a CHP plant that provided steam and power to the existing paper mill facility and to the new box plant adjacent to the main plant. The existing CHP plant was at the end of its service life. Due to the increased maintenance cost, environmental fees and changes in environmental regulations, New-Indy decided to upgrade its existing CHP plant with a new, efficient and environmentally friendly system. The new upgraded CHP plant uses natural gas for all operations to produce power and steam. The two new Titan 130 gas turbines from Solar are fitted with SoLONOx emissions systems and will be much cleaner and more efficient that the replaced unit, the company said.

These two Titan 130 generator sets provide the Ontario manufacturing facility with 100% of its electrical requirements, steam for drying the paper during production and power to the grid. New-Indy said it prides itself on its environmentally conscious manufacturing processes that enable it to maintain a strong business presence in the market it services.

Long-term service solution

Additionally, New-Indy purchased a full-service agreement with Solar Turbines for the two Titan 130 generator sets. This provides a long-term service solution that is designed to help extend the life of their equipment by providing a fixed service cost over the long term and significantly reducing financial risk of equipment reqpirs. This comprehensive service offering includes several service capabilities that, when combined, will successfully maintain the operational health of the machinery and mitigate unplanned machinery downtime while extending its lifecycle.

Advanced gas turbines' testing and validation

Siemens Energy develops a comprehensive testing path for its gas turbines to ensure customer confidence

The past few years have seen a sort of race among major OEMs to introduce the latest generation advanced gas turbines and, given the characteristics of today's energy market, it is a race that is based on higher power outputs and increased efficiency, where even one percentage point improvement is a key milestone.

The way towards increased power and better efficiency passes through continuous developments in component design, base materials, coatings, and new manufacturing technologies. This brings high-power gas turbines to new technological limits, which poses concerns among customers about the availability and reliable operation of these expensive and critical pieces of equipment.

A new importance

For this reason, the testing and validation process for high-power gas turbines has assumed even greater importance than in the past. The process has always been a complex and vast undertaking but recently it has taken on a new dimension where customers are concerned: the confidence that a new unit will be thoroughly proven before starting its working life in commercial operation.

OEMs in this field have adopted different approaches to perform through product validation while at the same time maintaining the best possible time to market for new launches.

Siemens Energy, one of the major global players in large gas turbines, chose a unique and comprehensive path for its gas turbines when it comes to making sure new engine versions, new design features, new technologies, or engine upgrades are proven to the largest extent possible before being handed over to customers for commercial operation.

Three-step process

The process at Siemens Energy is based on three steps (besides material and base technology testing in a very early phase of new designs): components testing at full temperature and pressure in facilities like the company-owned Clean Energy Center (CEC) near Berlin, Germany; full-load prototype engine testing in the Berlin Test Facility (BTF); and long-term endurance testing and validation under site conditions, as it happened for the latest versions of the F- and H-Class turbines and currently unfolding for the SGT-9000HL gas turbine in the Lincoln County power plant of Duke Energy in North Carolina, USA (60 Hz) and soon for the Keadby 2 power plant by SEE Thermal in the UK (50 Hz).

According to Siemens Energy, no one else in the industry carries out both full-load tests on test beds, allowing off-frequency testing across the entire design range and on-grid endurance testing in real power plants.

"Technology development is one thing, but we also need to make technology robust and reliable to ensure durability and availability of our engines for application in commercial operation conditions for our customers," said Willibald Fischer, director Project Engineering, Large Gas Turbines at Siemens Energy. "That is the conflict existing between time-to-market and proven technology and we decided to exploit our full capabilities."

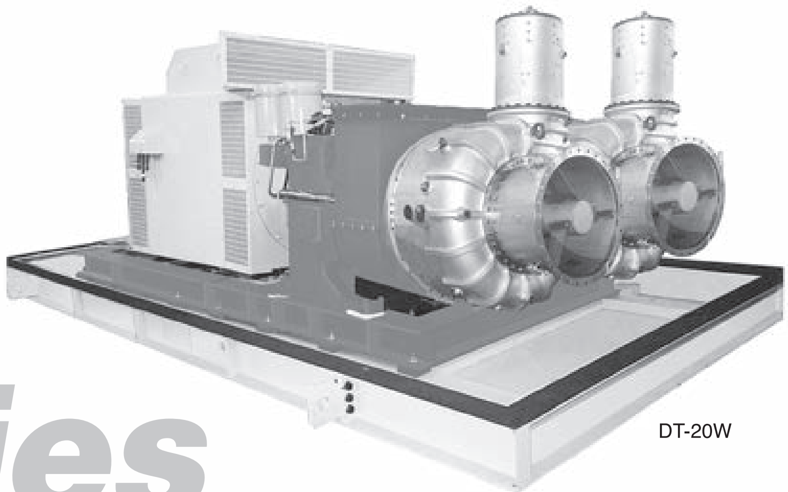
Siemens Energy's three-step process was first used over 10 years ago for its new SGT-8000H gas turbine. The company now has nearly a hundred SGT-8000H's installed across the globe, in 50 and 60 Hz models.

The validation of the HL-class gas turbines is taking place in real-life conditions at the Lincoln County, North Carolina, USA, where one SGT6-9000HL is connected to the grid during a four-year test process.

DAIHATSU DIESEL

Gas Turbine Generator Set
Emergency Use

- Compact & lightweight
- High quality electricity
- No cooling water
- Quiet running
- Minimum vibration & easy installation
- Easy operation & maintenance
- Clean exhaust



DT-20W

TX series

200~5,000kVA

Specifications

Models TX-	200	250	300	375	400	500	625	750	1000	1250	1500	1750	2000	2500	3000	3500	4000	4500	5000
Output (In air temp. 40°)(kW)	160	200	240	300	320	400	500	600	800	1000	1200	1400	1600	2000	2400	2800	3200	3600	4000
Voltage (V)	200·220/400·440/6000·6600					400·440/6000·6600													
Start-up time	within 40 seconds																		
Gas turbine Model DT-	4						6		4W	10	10A	14	20		10AW	14W	20W		
Type	Single - shaft simple open cycle																		
Output (kW)	180	228	268	331	353	441	552	662	883	1103	1324	1546	1765	2206	2648	3089	3529	3971	4412
Main Shaft speed (min^{-1})	41000						34200		41000	25000		23300	21000		25000	23300	21000		
Output Shaft speed (min^{-1})	1500 / 1800																		
Fuels	Kerosene, Gas oil, Diesel oil																		
Weight (kg)	250						450		250×2	1200			1750		1200×2		1750×2		
Dimension Length (mm)	3200						4000		4000	5000			5400		6000		6550		
Width (mm)	1550						1800		2300	2300			1750		2800		2590		
Height (mm)	2100						2520		3520	3150			3300		4800		3700		

DAIHATSU DAIHATSU DIESEL MFG.CO.,LTD.
Tokyo Office. 1 2-10, Nihonbashi-Honcho 2-chome, Chuo-ku, Tokyo, 103-0023 Japan TEL:+81-3-3279-0827 FAX:+81-3-3245-0359

Modification of gas turbine fleets for a more sustainable future

The 'hydrogen economy' looks at changing the hydrocarbon-based infrastructure and running on hydrogen instead

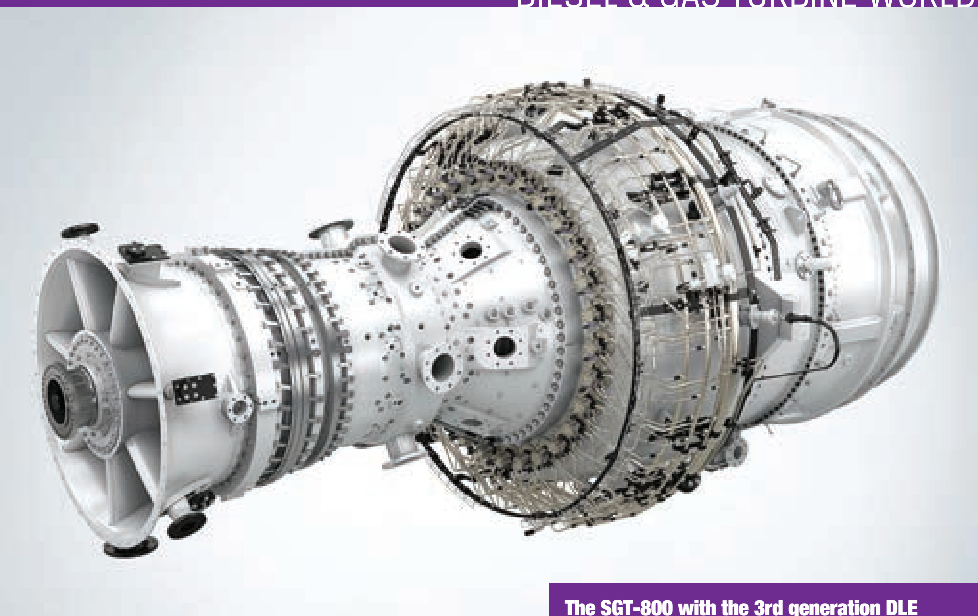
Is hydrogen the savior of the planet? Well, maybe not, but it is certainly a strong instrument to reduce carbon emissions and is a hot topic for discussion by governments throughout the world. But what does a switch to increased hydrogen mean for existing gas turbines in the field? Mattias Samuelsson, sales manager in Modernization and Upgrades at Siemens Energy, discusses opportunities for hydrogen and upgrade options to enable existing gas turbines to consume greater volumes of this gas.

There are different ways to produce hydrogen today, depending on availability and producing industries and they are classified as blue, green, and brown. Blue hydrogen is produced from natural gas and the carbon is captured by CCS (Carbon Capture & Storage). However, the production of 'green' hydrogen is now on the rise. Green hydrogen is when hydrogen is created through the electrolysis of water using electricity generated from renewable sources. Both green and blue hydrogen is a clean energy carrier that can be utilised as burning fuel and used to decarbonise areas such as transport, heating, and industrial processes. It can also be used for long-term energy storage of renewable resources and added to existing natural gas supplies to reduce greenhouse gas emissions. Whereas, 'brown' hydrogen which is produced from fossil fuels or a by-product from industrial processes, accounting for around 95% of global production.

The 'hydrogen economy' looks at changing our hydrocarbon-based infrastructure to run on hydrogen instead. In theory, hydrogen can be used as a fuel anywhere where hydrocarbons are used today, but the change will happen in stages.

Hydrogen as fuel has been in the 'pipeline' for many years but it is now gaining more traction and momentum than ever. In July, it was announced that a group of 11 European gas infrastructure companies plan to create a hydrogen pipeline backbone throughout Europe; revealing outlines of plans to scale up European green hydrogen to one million tonnes by 2024 and 10 million tonnes by

Testing on an SGT-700 gas turbine at Siemens Energy's Zero Emission Hydrogen Turbine Centre in Finspång, Sweden.



The SGT-800 with the 3rd generation DLE is capable of burning a mix of up to 50% hydrogen.

2030. Therefore, an increasing number of operators are asking what the impact of hydrogen will have on their existing gas turbine installations – from cost efficiency to lower emissions.

Siemens Energy has had experience

with hydrogen combustion since the late 1980s. In recent times, it has seen a sharp rise in enquiries from operators about modifying existing turbines to burn varying percentages of hydrogen as part of their fuel supply. Siemens SGT- 800 turbines can operate with a mix of 50% volume of hydrogen into the fuel, which will typically reduce CO_2 emissions by 53,000 tons per annum compared with 100% methane. Considering an average car driving 20,000 km in a year emits around 2.1 tons of CO_2, the contribution of such a change would have to a sustainable future is clear.

HYDROGEN TESTING

Siemens SGT-600, -700 and -800 dry low emission (DLE) burner systems are all capable of burning large percentage volumes of hydrogen. Indeed, the capacity of these models in the field to burn hydrogen is currently larger than the amount of hydrogen available. Due to todays' limited availability of hydrogen in the market, customers are mainly looking at lower percentage volumes, in the area of 5-15%, for now. However, industry customers that have hydrogen from the process available in larger quantities are interested in mixing in hydrogen into the gas turbine fuel in volumes as large as 60%.

Original gas turbine technology was developed for the aircraft industry. When attention turned to industrial applications NOx emissions became important and the DLE (Dry Low Emissions) was developed to minimize the NOx emission without any need for water injection. The Siemens DLE burner technology for the industrial gas turbine has been formed by evolutionary development throughout the years and is now in its 3rd generation.

WHAT MODIFICATIONS ARE REQUIRED?

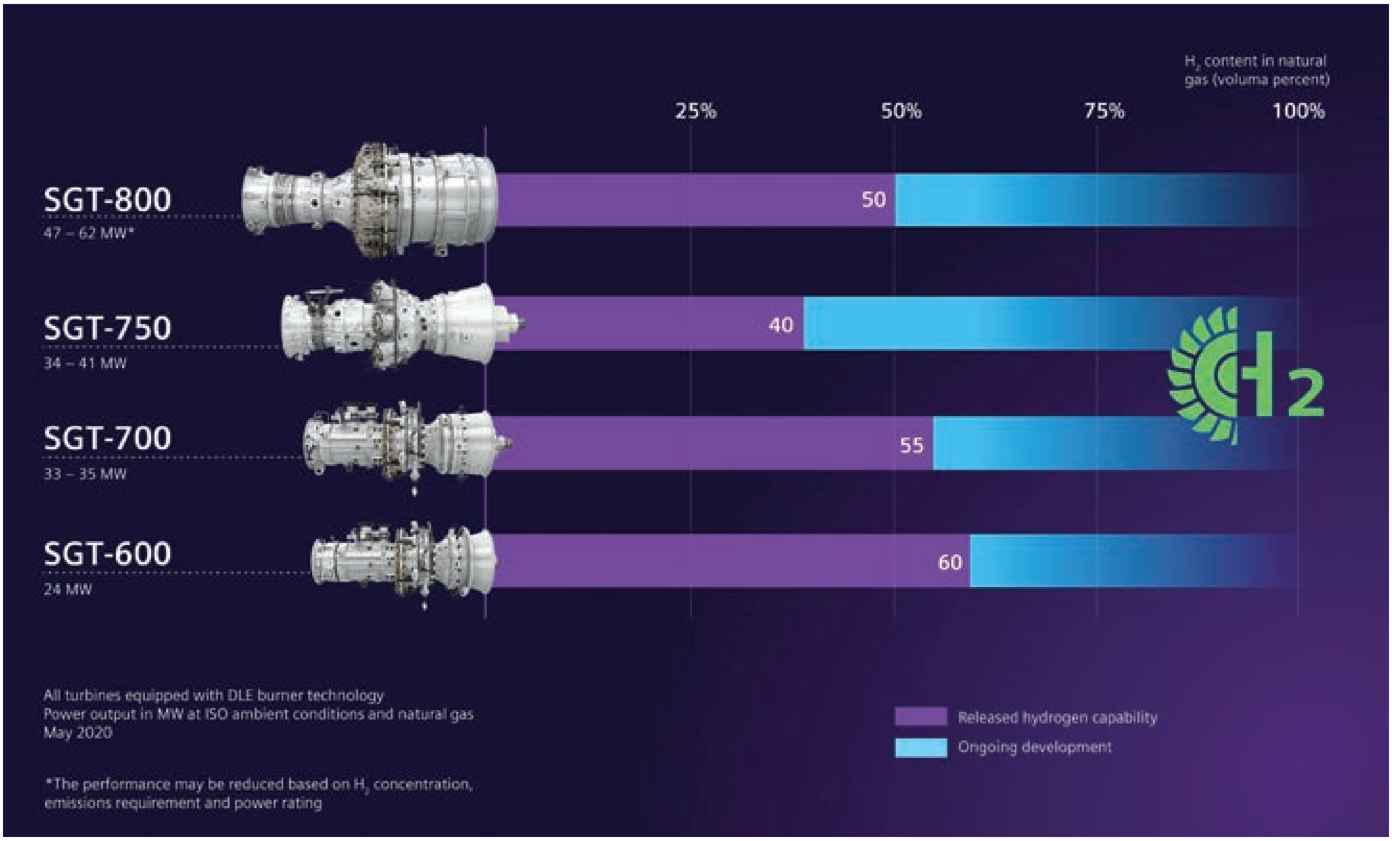
Clearly, the modifications required for a turbine to burn hydrogen will depend on the turbine model, age, and installation details. A pre-study can be performed to define complete scope of supply.

For SGT-600 turbines with an earlier generation of DLE, burning higher amounts of hydrogen entails upgrade to the 3rd generation DLE burners. Additive manufacturing is used to produce burners for the exact hydrogen levels required. The scope for the hydrogen modification will depend on, for example, the amount of hydrogen that will be utilized, the constituents of the existing fuel, target emission levels, operating profile, existing auxiliary equipment, and the control system installed.

Hydrogen ignites and burns quickly with a much wider fuel/air ratio than natural gas and that will have an impact on design of the auxiliary equipment. The hydrogen combustion moves the flame closer to the burner, so air and fuel distribution need to be optimized to prevent 'flash-back'. Low ignition energy also means ventilation and gas detection systems need to be adapted and electrical equipment placed to eliminate ignition sources. Computational fluid dynamic (CFD) analysis may be used to optimize ventilation flow distribution. Fire detection systems will be revised to ensure detection of the different appearance of flames with varying percentage volumes of hydrogen as the pale blue flames produced by pure hydrogen are almost invisible in daylight. The need for additional safety classification will be investigated in areas with explosion proof components.

Other checks include assessments on the suitability of materials used with

>



hydrogen and if other equipment has been installed in the plant since it was installed that will also need to be checked that it is compatible with hydrogen. Depending on the level of hydrogen content, engine start procedures may need to be amended with updated settings in the control system and modified start sequence.

This may sound daunting, but for many installations, modifications are minimal and can be carried out during normal scheduled shutdown periods. The SGT-600, -700 and -800 with the 3rd generation DLE, which has been used since the 1990s, are all inherently capable of burning up to 60%, 55% and 50% hydrogen, respectively.

BENEFITS OF GREATER LEVELS OF HYDROGEN

Increasing the levels of hydrogen in fuel supplies offers numerous benefits in terms of cost and emissions. For plants that already produce brown hydrogen as part of their processes, channelling this to fuel gas turbines reduces overall carbon footprint as well as significantly reduces operational costs. If green hydrogen is used, this is carbon free and a clear winner for the future of the planet.

EFFICIENCY MODIFICATION

Increasing the efficiency of gas turbines also contributes to sustainability since higher efficiency gives lower fuel consumption and by that reduced emissions. By infusing latest design of internal components – at a planned service occasion of older units – an CO_2-emission reduction of up to 5% is possible. And if a larger up-grade scope is considered, like an up-grade of the combined cycle and a gas turbine swap, the emission reduction can be >10%."

THE FUTURE: CHALLENGES AND OPPORTUNITIES

The growing demand for higher content of hydrogen in gas turbine fuels needs to be matched with availability of the fuel and increased production of green hydrogen. Governments and pipeline operators in Europe are taking actions to meet demands for hydrogen with some strong targets for the coming years. At Siemens Energy, our mission is to contribute to the goals of the UN's 2030 Agenda for Sustainable Development with 100% hydrogen fuel DLE gas turbines firmly on our road map.

CONCLUSION

We are at an exciting point in the transformation to a sustainable energy system. Although there are still challenges to overcome in terms of production and distribution of green hydrogen, having even a relatively small percentage content of this carbon-neutral resource in turbine fuel supplies will make a huge impact on carbon emissions. Siemens Energy is prepared and ready to help meet increasing demand for hydrogen as a fuel, helping customers meet their decarbonisation and efficiency goals with practical and economical upgrade services for existing medium size gas turbine installations.

Design Begins Here

POWER GENERATION

SPONSORED BY:

Diesel & Gas Turbine WORLDWIDE

POWER SOURCING GUIDE 2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DIESEL PROGRESS DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

khl

POWER GENERATION

Design Begins Here

POWER GENERATION

SPONSORED BY:

Diesel & Gas Turbine WORLDWIDE

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DIESEL PROGRESS DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

khl

POWER PLANTS OF THE WORLD

Each year, **Diesel & Gas Turbine Worldwide** asks prime-mover original equipment manufacturers to submit one specific power generation project they feel merits special attention because of advances in one or more of the following areas: efficiency increase, environmental aesthetics, operation characteristics, emissions improvements or construction principles. Here are some of the most innovative power generation installations around the globe.

MALAYSIA: GE POWER

A first for GE

Malaysia is targeting a 45% reduction in CO_2 emissions by 2030. The country of 33 million consists of several large, hilly islands and a peninsula where open land suitable for building large wind or solar farms are scarce. The country's recent economic growth has driven a steady increase in power capacity, answering the increasing need for more electricity, however, there is a need to achieve the right balance between cost and environmental impact.

Most of the electricity generated in Peninsular Malaysia is based on coal plants as this is the cheapest solution for $/kWh. Today, coal plant contributes to about 65% of electricity generated in Peninsular Malaysia. However, in line with government aspirations, there is a strong commitment from industry players for reduced/ near zero carbon emissions for their operations.

With the country's latest development plan to add more renewable power while reducing dependence on coal, gas power remains critical for the country's prosperity.

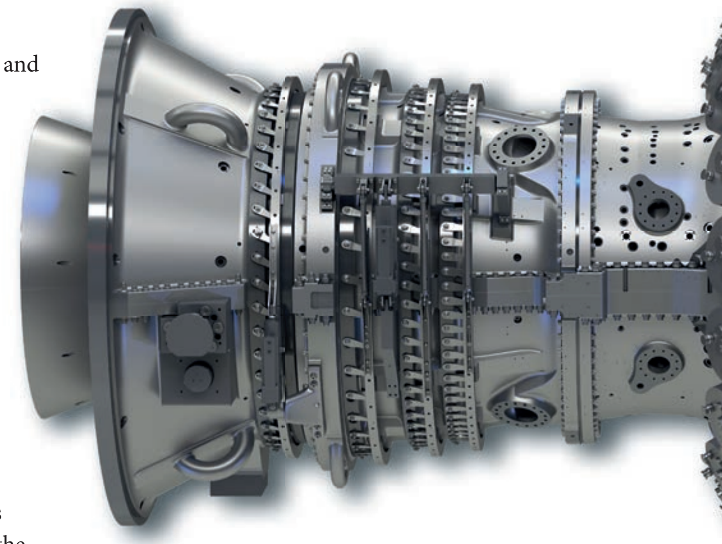
GE'S GIANT 9HA.02 GAS TURBINE DEBUTS

On February 2021, Southern Power Generation's gas fired Track 4A Power Plant went online with 1440 MW. The plant is located in Pasir Gudang, an industrial city at the southern tip of Malaysia's peninsula, just a few miles from Singapore. It will power approximately 3 million homes.

The plant consists of two generating blocks, each equipped with a 9HA.02 >

gas turbine and a STF-D650 steam turbine, driving a W88 generator, and, for the first time installed in an H-Class Plant, a GE Once Through (OT) Heat Recovery Steam Generator (HRSG). GE's OT HRSG technology is a key enabler in advanced water-steam cycles delivering higher combined cycle efficiency.

Track 4A power plant is powered by GE's first 9HA.02 gas turbines in commercial operation globally. The turbines come from a new generation of GE machines that had already set a world power plant efficiency record. The 9HA.02 integrates advances in additive manufacturing and combustion breakthroughs present also in the 7HA.01 and 7HA.02 models. The 9HA.02 features a DLN 2.6e combustor with axial fuel staging (AFS) which enables lower nitrogen oxide (NOx) emissions with improved turndown. In addition it embeds an evolutionary improvement to the premixing fuel nozzles, a technology GE developed in collaboration with the U.S. Department of Energy to deliver improvements in terms of performance, emissions, and fuel flexibility.



The combustion system DLN 2.6e allows the turbine to burn up to 50% by volume of hydrogen when blended with natural gas. In the future, the system could be adjusted to run on 100% H2. This capability is enabled by the DLN2.6e combustion system that is standard on current HA gas turbines offerings. Hydrogen is not the only path for decarbonizing gas turbines. GE's H-class Combined Cycle Plants can also be configured with a post-combustion capture system to reduce CO_2 emissions by up to 95%.

ADVANCED ANALYTICS ACROSS THE PLANT

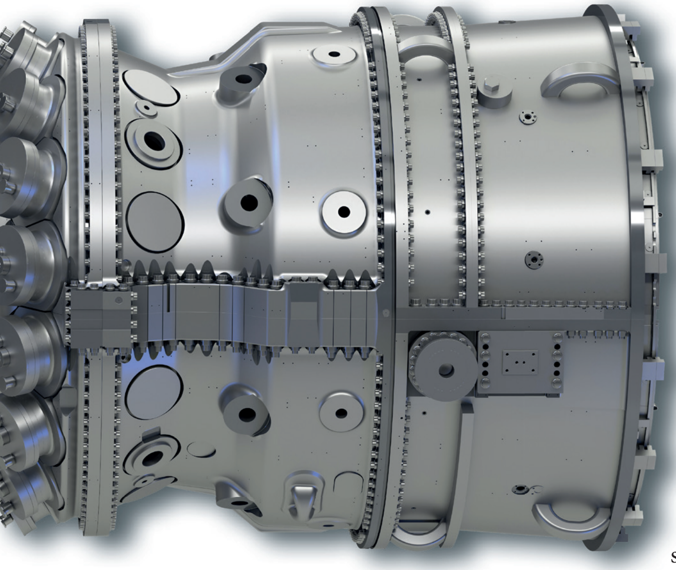
The plant is controlled by GE's Mark VIe integrated Plant Control System. Equipped with a single Operator Interface and common troubleshooting tools, plant personnel can operate the plant more efficiently and, when issues do arise, rapidly recover to improve overall plant availability. Featuring superior responsiveness and flexibility, it enables plant operators to dispatch power to the grid quickly.

USA: SOLAR TURBINES

Environmental upgrade

New-Indy Containerboard operates four mills producing 750 000 tons of recycled containerboard per year. New-Indy's mills receive more than 100 truckloads of old corrugated cardboard (OCC) daily. This material is cleaned, reduced to a slurry and then reformed to create new containerboard. The recycled paper is then sent to box plants throuout local markets. Each of their California, USA, locations have combined heat and power (CHP) plants that provide all of the mill's electrical power and also supply power to thousands of Southern California homes through their partnership with Southern California Edison.

New-Indy previously owned and operated a CHP plant that provided steam and power to the existing paper mill facility and to the new box plant adjacent to the main plant.



For 21 years, overall plant performance will be monitored and enhanced with GE Digital's Predix Asset Performance Management software to help improve asset visibility, reliability, and availability while reducing operating and maintenance costs. In addition, data collected from sensors throughout the facility will be monitored and analyzed 24/7 at GE's Monitoring & Diagnostics (M&D) Center in Kuala Lumpur.

SAFETY DURING A PANDEMIC

This plant was safely constructed with the Taiwanese EPC partner, CTCI. Despite the COVID-19 pandemic, CTCI and GE have collaborated together without compromising on health and safety.

The turbines arrived in modular containers that enabled engineers to install them relatively quickly. GE's H-class machines are engineered with more modular architecture that allows for quicker inspection and maintenance activities, resulting in better reliability. In addition, GE engineers and manufactures all major combined cycle equipment in-house for a full-system approach. GE's full system approach enables high power output and efficiency as well as improved plant operability.

CTCI and GE have achieved more than 10 million safe man-hours on this project, a testament to the team's reliability. The two companies' joint success also paved way to another recent partnership in late 2020, helping GE win a multi-billion dollar EPC contract for five combined cycle gas power units in Taiwan. Together with GE's expertise and support on site, this will ensure the long-term operations and sustained power dispatch to the grid.

"The world's first commercial operation of our flagship turbine marks a tremendous milestone for our HA fleet," said Ramesh Singaram, president and CEO of GE Gas Power in Asia "We look forward to helping Southern Power Generation reap the benefits of our latest technology as well as combined services and digital solutions, helping to deliver more reliable and flexible power generation for the country." ■ >

Two Titan 130 generator sets provide the Ontario, California, USA, facility with 100% of its electrical requirements as well as steam for drying the paper during production.

The existing CHP plant was at the end of its service life. Due to the increased maintenance cost, environmental fees and changes in environmental regulations, New-Indy decided to upgrade their existing CHP plant with a new, efficient and environmentally friendly system. The new upgraded CHP plant uses natural gas for all operations to produce power and steam. The two new Titan 130 gas turbines from Solar are fitted with SoLONOx emissions systems and will be much cleaner and more efficient that the replaced unit, the company said.

These two Titan 130 generator sets provide the Ontario manufacturing facility with 100% of its electrical requirements, steam for drying the paper during production and power to the grid. New-Indy said it prides itself on its environmentally conscious manufacturing processes that enable it to maintain a strong business presence in the market it services.

Additionally, New-Indy purchased a full-service agreement with Solar Turbines for the two Titan 130 generator sets. This provides a long-term service solution that is designed to help extend the life of their equipment by providing a fixed service cost over the long term and significantly reducing financial risk of equipment reqpirs. This comprehensive service offering includes several service capabilities that, when combined, will successfully maintain the operational health of the machinery and mitigate unplanned machinery downtime while extending its lifecycle. ■

New-Indy Containerboard operates four mills procuding recycled containerboard in California, USA.

USA: WÄRTSILÄ

Flexible power, rain or shine

Its efficiency and reliability make the Wärtsilä 31SG the engine of choice for utilities that are transitioning to renewables. The case of Cooperative Energy in Mississippi is one such example, allowing for flexible generation to support solar power, as well as resiliency in case of hurricanes.

A 22.7 MW flexible gas power plant with two highly efficient Wärtsilä 20V31SG gas engines as prime movers started commercial operations in Benndale, Mississippi, USA in April 2020. The plant is owned by Cooperative Energy, a member owned not-for-profit electric cooperative, covering 432 000 homes and businesses in Mississippi. Wärtsilä supplied the plant on a full Engineering, Procurement & Construction (EPC) contract, mitigating thus financial and timing risks in construction.

Cooperative Energy's mission is to provide its members with electricity that is both reliable and economical. According to Cooperative Energy, the Wärtsilä engines provide efficiency that is far greater than any of the company's simple cycle units, while also adding flexibility to the company's generation fleet. In 2005 coal produced more than half of their energy, but today cleaner natural gas makes up about two-thirds of the mix. Cooperative Energy also has ten solar sites, showing the increasing importance of Mississippi's sunshine in providing power.

POWER PLANT WITH A CRITICAL ROLE

The plant provides valuable grid support for renewable integration for the Cooperative Energy system today and in the future, as well as reliability during potential transmission outages caused by hurricanes or other severe weather conditions. Summer in Mississippi is defined by hot sunshine, and hurricane season provides its well-known challenges. Weather plays a vital role in Mississippi's energy system and was on top of the agenda when Cooperative Energy began to talk to Wärtsilä about upgrading their Benndale plant. The plant is located in the southern part of the power system and has an important role in restoring critical loads in the area.

Cooperative Energy was not only looking for reliability, quick start, efficiency and good operational flexibility, but they also needed black start capability. The Benndale plant can carry out initial energisation of sections of the network so it can provide power to critical local infrastructure like hospitals, communications and other larger units in the system to facilitate full restoration of the grid. The Wärtsilä solution meets all the customer needs which is important for both Cooperative Energy and the community.

RECORD-SETTING TECHNOLOGY

The diesel version of the Wärtsilä 31 engine has been recognized by Guinness World Records as being the world's most efficient 4-stroke diesel engine. The generating set can provide up to 49% open-cycle electrical

A 22.7 MW flexible gas power plant with two highly efficient Wärtsilä 20V31SG gas engines as prime movers started commercial operations in Benndale, Mississippi, USA in April 2020.

efficiency. It has a very wide load range from 10% to 100%. While the plant is not running it has very small stand-by power consumption. Importantly also, the plant efficiency is not significantly changed in more hot, cold or humid conditions and it is very resilient against output derating against different gas qualities or ambient conditions.

Flexibility is perhaps the most important value required from dispatchable power generation equipment. Wärtsilä 20V31SG provides full power in just 2 minutes from start command and it gets synchronized with the grid in less than 30 seconds. The engine has continuous minimum load limit at 10%. When running hot it can be loaded at 2% per second. It has no minimum uptime or downtime. The genset has very high partial load efficiency making it a very feasible choice to handle continuously changing load patterns. Whenever there is a saturation of renewable power in the system, generating sets can be stopped individually or all at the same time. There are no limits for start or stops and those do not have impact on overhaul schedule of the engines.

The first year of operation of the Benndale plant has demonstrated the flexibility and efficiency of Wärtsilä 20V31SG engine technology. Recent operating results show the full load LHV heat rate of the plant achieving 6989 Btu/kWh. ■ >

GERMANY: INNIO

Harnessing the power of green hydrogen

According to the International Energy Agency (IEA), the power sector produces 40% of the world's CO_2 emissions. This intense production of greenhouse gases is driving the power industry to an intense competition to present economical, safe, clean alternative energies as the world transitions from fossil fuels to cleaner technologies that will reduce its carbon footprint. Hydrogen has re-emerged as a viable technology for large scale industrial electrification. INNIO is disrupting the electricity industry by proving that green hydrogen-run power plants are not only a theoretical solution to large-scale, industrial electrification, but are a real, workable solution. In 2020, INNIO worked closely with German utility HanseWerk Natur to build a pilot "Green Utility" that can generate power and heat with an INNIO gas engine fueled with 100 percent hydrogen, a mixture of hydrogen and natural gas or natural gas in Hamburg, Germany.

HYDROGEN-FUELED CHP PLANT

INNIO worked with German utility HanseWerk Natur to develop a hydrogen-fueled combined heat and power (CHP) plant in the 1 MW range in the center of Hamburg. The plant started field testing in November 2020. This flagship pilot project led to the large-scale execution of hydrogen technology in CHP plants. "By field testing this INNIO CHP plant with up to 100% hydrogen, we are demonstrating that a greener, more reliable, more flexible, and future-orientated energy supply for Hamburg is technically feasible," explained Thomas Baade, Technical Director of HanseWerk Natur GmbH. The converted CHP plant is part of the heating network in Bahrenfeld, in which HanseWerk Natur provides 30 residential buildings, a sports center, a daycare center, and the Othmarschen Park leisure complex with a reliable supply of local heating that equates to 13 000 MW/h every year. The electricity generated is fed to electric vehicle charging points in Othmarschen's multi-level parking garage as well as to the local power grid.

"Together with HanseWerk Natur, we are paving the way for a future energy supply in Hamburg that is greener, more secure, more flexible and more decentralized," said Carlos Lange, president and CEO of INNIO. The output will be fed into HanseWerk Natur's local heating network, serving approximately 1.3 million customers. The use of hydrogen-fueled engines as a source of safer, cleaner energy is paving the way forward for decentralized applications for communities around the world. A 16-cylinder gas engine from INNIO Jenbacher, for example, that once ran on natural gas can now run on 100 percent hydrogen or any mixture of hydrogen and natural gas or natural gas. With hydrogen as a fuel source, there are no CO_2 emissions because hydrogen is combusted CO_2 free.

The Green Utility facility, located in Jürgen-Töpfer-Strasse in central Hamburg, has an electrical output of 999 kW in natural gas mode and runs on variable hydrogen/natural gas mixes, as well as 100% green hydrogen. The facility, which has been optimized for use with natural gas, is remarkable for its excellent overall efficiency of 93%. When operating with pure hydrogen or hydrogen blends, the output will be adjusted accordingly. The heat generated is fed into HanseWerk Natur's local heating network, while

The INNIO Jenbacher 'Green Utility' facility, located in Jürgen-Töpfer-Strasse in central Hamburg.
PHOTO: BUSINESS WIRE

electrical energy is fed into the grid and made available for recharging electric vehicles at the site when required. The integrated energy system combining the electricity, heating and gas networks is the key to a greener energy future. By using power-to-gas (P2G) technology, Green Hydrogen is converted from surplus renewable energy produced mainly from the sun and wind. Unlike electricity, it can be stored long term in tanks or in large quantities in underground caverns – like natural gas – over months or seasons.

GREEN HYDROGEN OPPORTUNITIES

Initially, green hydrogen produced with P2G technology will be expensive, and the volume produced will be limited. During this transitional stage – as research continues green hydrogen technologies – blue hydrogen produced from natural gas with Carbon Capture Utilization and Storage (CCUS) can play a role and enable the transition. A small amount of hydrogen can be fed into the existing natural gas network, with larger amounts of hydrogen transported in a separate infrastructure. Hydrogen as a fuel could be used locally across all sectors including industry, transportation, and CHP generation. Columbia University's Earth Institute reports that many experts view Green Hydrogen as essential to meeting the goals of the Paris Agreement when considering that certain portions of the economy produce emissions that are difficult to eliminate. In the U.S., the top three sources of climate-warming emissions come from transportation, electricity generation and industry.

Green hydrogen offers Northern Germany significant opportunities given its vast wind resources and increasing importance as an energy storage medium. As the energy industry continues to look toward wind-generated electricity conversion into green hydrogen, it is also seeing how it can be deployed across the power, heat, transportation and industrial sectors. In January 2020, the German government responded to the efforts of energy companies like INNIO by approving Germany's nationwide phaseout of coal generation by 2038.

By definition, green power sources, such as INNIO's and HanseWerk Natur's 100 percent hydrogen fueled power plant, operate as zero-emission energy sources. Essentially, green energy sources produce no additional carbon dioxide nor other greenhouse gases across the power generation process. This flagship pilot project will not only drive forward the large-scale use of hydrogen technology in CHP plants, but the city of Hamburg has also set itself the goal of ensuring that all interested customers in the power, heat and transportation sectors can be supplied almost entirely with Green Hydrogen by 2035.

Green hydrogen can be reconverted by flexible gas engine power plants into dispatchable renewable power. Like natural gas, it is ideally suited for CHP applications and can provide heating and cooling while achieving a fuel utilization rate of 90% and more. Gas engines running on hydrogen are a mature technology, do not require high hydrogen purity, are available at very competitive CAPEX and OPEX, and provide necessary operating flexibility while achieving very low emissions. Further, hydrogen gas engine power plants are CO_2 neutral and can achieve more than 80% lower NOx emissions compared to natural gas. This solution will put the world on the path to a greener future. ■ >

GERMANY: MWM

Power in a time of crisis

Dräger is a leading international maker of medical and safety technology products, including ventilators. In the current pandemic, it's no surprise that the Lübeck, Germany-based company has great demand for its products, especially for the ventilators it produces. The company's headquarters on Moislinger Allee in the Hanseatic city of Lübeck manage the production facilities and sales companies around the globe. To make sure that everything works smoothly at all times – not only in times of crisis – a dedicated MWM cogeneration power plant supplies about 30% of the heat and power. A substantial amount of energy is needed for the workforce of 3000 at the Moislinger Allee site.

RELIABLE SUPPLY

When the cogeneration power plant was first set up in 2007, Dräger opted for reliable, efficient MWM engine technology in the form of a TCG 2020 V12. After 13 years of smooth operation, the core of the cogeneration power plant was replaced in 2020 with an MWM TCG 2020 V12 gas genset with improved efficiency.

"By replacing the engine of the Dräger cogeneration power plant, we want to achieve even more carbon savings and improve the profitability", said Sören Sievertsen, project manager at Stadtwerke Lübeck. In the past, the cogeneration power plant was operated directly by Dräger; now, this will be handled by Stadtwerke Lübeck under a contracting arrangement.

The heat-controlled cogeneration power plant supplies heat energy and power for Dräger and heat energy for various service providers on the premises. All of the generated heat is used for heating the workplaces in the factory halls and offices, and almost all of the 1 MW of power that will henceforth be produced will be used locally and will not be fed into the local power grid.

"In this way, we are able to cut Dräger's power costs, as self-generated power is not subject to additional levies", explains Björn Verwold, account manager at Stadtwerke Lübeck. Thermal output is 1272 kW, thermal efficiency is 53%, electrical efficiency is 41.7% which leads to an overall efficiency of 94.7%.

MODERN ENGINE, MORE PERFORMANCE

The long-standing cooperation for reliable power and heat supply thanks to MWM will also continue with the Stadtwerke Lübeck. In June 2020, the new MWM gas engine – which boasts best-in-class electrical and thermal efficiency – went live and continues to ensure hassle-free power and heat supply at Dräger. ■

Design Begins Here

POWER GENERATION

Electrical Power Generation Equipment

INCLUDING: **AC and DC Generators, Exciters, Regulators, Switches and Breakers, Chargers, Load Banks, Automatic Transfer Switches, Power Control and Safeguard Devices**

POWER SOURCING GUIDE

2021-2022

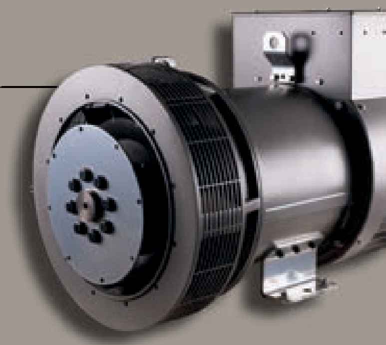
www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DIESEL PROGRESS
DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

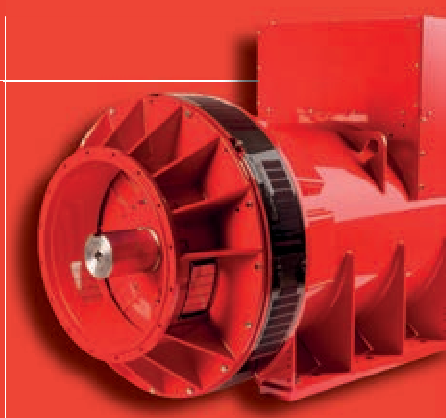
NEWAGE®

The **NEWAGE®** alternator range offers the low voltage, simple solution for a range of applications, including Standby and Telecom. Built to market-driven specification, **NEWAGE®** delivers compact, market leading alternators, equipped with 3 phase sensing Digital AVR as standard and the ability to sustain 3X short-circuit without the need for excitation enhancement options.



STAMFORD®

The **STAMFORD®** S-Range utilises wire-wound technology and with an output extending from 7.5 to 5,000kVA, genuine **STAMFORD®** alternators are designed for delivering superior efficiencies in marine, oil and gas auxiliary, UPS, telecoms, CHP, construction and other continuous or standby power applications. **STAMFORD®** alternators are available with a choice of SAE adaptors to ensure easy coupling to a wide range of prime movers. All **STAMFORD®** S-Range is fitted with CoreCooling™ Technology.



AvK®

With a robust bar wound configuration, **AvK®** alternators are robustly engineered products up to 11,200kVA, specifically designed to meet the challenges of the most arduous applications and environments - be it in extraction of oil and gas, coal and minerals, critical marine power to tankers and container vessels. Our extensive experience and knowledge gathered from a large number of diverse alternator installations worldwide provides expertise in offering integrated design solutions that helps our customers compete more successfully throughout the world.

www.stamford-avk.com

Nidec
All for dreams

Electric Power Generation



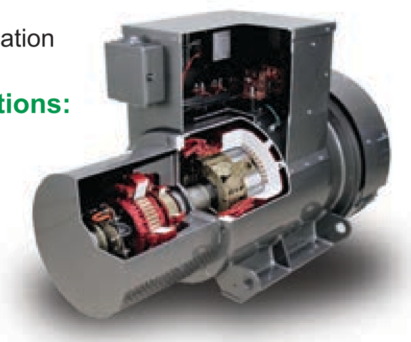
Leroy-Somer™ and KATO™

The brands you trust, the power you depend on

Known for quality and reliability, Leroy-Somer™ and KATO™ branded low, medium and high voltage synchronous alternators are built for standby, essential and critical applications from 10 kW to 50 MW for generator set packagers and power producers worldwide.

Higher design & manufacturing standards:

- Vacuum Pressure Impregnation (VPI)
- High grade magnetic steel
- Voltage regulation options
- Comprehensive testing & certification



Built to your needs & specifications:

Certifications and Standards

- NEMA
- IEEE
- IEC
- API546
- ATEX
- UL
- CSA
- Marine: ABS, DNVGL, Bureau Veritas, NKK, RINA and more

Leading global supplier:

- Preferred OEM alternator supplier
- 3,500 dedicated employees wordwide
- 9 factories strategically located around the world
- 100+ service centers

World-class customer service & support:

- Skilled specialists available 24/7
- Equipment installation and start-up services
- Extended warranty
- Preventative maintenance programs
- On-site troubleshooting and repairs
- Genuine aftermarket parts
- Generator remanufacturing

Design Begins Here

POWER GENERATION

Engine System Contractors and Packagers; Diesel Power Plants, Generator Sets

INCLUDING: Cogeneration and Energy Recovery; Pump and Compression Equipment

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS DPI DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

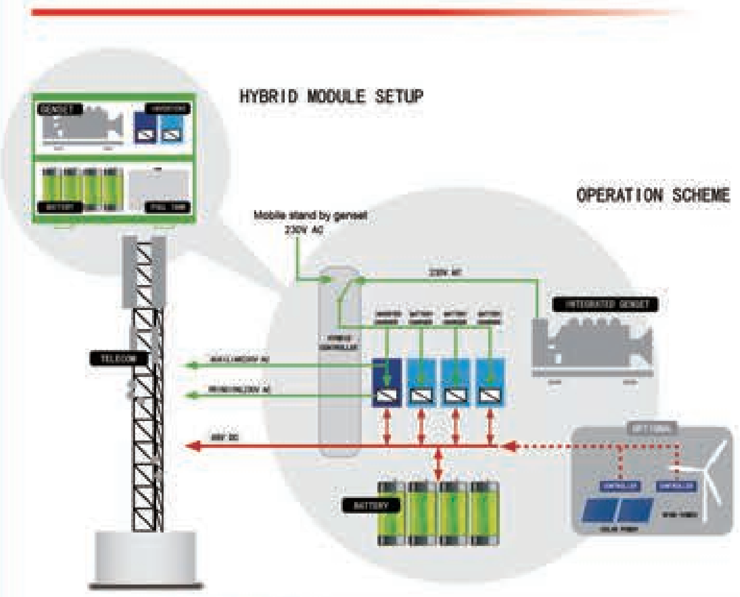
khl

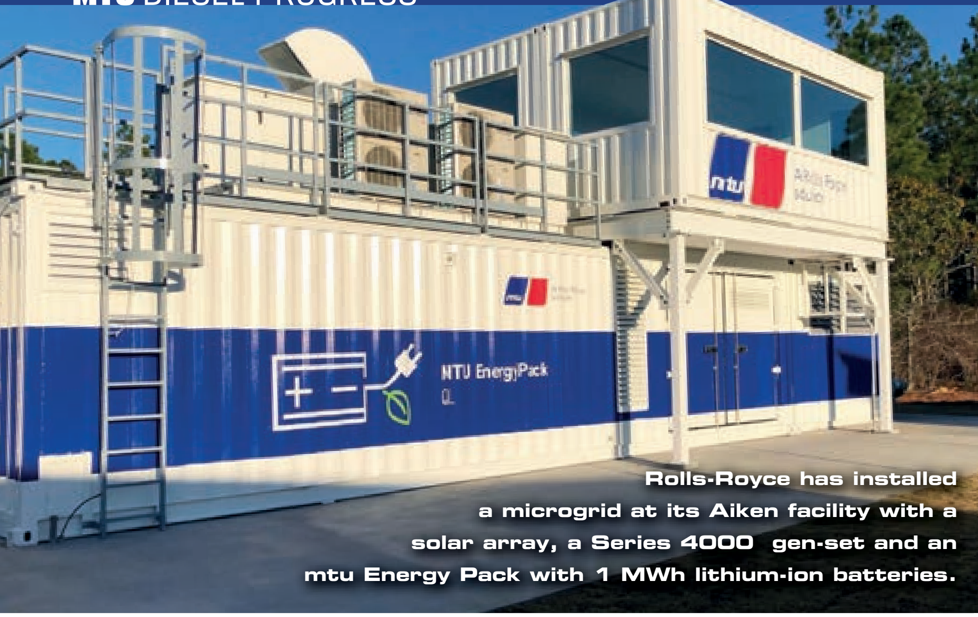
TidePower

Incorporated in 2006, being acquired by Alanta Power Engineering (UK) Co., Ltd. in 2020, Tide Power has always been a prominent and leading provider of power generation solution with products being expo-rted globally.

Our focus lies in our insatiable effort and professional know how in the capability of meeting the highest standard of the business practice which by all means surpasses the demand for all application and the requirement. Given our thought in providing perfect configuration to meet the demand and need, Tide Power has always been recognized and considered as the leading provider in the industry.

No doubt that the rated ranges offered whether in diesel or gas power can be satisfied and easily fit into most needs not to mention with our prompt and efficient delivery. This of course will at all time assure our working partner the guaranteed power with our round the clock services.





Rolls-Royce has installed a microgrid at its Aiken facility with a solar array, a Series 4000 gen-set and an mtu Energy Pack with 1 MWh lithium-ion batteries.

Rolls-Royce's mtu Aiken plant marks 10 years, while new microgrid points toward the future. By **Mike Brezonick**

A MILESTONE AND A MICROGRID

As Rolls-Royce's mtu Aiken manufacturing facility looks back on its now 10-year history, it's perhaps more noteworthy that the site is providing a glimpse into a growing aspect of power generation.

The 395,000 sq. ft. campus in Graniteville, S.C., which produces off-highway mtu-brand diesel engines, opened in the fall of 2010 when the company decided to move its manufacturing operations from Detroit, Mich. What started off as an assembly plant for two product lines has continually expanded in size and scope.

"The original goal of the Aiken plant was to carve out our own space where we could take greater control over our destiny and our manufacturing here in the U.S.," said Joerg Klisch, director of Operations at the mtu Aiken plant. "Everything that we've been able to achieve here over the past 10 years reflects the positive culture and spirit of innovation that we have."

ENGINES FIRST

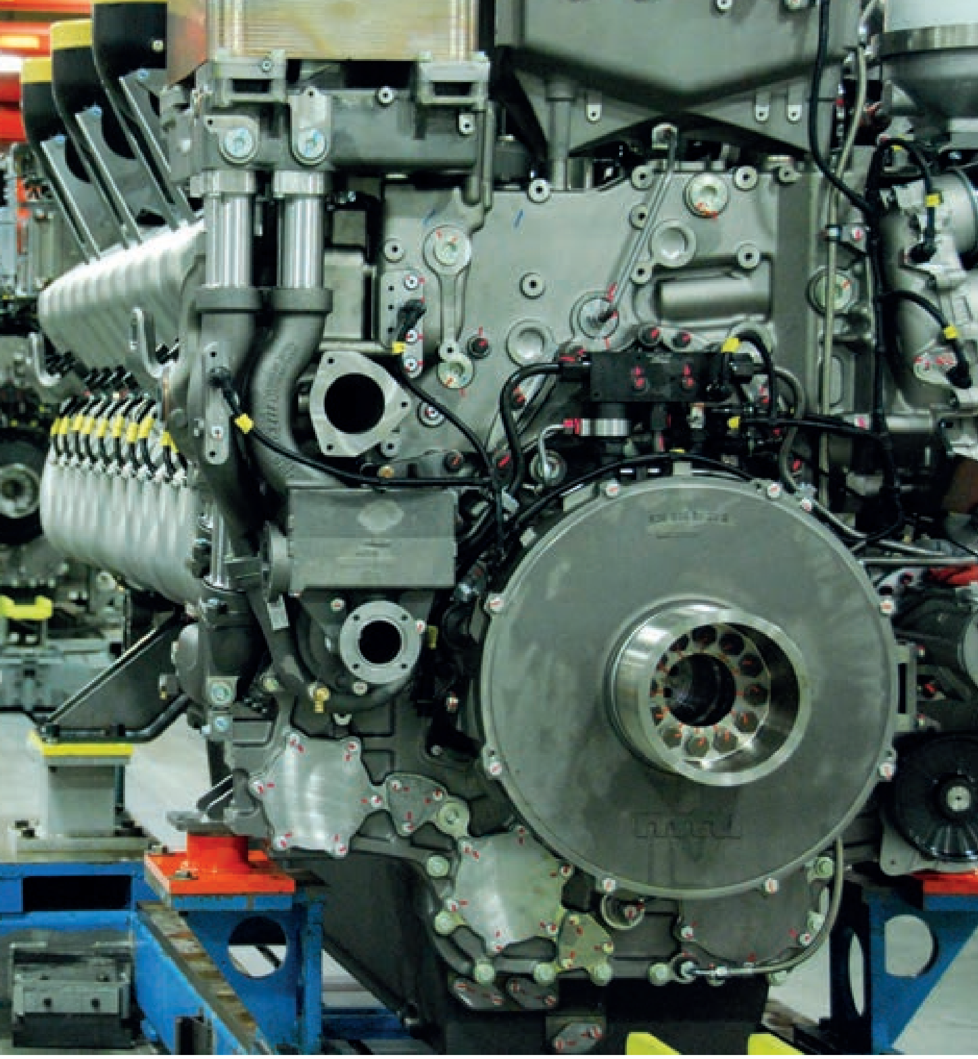
The facility began with the assembly of mtu Series 2000 and Series 4000 diesel engines, which are used in a variety of mobile and stationary applications. Tognum, which owned mtu before it was acquired by Rolls-Royce, bought the 100-acre campus in March of 2010.

By mid-October of the same year the 270,000 sq.ft. assembly building was modified and expanded to accommodate engine assembly and testing and since then, the company has added machining capacity for a range of large components.

Rolls-Royce has continued to invest in the site, with additions including a Research & Development Center, incorporating test cells capable of emissions calibration and certification testing, as well as an administration building. The plant has also grown to incorporate military propulsion systems, conducting complete overhauls of mtu Series 883 engines and power packs.

More intriguing have been additions focused on power generation. In 2017, Rolls-Royce installed a $1.9 million solar field made up of more than 4200 photovoltaic panels. With a peak output of 1 MW, the solar energy is sent directly to the local utility grid.

As part of its microgrid system at Aiken, mtu has installed a second, 800 kW solar field, over the employee parking lot.



Rolls-Royce is marking 10 years of engine manufacturing at its MTU Aiken manufacturing facility in Graniteville, S.C. The facility builds mtu Series 2000 and Series 4000 engines, as well as military propulsion systems.

MICROGRID INSTALLED

More recently, Rolls-Royce has installed a second solar field, this one generating approximately 800 kW, that will be part of a newly installed microgrid that is set to go online in early 2021. The microgrid will initially provide power to the administration building and later will offset peak demand for the entire facility.

In addition to benefitting the plant, the installation will serve as a demonstration platform.

"Number one, it will be a technology demonstrator for the North and South American markets," said Dr. Arunachalam Lakshminarayanan, senior development engineer and microgrid project manager at Aiken. "Number two, it will serve as a test bed for our company's future technologies. Third, which is equally important, is we will be consuming that power from the microgrid at our own facility for peak shaving purposes."

TESTING NEW OPTIONS

Along with the solar arrays, the microgrid incorporates a 1.9 MW mtu Series 4000 diesel generator set, as well as a 1 MWh mtu Energy Pack with lithium-ion batteries. It is managed by a control technology sophisticated enough to deal with the various energy inputs.

"In a microgrid, the system can get a little complicated," Lakshminarayanan said. "If you're going to have inverter based power generation using solar panels, you have dc converted to ac versus if you have a rotating machine like an engine, which is going to produce ac current directly. Tying these together with the local utility to deliver optimum power can be quite challenging, yet very rewarding.

"If you're using solar and suddenly there is cloud cover and less energy, how fast can your gen-set ramp up? Or are you able to predict the solar cover over the next 10 or 15 minutes and coordinate the power sources to adjust for that? We have controls that are quite stable with fast response and we can work with the customer to develop controls for their specific needs."

Lakshminarayanan said Rolls Royce will use the Aiken installation to refine its microgrid technology, which could include new energy options. "We have started to develop our own fuel cell," he noted. "So in the future, we will perhaps be integrating a fuel cell into the microgrid. If tomorrow, someone develops a new battery system, a new energy storage system or something involving hydrogen, which is becoming quite exciting nowadays, we have a platform for testing.

"As the energy landscape changes toward clean, green and decarbonized power, it's very important that we as a company, look into the future and are pioneers of providing such solutions. We are looking to be the go-to source for a complete energy solution. It's not just selling an engine, it's looking to provide a complete energy system so that all the customer needs to do is come and say, 'I need 1 MW, I need 5 MW, 10 MW or I need 100 MW,' and we take care of everything." ■

www.mtu-solutions.com

Reprinted from January 2021 **Diesel Progress**

Design Begins Here

POWER GENERATION

Compression Equipment

INCLUDING: **Reciprocating, Rotary Screw Compressors, Centrifugal Compressors, Valves, Compression Controls & Components**

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DIESEL PROGRESS DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

khl

COMPRESSOR HORSEPOWER SELECTION CHART

(Brake Horsepower Per Million Cu. Ft.)

SUCTION PRESSURE	DISCHARGE PRESSURE (PSIG)																												
	25	50	75	100	125	150	175	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200	
0	65	99	128	144	156	168	178	187	203	218	233	233	241	248	254	260	266	272	277	282	286	291	295	299	303	307	311	315	3 STAGE
10	35	63	85	104	121	131	140	149	163	175	186	196	205	214	223	231	228	233	237	242	245	250	253	257	260	264	267	270	
20		43	62	78	92	106	118	126	139	151	160	170	178	186	193	199	206	212	218	225	231	226	229	232	236	239	242	245	
30		29	47	62	74	85	96	107	123	133	143	152	159	167	173	179	185	191	196	201	206	211	216	221	226	230	224	227	
40			36	50	61	72	81	90	107	121	130	138	145	152	158	164	170	175	180	185	190	194	198	202	206	210	214	218	2 STAGE
50			26	41	52	61	70	78	93	106	119	127	134	141	147	153	158	163	168	173	177	181	185	189	193	196	200	203	
60				32	44	53	61	69	83	95	108	118	125	131	137	143	148	153	158	162	166	170	174	178	182	185	188	192	
70				25	37	46	54	61	74	86	97	109	117	123	129	135	140	145	149	153	157	161	165	169	172	176	179	182	
80					30	40	47	54	67	78	89	98	109	117	122	127	132	137	142	146	150	153	157	161	164	167	171	174	
90					24	34	42	49	61	72	81	91	100	109	116	121	126	131	135	139	143	147	150	154	157	160	163	166	
100						28	37	44	55	66	75	84	92	100	109	116	120	125	129	133	137	141	144	148	151	154	157	160	
125							25	32	44	54	63	71	78	85	92	99	106	113	117	121	124	128	131	134	137	140	143	146	
150								22	35	45	53	60	67	74	80	86	92	98	103	110	114	118	121	124	127	130	133	135	
175									27	37	45	52	57	60	71	76	82	87	92	97	102	107	112	115	118	121	123	126	
200										30	38	45	52	58	63	68	73	78	83	88	92	96	101	105	110	113	116	119	
250											26	33	40	46	51	56	60	65	69	73	77	81	85	88	92	95	99	102	1 STAGE
300												23	30	36	41	46	50	54	58	62	66	69	73	76	79	83	86	89	
350													21	27	33	38	42	46	50	53	57	60	63	67	70	73	75	78	
400															25	30	35	39	43	46	50	53	56	59	60	64	67	70	
450																23	28	32	36	40	43	46	49	52	55	58	60	63	
500																	22	26	30	34	38	41	44	46	49	52	54	57	
550																		20	25	20	32	36	39	41	44	46	49	51	
600																				23	27	30	34	37	39	42	44	46	
650																					22	26	29	32	35	38	40	42	
700																						22	25	28	30	33	36	38	
750																							20	24	27	29	32	34	

NOTE:
1 MMSCFD MEASURED 14.7 AND 60°F NOT CORRECTED FOR COMPRESSIBILITY
2 "N"=1.26
3 SUCTION TEMPERATURE 100°F
4 NATURAL GAS

Design Begins Here

ENGINE SYSTEMS

SPONSORED BY:

Off-Highway RESEARCH

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS DPI DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

khl

Design Begins Here

ENGINE SYSTEMS

SPONSORED BY:

Off-Highway RESEARCH

POWER SOURCING GUIDE 2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

Design Begins Here

ENGINE SYSTEMS

Pumps, Motors, Valves and Fluid Power Technology

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

Design Begins Here

ENGINE SYSTEMS

Turbochargers and Superchargers; Cooling System, Heat Transfer and Heat Recovery Equipment

INCLUDING: **Cogeneration System Components**

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

Oesse's new app for IC engine cooling

Oesse's HR.ange app includes information on 700 different projects

Cooling specialist Oesse has introduced its HR.ange app, a digital collection of about 700 projects of Oesse's HR cooling units for internal combustion engines.

The app includes solutions from basic set-up – from the cooler core to advanced units fully equipped with hoses, brackets, hydraulic motors and many other accessories, according to engine manufacturers' specifications and ready for a plug-and-play installation, the company said.

The app is periodically updated with new projects and is searchable by engine, type of equipment and application.

Oesse said its goal is to make the consultation of case histories quickly available based on several search criteria – the engine brand and model; the engine power range starting from a few kW up to more than 2 MW; the application sector, such as agricultural machines, material handling, off-road equipment, oil & gas, on-road and railway; and the product configuration with a wide range of accessories.

For each selected engine model a range of information will be available, such as performance data, technical drawings and a summary sheet that allows for specific requests such as to speed up an economic offer or for customization. More specifics are available at www.oesse.com.

Online academy

Also available at the company's website is an online academy dedicated to heat exchange and its applications. Oesse Clips is available on the Blog section of the company's website and the videos are also distributed via Oesse's YouTube channel and social media.

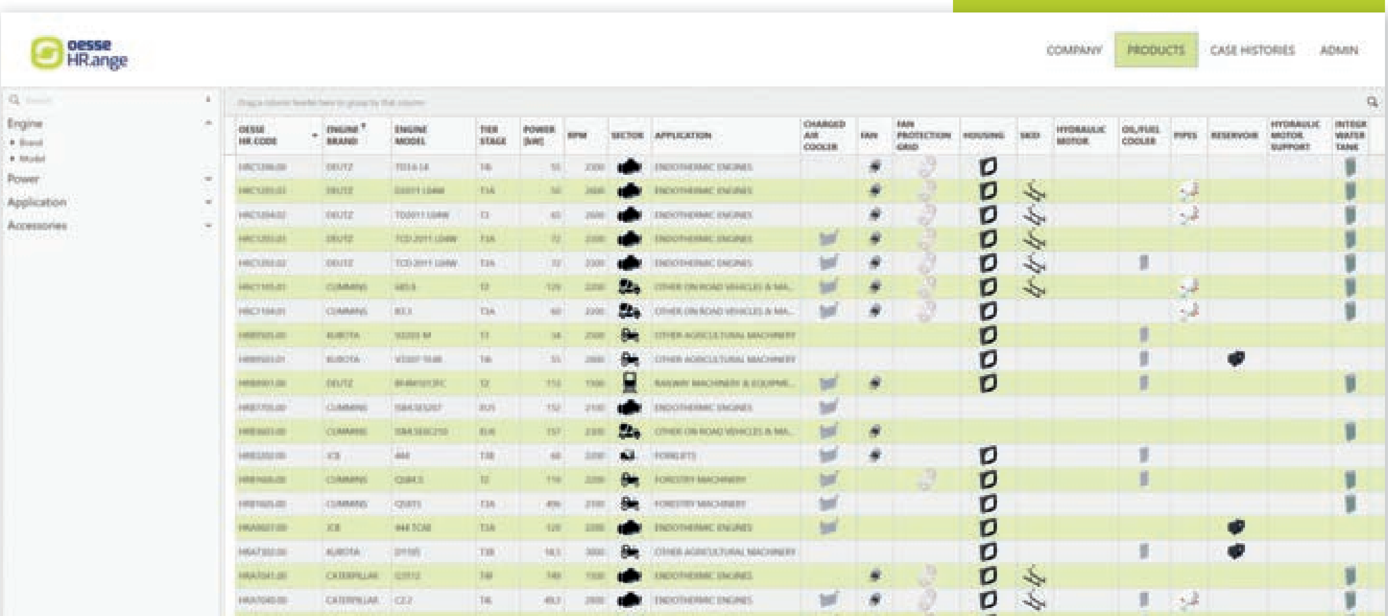
The academy consists of a series of appointments describing processes and technological solutions for Oesse's heat exchangers and their application sectors. Corporate culture, corporate social responsibility, organizational and process management projects are featured as well.

The first Oesse Clips included:

- A presentation on the Oesse HR.ange app.
- A three-part guide on heat exchange that described the different types of coolers, the operating principles of a crossflow heat exchanger and how the compactness of a plates and bars technology and the brazing process improve the exchange efficiency and mechanical resistance

Other Clips topics include lean techniques such as value added and non-value added (va/nva), a life-cycle assessment study on the environmental impact of a heat exchanger, air-oil coolers, and some specific solutions for the agricultural and forestry sector.

A view of Oesse's HR.ange app.



Design Begins Here

ENGINE SYSTEMS

Pistons, Rings, Valves, Valve Seats, Bearings, Gaskets and Seals, Cylinder Liners and Other Valve Train Components

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

Rheinmetall joins UN Global Compact

Company makes worldwide commitment to responsible and sustainable business and management

Rheinmetall is joining the United Nations Global Compact, or UNGC, a globe-spanning network. As a signatory, the company pledges to uphold the 10 principles of the UNGC regarding sustainable and responsible business management and development.

"Moving forward, we'll be supporting this important, globe-spanning initiative with all our might, something we're very proud of," said Armin Papperger, chairman of the executive board of Rheinmetall AG. "Already today, we're committed to exercising our influence in important areas such as human rights, labor standards, health and safety as well as environmental sustainability and countering corruption.

"Joining the Global Compact is a visible manifestation of our willingness to take responsibility and our commitment to achieving these lofty goals. From now on, we will be reporting regularly on our contributions in support of UNGC principles",

Sustainability goals

Even before joining the UNGC, Rheinmetall oriented its sustainability strategy to the Sustainable Development Goals (SDG) of the United Nations. For example, the group aims to be CO_2-neutral by 2035. In this context, reduced consumption of energy and water is crucial.

"Transparent reporting on stability is very important to us. By publishing an annual UNCG progress report, we will be systematically pursuing this course in future," said Ursula Pohen, head of the Corporate Social Responsibility department at Rheinmetall headquarters.

The UN Global Compact is the world's biggest sustainability initiative. Called into being by the United Nations in 2000, it currently numbers 12,765 companies from 160 countries. All of the signatories are committed to running their businesses in accordance with 10 universally acknowledged principles relating to human rights, labor standards, environmental protection and combatting corruption.

Furthermore, the signatories are obliged to report annually on their progress regarding implementation. Based on the ten principles and the seventeen SDGs, the United Nations – acting in cooperation with signatories of the UNGC – is working to achieve an inclusive and sustainable global economy that benefits all peoples, communities and markets. ■

Rheinmetall, which makes a variety of components and systems for engines, commercial vehicle and military applications, announced it is joining the United Nation Global Compact.

Design Begins Here

ENGINE SYSTEMS

Castings and Forgings

INCLUDING: **Crankshafts, Camshafts, Turbine Blades, High-Temperature Alloys, Ceramics and Coatings & Related Piston and Turbine Engine Components**

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS DPI DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

khl

Maschinenfabrik ALFING Kessler GmbH
Business Unit Large

WE KEEP IT RUNNING

Photography: Friedrun Reinhold

Maschinenfabrik ALFING Kessler GmbH stands for highest competence in forging, heat treatment and machining of precision parts. Since more than 100 years over 10 million crankshafts, in a range between 0,5 to 8 m in length, have been produced. Due to our broad manufacturing capabilities and our experience, we added various other compenents to our product portfolio.

All operations starting from material testing, forging, heat treatment, pre-machining, surface treatment with induction hardening machines developed inhouse, grinding, finishing, assembly of accessories and balancing are made in our plant in Aalen-Wasseralfingen.
The medium-sized business is a global player which has acquired a prominent position on the world market.

MASCHINENFABRIK
ALFING KESSLER GMBH

Maschinenfabrik ALFING Kessler GmbH
Business Unit Large Crankshafts
Auguste-Kessler-Str. 20
73433 Aalen / DE

T: + 49 (0)7361 / 501 - 13 40
F: + 49 (0)7361 / 501 - 44 16
large@mafa.alfing.de
www.alfing-crankshafts.com

How lubricants are enabling gas engine operators to upgrade their performance

Effectiveness of engine oil is influenced by a variety of stresses. By **Zoe Fard**

Marginal gains in gas engine performance can equate to significant savings in downtime, manpower and for the bottom line. In an industry that is constantly experiencing a financial squeeze, those margins are being strived for by operators and Original Equipment Manufacturers (OEMs), who gain from greater efficiencies.

The OEMs are at the forefront of improving performance, driven by three main factors. First, they are all seeking competitive advantage in a crowded global field. Gas engine manufacturers in power generation applications have created a highly competitive environment to advance their engines and achieve higher efficiencies and power. Second, changing emission regulations. OEMs are looking to the strictest emerging regulations when designing their engines and as a result, the environment becomes increasingly competitive. And third, unconventional sources of gas are being developed quickly in many markets. From biogas, to landfill gas and coal gas, OEMs need to adapt their engines to run on different fuel types, which constitute varying amounts of methane, again, to stay ahead of the competition and meet increasingly strict regulations.

One of the outcomes of this evolution of modern gas engine technology is increased stress on the engine oil. Before advancing technologies are taken into account, the lubricant of a gas engine already needs to provide a number of functions that only complex formulations can achieve. It needs to be able to neutralize acids, resist oxidation and nitration based on combustion type, maintain OEM's required sulfated ash content and be compatible with the catalyst in addition to working for extended periods. The effectiveness of the oil will be influenced by a variety of stresses, which is why ongoing monitoring of the oil quality, adequate maintenance and timely replacement (if needed) are imperative. The selection of the type and grade of lubricant should be based on the engine operating conditions, OEM recommendations, condition of the gas and the environment in which the engine is to operate.

However, during the past decade, gas engine oil developments have become more dynamic to adapt with the latest engine advancements. Incremental improvements made to the engine technology are driving lubricant companies to invest their own research and development. Petro-Canada Lubricants works closely with gas engine >

ABOUT THE AUTHOR

ZOE FARD, R&D product specialist at Petro-Canada Lubricants.

Reprinted from Spring 2021 **Diesel & Gas Turbine Worldwide**

OEMs to anticipate the demands of next generation engines. This is a positive drive for the industry as a whole; advancement is cyclical – while the machines improve, the oils step up and operators achieve an overall upgrade on their performance.

OILS CATCH UP – WHAT DO MODERN ENGINES REQUIRE?

Higher mechanical efficiency and power output in high performance modern engines is achieved by increasing the boost pressure of the engine and seeking higher compression ratios through engine design changes. Recent examples of design changes are the switch to steel pistons from traditional aluminium pistons and shorter piston top land. These highly efficient engines are operating at higher brake mean effective pressure (BMEP). The increased pressure means higher temperatures which new engine designs are built to accommodate. But it means the oil must also be able to handle sustained higher temperatures and harsher environments.

The advantage of steel pistons is better component strength, but thermal conductivity in steel is not as good as in aluminium. The oil is consequently exposed to higher temperatures for longer periods of time. In new piston designs, piston ring packs are located closer to the top of the piston where fuel burns. All of this puts additional stress on the lubricant, risking higher rates of oxidation and nitration, Base Number (BN) depletion, together with an increase in Acid Number (AN) and viscosity. This can result in shorter oil drain intervals as condemning limits are reached faster. In addition, accelerated oil degradation can result in increased ring groove and land deposits and piston undercrown varnish that can lead to efficiency loss and engine reliability issues. This supports the need for developing even more advanced, high-performance gas engine oils. Operators who have invested in advanced engine technology expect to avoid maintenance and unplanned downtime where possible. Therefore, selecting the right lubricant and avoiding a shortening of its life, is crucial. If oil changes must become more regular, any efficiencies gained from the improved engine technology could be cancelled out.

Another trend is to reduce oil consumption and emissions. The oil consumption rates have dropped considerably in the past decade. This reduction in oil consumption is the result of modified piston ring designs, oil spinners and updated valve stem sealing. Another design change is reduced clearance between piston crown land and cylinder liner for reduced emissions. These design changes improve combustion efficiency and reduce lube impacts on emissions but also results in higher level of stress to the lubricant, accelerating its degradation.

When considering the increased usage of alternative fuels, further development of the lubricant is demanded. Biogases or landfill, sewage and wood gases have multiple impurities including high sulfur, halogens and siloxanes that must be addressed by providing better acid control and deposit prevention properties in the oil formulation.

LUBRICANT COMPANIES RESPOND

Lubricant companies are striving to anticipate what OEMs are going to need for their evolving engines. Formulations are being developed with greater thermal and oxidative stability, neutralization ability, and high temperature deposit control tendency through advanced detergency and dispersancy. Modern engine technology is also pushing lubricant development to improve operation at reduced oil consumption rates and as mentioned, better performance with emerging raw fuels.

Companies are also forming technology partnerships to jointly recognize the adaption of new engine technology and its impact on the wider industry. Petro-Canada Lubricants, for example is working closely with gas engine OEMs and market-leading additive companies to anticipate the need for new formulations.

Additive technology is responding hand in hand with advancing engine requirements, preventing harmful deposits in the top ring grooves of steel piston engines to reduce wear in key engine parts and increase engine durability and life. Oils need to withstand increasingly severe operating environments to enable optimum output from new high-performance engines.

Lubricant development is focused on supporting operators in getting the most from their engines and assisting them in making their business as efficient and profitable as possible.

CONTINUED EVOLUTION

Of course, improvements to performance are an ongoing phenomenon. For example, for the purpose of fuel economy and minimizing the overall greenhouse gas footprints, another trend in gas engines is emerging among manufacturers, whereby they are moving toward rich-burn engines with design changes to get comparable efficiency to lean-burn engines. Rich-burn combustion type creates more nitrogen oxide (NOx) which must be accounted for in the formulation. High NOx environments are one example of the myriad of routes the lubricant companies are required to explore as engine technology develops.

The need for gas engine oils to keep evolving is laid bare when it is considered that the development procedure takes two to five years. There is a need for about 6000 to 10 000 hours of field testing to verify performance and it is only through this level of rigorous testing that the oil can be formally adopted.

Gas engine OEMs and lubricant companies alike have pushed performance levels to new heights thanks to cutting-edge innovation, but the future offers further opportunity for improvement throughout the industry. Efficiencies will continue to be sought, no doubt achieved, and operators will attain a performance level not previously possible. It is an exciting time for the industry. ■

Engines powered by unconventional sources of gas, such as these using landfill gas, are being developed quickly in many markets. As engine manufacturers adapt their engines to run on different fuel types, one area of concern is the increased stress on engine oil.

Design Begins Here

MOBILE HYDRAULICS

SPONSORED BY:

POWERFUL FORCES WORKING TOGETHER · NFPA ·

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS

DPI DIESEL PROGRESS INTERNATIONAL

Diesel & Gas Turbine WORLDWIDE

khl

MOBILE HYDRAULICS

Design Begins Here

MOBILE HYDRAULICS

SPONSORED BY:

POWERFUL FORCES WORKING TOGETHER · NFPA ·

POWER SOURCING GUIDE 2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

MOBILE HYDRAULICS

DIESEL PROGRESS DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE khl

Manufacturer	Page Reference	Model	Type (P = Axial Piston, RP = Radial Piston, G = Gear, V = Vane)	Displacement (cc)	Pressure (bar) Continuous	Pressure (bar) Intermittent	Pressure (bar) Maximum	Speed (rpm) min	Speed (rpm) max	Rotation (B = Bidirectional, U = Unidirectional)	Operating Temperature (°C) min	Operating Temperature (°C) max	Frame Size (mm) L	Frame Size (mm) W	Frame Size (mm) H	Weight (kg)
CONCENTRIC AB	*	D SERIES	G	22.9	207	228		600	3600	U		96	111	101	98	3.6
		FM15 SERIES	G	50	275	300		600	3600	U		96	150	118	124	10.5
		FM20 SERIES	G	23 TO 87	275	300		600	2800	U		96	202	159	160	12.3
		FM30 SERIES	G	58 TO 161	275	300		600	2500	U		96	243	179	194	21.8
		GC SERIES	G	1.06 TO 11.65	207	275		1000	4000	U, B		120	106	76.2	83.3	2.5
		H SERIES	G	39.4	207	228		600	3600	B		96	100	111	135	6.8
		WM1500 SERIES - AL CTR	G	19 - 50	275	300		500	3300	U		105	184	110	135	3.6
		WM1500 SERIES - AL CTR	G	19 - 50	275	300		500	3300	B		105	184	110	135	3.6
		WM300 SERIES	G	5.7	230	255		800	6000	U		90	89	62	70	1.6
		WM600 SERIES	G	4 TO 12	207	228		500	4000	U		93	130	69	86	2.8
		WM900 SERIES - AL CTR	G	16 TO 28	275	300		500	4000	U		105	125	88	107	
HEMA	*	1MN	G	8,2 - 28,1	250	280		600	4000	B	-20	80	138	84	100	
		1600	M	12.38 - 41.30	170	180		500	3000	B	-20	80	183	127	134	
		1900	M	22 - 74.2	210	250		600	3000	B	-20	80	172	184	168	
		2200	M	53.6 - 110.8	210	250		600	2700	B	-20	80	186	187	184	
LIEBHERR MACHINES BULLE SA	202, 299, 320	FMF 25	P	25	350		380		5180	B	-25	115	135			15
		FMF 32	P	31	350		380		5180	B	-25	115	135			15
		FMF 45	P	46	420		450		4620	B	-25	115	156			22
		FMF 58	P	58	420		450		4110	B	-25	115	164			23
		FMF 64	P	64	420		450		4110	B	-25	115	164			23
		FMF 90	P	91	350		380		3670	B	-25	115	159			32
		FMF 100	P	103	350		380		3540	B	-25	115	159			34
		FMF 125	P	126	350		380		3290	B	-25	115	179			45
		FMF 165	P	166	350		380		3000	B	-25	115	201			58
		FMF 250	P	257	350		380		2606	B	-25	115	214			85
		DMFA 355	P	356	400		450		2400	B	-25	115	406			135
		CMVE 85	P	85	380		400		3900	B	-25	115	303			52
		CMVE 108	P	108	380		400		3470	B	-25	115	313			65
		CMVE 135	P	136	380		400		3250	B	-25	115	333			73
		CMVE 165	P	166	380		400		3000	B	-25	115	374			78
		FMV 75	P	75	420		450		3900	B	-25	115	175			34
		FMV 100	P	103	350		380		3540	B	-25	115	175			41
		FMV 140	P	141	350		380		3160	B	-25	115	194			58
		FMV 165	P	166	350		380		3000	B	-25	115	220			79
		FMV 250	P	259	350		380		2600	B	-25	115	238			106
		DMVA 108	P	108	450		500		3350	B	-25	115	345			70
		DMVA 165	P	168	450		500		3000	B	-25	115	376			80
		DMVA 215	P	217	450		500		2700	B	-25	115	435			90
		DMVA 370	P	371	450		500		2400	B	-25	115	434			200
		DMVA D 165-108	P	275	450		500		3000	B	-25	115	547			137
		DMVA D 165-165	P	336	450		500		3000	B	-25	115	567			158
		DMVA D 215-165	P	384	450		500		2700	B	-25	115	616			179

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Model	Type (P = Axial Piston, RP = Radial Piston, G = Gear, V = Vane)	Displacement (cc)	Pressure (bar) Continuous	Intermittent	Maximum	Speed (rpm) min	max	Rotation (B = Bidirectional, U = Unidirectional)	Operating Temperature (°C) min	max	Frame Size (mm) L	W	H	Weight (kg)
CONCENTRIC AB	*	Calma Series	G	6.2 - 23.7			250	400	4000	U, B		105				
		D Series	G	3.8 - 22.9	207	228		600	3600	U		96	111	101	98	4
		Ferra F12 Series	G	16 - 41	275	300		700	3000	U		93	166	106	107	10
		Ferra F15 Series	G	19 - 50	275	300		600	3600	U		96	150	118	124	11
		Ferra F20 Series	G	123 - 161	275	300		600	3600	U		96	202	159	160	12
		Ferra F30 Series	G	123 - 161	275	300		600	3600	U		96	243	179	194	22
		GC Series	G	1.0 - 11.6	207	275		1000	4000	U, B		120	106	76	83	3
		H Series	G	39	207	228		600	3600	B		96	100	111	135	7
		W100 Series	G	2	207	228		800	6000	U		90	75	49	54	1
		W1200 Series - Al Ctr	G	33	214	235		700	3000	U		93	132	88	107	6
		W1200 Series - CI Ctr	G	33	214	235		700	3000	U		93	132	88	107	13
		W1500 Series - Al Ctr	G	50	275	300	330	500	3300	U		105	156	110	135	9
		W300 Series	G	0.8 - 5.7	230	255		800	6000	U		90	89	62	70	2
		W600 Series	G	4 - 12	275	290		700	4000	U		93	130	69	86	3
		W900 Series - Al Ctr	G	31	275	300		500	4000	U		105	129	88	107	5
		W900 Series - CI Ctr	G	31	275	300		500	4000	U		105	129	88	107	11
HAWE HYDRAULIK SE	*		P		205 - 400		300 - 450	500	1900 - 3600	u	-40	60	211 - 432	115 - 272	150 - 326	21 - 130
			G	1.2 - 8.1	280	300		600	4000	U	-40	100	88	76	91	
HEMA	*		G	4 - 250	170 - 250	180 - 280		450- 600	2500 - 3000	u	-40	250	138 - 318	84 - 255	100 - 239	
KRAL AG	*	CL	G				100			U	-40	250				
		CK	G				70			U	-40	150				
LIEBHERR MACHINES BULLE SA	202, 299, 320	DPVO 108	P	108	400		450		2100	U	-25	115	311			56
		DPVO 140	P	140	400		450		2100	U	-25	115	344			65
		DPVO 165	P	168	400		450		2100	U	-25	115	348			74
		DPVO 215	P	217	400		450		2000	U	-25	115	405			125
		DPVO 215i	P	217	400		450		2600	U	-25	115	398			125
		DPVD 108	P	108	400		450		2200	U	-25	115	476			158
		DPVD 165	P	168	400		450		2100	U	-25	115	558			144
		DPVP 108	P	108	400		450		2300	U	-25	115	416			227
		DPVP 108i	P	108	400		450		2800	U	-25	115	556			313
		DPVP 165	P	168	400		450		2100	U	-25	115	518			380
		DPVP 165i	P	168	400		450		2600	U	-25	115	606			380
		DPVG 108	P	108	450		500		3000	U	-25	115	331			69
		DPVG 140	P	140	450		500		2850	U	-25	115	365			79
		DPVG 165	P	168	450		500		2700	U	-25	115	359			96
		DPVG 280	P	283	450		500		2500	U	-25	115	395			134
		LH30VO045	P	47	280		320		3000	U	-25	115	216			20
		LH30VO085	P	85	280		320		2400	U	-25	115	281			43
		LH30VO028	P	28	280		320		3300	U	-25	115	208			18
VOITH TURBO GMBH & CO. KG	*	Low Pressure IGP Type IPN	G	32.1 - 200	63 - 100		80 - 125	400	3600	B	-20	80				
		Low/Med. IGP Type IPNE/ IPME	G	13.1 - 200	40 - 125		40 - 125	400	3600	B	-20	80				
		Med. Pressure IGP Type IPM	G	6.7 - 80.3	175		210	400	3000	B	-20	80				
		Med. Pressure IGP Type IPC	G	20.7 - 252	210		250	400	3200	B	-20	80				
		Med. Pressure IGP Type IPA	G	6.7 - 80.3	175		210	400	3600	B	-20	80				
		High Pressure IGP Type IPH	G	20.7 - 126	250 - 300		300 - 330	300	3000	B	-20	80				
		High Pressure IGP Type IPV	G	3.6 - 252	250 - 345		250 - 345	400	3600	B	-20	80				
		High Pressure IGP Type IPVS	G	3.6 - 64.9	265 - 345		300 - 420	400	3600	B	-20	80				

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

Manufacturer	Page Reference	Model	Type: DV - Directional Valve, IL - Inline Aux. Control, CV - Cartridge Valve, D - Divider	Construction: P - Poppet, S - Spool, PC - Pressure Compensated Spool	Actuation: M - Manual, HP - Hydraulic Pilot, OO - On/Off Solenoid, E - Electric Proportional	Function: D - Directional Control, P - Pressure Control, F - Flow Control, S - Solenoid Valve, PS - Proportional Solenoid, M - Motion Control	Flow Rating (L/min)	Pressure Rating (bar)
BRAND HYDRAULICS CO.	*		D	S	HP	F	114 - 454	207
			DV	S, PC	M, E	D	22.7 - 170	207 - 310
			DV	S	E/M	D	22.7	276
			DV	S	M	D	45.4	241
			DV	S	E/M, E	D	45.4	241
			DV	S	E/M, E	D	90.8	241
			DV	S	E	D	114.0	207
			IL	P, PC, S	M, E, HP	F, P, D	37.8 - 341	207
HAWE HYDRAULIK SE	*	PSL, Size 2	DV	PC	M, HP, E	D	60.0	420
		PSL, Size 3	DV	PC	M, HP, E	D	120	420
		PSL, Size 5	DV	PC	M, HP, E	D	270.0	400
		PSLF, Size 3	DV	PC	M, HP, E	D	120	400
		PSLF, Size 5	DV	PC	M, HP, E	D	270.0	400
		LHT, Size 2	IL	P	HP	P	28	400
		LHT, Size 3	IL	P	HP	P	130.0	420
		LHT, Size 5	IL	P	HP	P	250	400
		LHK, Size 2	IL	P	HP	P	20.0	400
		LHK, Size 3	IL	P	HP	P	60	360
		LHK, Size 4	IL	P	HP	P	100.0	350
		LHDV	IL	P	HP	P	80	420
HEMA	*	MV025	DV	S	M	D	25.0	250
		MV024	DV	S	M	D	30	250
		MV026	DV	S	M	D	30.0	250
		MV045	DV	S	M, HP, OO	D	50	280
		MV046	DV	S	M, HP, OO	D	50.0	280
		MV050	DV	S	M, HP, OO	D	80	280
		MV051	DV	S	M, HP, OO	D	50.0	280
		MV052	DV	S	M, HP, OO	D	50	280
		SV033	DV	S	M, HP, OO	D	150.0	230
		33	DV	S	M,HP	D	150	230
		34	DV	S	M, HP, OO	D	150.0	230
		35	DV	S	M, HP, OO	D	150	230
		MV180	DV	S	M	D	180.0	250
		MV181	DV	S	M, HP, OO	D	180	250
		MV182	DV	S	M, HP	D	180.0	250
		MV183	DV	S	M, HP, OO	D	180	250
		MV4009	DV	S	M, HP	D	205.0	210
		MV4109	DV	S	M, HP	D	205	210
		MV4011	DV	S	M, HP, OO	D	270.0	230
		MV059	DV	S	HP	D	375	250
		MV4013	DV	S	M, HP, OO	D	450.0	230

* This manufacturer is not represented in this 2021-2022 edition of the Power Sourcing Guide with a section description of its products.

STANDARDS
A KEY PART OF FLUID POWER TECHNOLOGY

Why Standards matter
Designing, assembling and maintaining a hydraulic or pneumatic system often involves putting together a variety of components, often from a variety of suppliers. Without standards for dimensional interchangeability, performance measurement and communication, these processes would be much more difficult.

Standards benefit users because they:
• simplify the use of fluid power;
• help educate users on how to correctly size and apply products;
• determine product performance and how it is measured, allowing comparison;
• communicate needs in a commonly understood language;
• are written with input from users.

Standards benefit manufacturers because they:
• provide uniform methods for testing products and advertising their ratings;
• help to assure system integrity and safety in the application of fluid power;
• help to improve efficiency of fluid power products and systems;
• simplify the variety of products and sizes in the marketplace;
• encourage new product development;
• help avoid confusion in communicating with customers.

Since 1969, the National Fluid Power Association (NFPA) has worked to foster cooperation among users and manufacturers by developing International (ISO) standards.

Standards for fluid power products and systems fall into three basic categories:

Communication standards define the basic terms, symbols and other communication tools used in the fluid power industry. Vocabularies, graphic symbols and dimension codes are typical subjects for communication standards.

Design standards establish dimensions, tolerances or other physical characteristics of products. They ensure that fluid power products meet dimensional criteria that enable interfacing and interchangeability.

Performance standards provide a voluntary method of rating products. Pressure rating, particle counting methods used in contamination analysis, and methods of testing for strength and volume are typical performance standards.

To learn more about fluid power standards and/or get involved with the development of ISO standards contact Denise Husenica at 414-778-3354 or email dhusenica@nfpa.com.

NATIONAL FLUID POWER ASSOCIATION • NFPA •

List Of Published Standards Developed By ISO/TC 131

as of 2021-05-11 (ISO/TC 131 SC or WG that is responsible for the standard is listed to the right)

REFERENCE	DOCUMENT TITLE	COMMITTEE
ISO 10041-1:2010	*Pneumatic fluid power — Electro-pneumatic continuous flow control valves — Part 1: Main characteristics to include in the supplier's literature*	ISO/TC 131/SC 5
ISO 10041-2:2010	*Pneumatic fluid power — Electro-pneumatic continuous flow control valves — Part 2: Test methods to determine main characteristics to include in the supplier's literature*	ISO/TC 131/SC 5
ISO 10094-1:2010	*Pneumatic fluid power — Electro-pneumatic pressure control valves — Part 1: Main characteristics to include in the supplier's literature*	ISO/TC 131/SC 5
ISO 10094-2:2010	*Pneumatic fluid power — Electro-pneumatic pressure control valves — Part 2: Test methods to determine main characteristics to include in the supplier's literature*	ISO/TC 131/SC 5
ISO 10099:2001	*Pneumatic fluid power — Cylinders — Final examination and acceptance criteria*	ISO/TC 131/SC 3/ WG 2
ISO 10100:2020	*Hydraulic fluid power — Cylinders — Acceptance tests*	ISO/TC 131/SC 3/ WG 1
ISO 10372:1992	*Hydraulic fluid power — Four- and five-port servovalves — Mounting surfaces*	ISO/TC 131/SC 5/ WG 2
ISO 10762:2015	*Hydraulic fluid power — Mounting dimensions for cylinders, 10 MPa (100 bar) series*	ISO/TC 131/SC 3/ WG 1
ISO 10763:2020	*Hydraulic fluid power — Plain-end, seamless and welded precision steel tubes — Dimensions and nominal working pressures*	ISO/TC 131/SC 4/ WG 6
ISO 10766:2014	*Hydraulic fluid power — Cylinders — Housing dimensions for rectangular-section-cut bearing rings for pistons and rods*	ISO/TC 131/SC 7/ WG 2
ISO 10767-1:2015	*Hydraulic fluid power — Determination of pressure ripple levels generated in systems and components — Part 1: Method for determining source flow ripple and source impedance of pumps*	ISO/TC 131/SC 8/ WG 1
ISO 10767-2:1999	*Hydraulic fluid power — Determination of pressure ripple levels generated in systems and components — Part 2: Simplified method for pumps*	ISO/TC 131/SC 8/ WG 1
ISO 10767-3:1999	*Hydraulic fluid power — Determination of pressure ripple levels generated in systems and components — Part 3: Method for motors*	ISO/TC 131/SC 8/ WG 1
ISO 10770-1:2009	*Hydraulic fluid power — Electrically modulated hydraulic control valves — Part 1: Test methods for four-port directional flow-control valves*	ISO/TC 131/SC 5/ WG 2
ISO 10770-2:2012	*Hydraulic fluid power — Electrically modulated hydraulic control valves — Part 2: Test methods for three-port directional flow-control valves*	ISO/TC 131/SC 5/ WG 2
ISO 10770-3:2020	*Hydraulic fluid power — Electrically modulated hydraulic control valves — Part 3: Test methods for pressure control valves*	ISO/TC 131/SC 5/ WG 2
ISO 10771-1:2015	*Hydraulic fluid power — Fatigue pressure testing of metal pressure-containing envelopes — Part 1: Test method*	ISO/TC 131/SC 8/ WG 11
ISO 11170:2013	*Hydraulic fluid power — Sequence of tests for verifying performance characteristics of filter elements*	ISO/TC 131/SC 6/ WG 2
ISO 11171:2020	*Hydraulic fluid power — Calibration of automatic particle counters for liquids*	ISO/TC 131/SC 6/ WG 1
ISO 11500:2008	*Hydraulic fluid power — Determination of the particulate contamination level of a liquid sample by automatic particle counting using the light-extinction principle*	ISO/TC 131/SC 6/ WG 1
ISO 11727:1999	*Pneumatic fluid power — Identification of ports and control mechanisms of control valves and other components*	ISO/TC 131/SC 5/ WG 3
ISO 1179-1:2013	*Connections for general use and fluid power — Ports and stud ends with ISO 228-1 threads with elastomeric or metal-to-metal sealing — Part 1: Threaded ports*	ISO/TC 131/SC 4/ WG 1
ISO 1179-2:2013	*Connections for general use and fluid power — Ports and stud ends with ISO 228-1 threads with elastomeric or metal-to-metal sealing — Part 2: Heavy-duty (S series) and light-duty (L series) stud ends with elastomeric sealing (type E)*	ISO/TC 131/SC 4/ WG 1
ISO 1179-3:2007	*Connections for general use and fluid power — Ports and stud ends with ISO 228-1 threads with elastomeric or metal-to-metal sealing — Part 3: Light-duty (L series) stud ends with sealing by O-ring with retaining ring (types G and H)*	ISO/TC 131/SC 4/ WG 1
ISO 1179-4:2007	*Connections for general use and fluid power — Ports and stud ends with ISO 228-1 threads with elastomeric or metal-to-metal sealing — Part 4: Stud ends for general use only with metal-to-metal sealing (type B)*	ISO/TC 131/SC 4/ WG 1
ISO 11926-1:1995	*Connections for general use and fluid power — Ports and stud ends with ISO 725 threads and O-ring sealing — Part 1: Ports with O-ring seal in truncated housing*	ISO/TC 131/SC 4/ WG 1
ISO 11926-2:1995	*Connections for general use and fluid power — Ports and stud ends with ISO 725 threads and O-ring sealing — Part 2: Heavy-duty (S series) stud ends*	ISO/TC 131/SC 4/ WG 1
ISO 11926-3:1995	*Connections for general use and fluid power — Ports and stud ends with ISO 725 threads and O-ring sealing — Part 3: Light-duty (L series) stud ends*	ISO/TC 131/SC 4/ WG 1
ISO 11943:2021	*Hydraulic fluid power — Online automatic particle-counting systems for liquids — Methods of calibration and validation*	ISO/TC 131/SC 6/ WG 1

List Of Published Standards Developed By ISO/TC 131

as of 2021-05-11 (ISO/TC 131 SC or WG that is responsible for the standard is listed to the right)

REFERENCE	DOCUMENT TITLE	COMMITTEE
ISO 12151-1:2010	*Connections for hydraulic fluid power and general use — Hose fittings — Part 1: Hose fittings with ISO 8434-3 O-ring face seal ends*	ISO/TC 131/SC 4/ WG 6
ISO 12151-1:2010/ Amd 1:2017	*Connections for hydraulic fluid power and general use — Hose fittings — Part 1: Hose fittings with ISO 8434-3 O-ring face seal ends — Amendment 1*	ISO/TC 131/SC 4/ WG 6
ISO 12151-2:2003	*Connections for hydraulic fluid power and general use — Hose fittings — Part 2: Hose fittings with ISO 8434-1 and ISO 8434-4 24 degree cone connector ends with O-rings*	ISO/TC 131/SC 4/ WG 6
ISO 12151-3:2010	*Connections for hydraulic fluid power and general use — Hose fittings — Part 3: Hose fittings with ISO 6162-1 or ISO 6162-2 flange ends*	ISO/TC 131/SC 4/ WG 6
ISO 12151-4:2007	*Connections for hydraulic fluid power and general use — Hose fittings — Part 4: Hose fittings with ISO 6149 metric stud ends*	ISO/TC 131/SC 4
ISO 12151-5:2007	*Connections for hydraulic fluid power and general use — Hose fittings — Part 5: Hose fittings with ISO 8434-2 37 degree flared ends*	ISO/TC 131/SC 4
ISO 12151-6:2009	*Connections for hydraulic fluid power and general use — Hose fittings — Part 6: Hose fittings with ISO 8434-6 60 degree cone ends*	ISO/TC 131/SC 4
ISO 1219-1:2012	*Fluid power systems and components — Graphical symbols and circuit diagrams — Part 1: Graphical symbols for conventional use and data-processing applications*	ISO/TC 131/SC 1/ WG 1
ISO 1219-1:2012/ Amd 1:2016	*Fluid power systems and components — Graphical symbols and circuit diagrams — Part 1: Graphical symbols for conventional use and data-processing applications — Amendment 1*	ISO/TC 131/SC 1/ WG 1
ISO 1219-2:2012	*Fluid power systems and components — Graphical symbols and circuit diagrams — Part 2: Circuit diagrams*	ISO/TC 131/SC 1/ WG 1
ISO 1219-3:2016	*Fluid power systems and components — Graphical symbols and circuit diagrams — Part 3: Symbol modules and connected symbols in circuit diagrams*	ISO/TC 131/SC 1/ WG 1
ISO 12238:2001	*Pneumatic fluid power — Directional control valves — Measurement of shifting time*	ISO/TC 131/SC 5/ WG 3
ISO 12669:2017	*Hydraulic fluid power — Method for determining the required cleanliness level (RCL) of a system*	ISO/TC 131/SC 6
ISO 12829:2016	*Hydraulic spin-on filters with finite lives — Method for verifying the rated fatigue life and the rated static burst pressure of the pressure-containing envelope*	ISO/TC 131/SC 6/ WG 2
ISO 13726:2008	*Hydraulic fluid power — Single rod cylinders, 16 MPa (160 bar) compact series with bores from 250 mm to 500 mm — Accessory mounting dimensions*	ISO/TC 131/SC 3/ WG 1
ISO 14540:2013	*Hydraulic fluid power — Dimensions and requirements for screw-to-connect quick-action couplings for use at a pressure of 72 MPa (720 bar)*	ISO/TC 131/SC 4
ISO 14541:2013	*Hydraulic fluid power — Dimensions and requirements for screw-to-connect quick-action couplings for general purpose*	ISO/TC 131/SC 4
ISO 14743:2020	*Pneumatic fluid power — Push-in connectors for thermoplastic tubes*	ISO/TC 131/SC 4/ WG 9
ISO 15086-1:2001	*Hydraulic fluid power — Determination of the fluid-borne noise characteristics of components and systems — Part 1: Introduction*	ISO/TC 131/SC 8/ WG 1
ISO 15086-2:2000	*Hydraulic fluid power — Determination of the fluid-borne noise characteristics of components and systems — Part 2: Measurement of the speed of sound in a fluid in a pipe*	ISO/TC 131/SC 8/ WG 1
ISO 15086-3:2008	*Hydraulic fluid power — Determination of the fluid-borne noise characteristics of components and systems — Part 3: Measurement of hydraulic impedance*	ISO/TC 131/SC 8/ WG 1
ISO 15171-1:1999	*Connections for fluid power and general use — Hydraulic couplings for diagnostic purposes — Part 1: Coupling not for connection under pressure*	ISO/TC 131/SC 4
ISO 15171-2:2016	*Connections for fluid power and general use — Hydraulic couplings for diagnostic purposes — Part 2: Coupling with M16 x 2 end for connection under pressure*	ISO/TC 131/SC 4/ WG 4
ISO 15217:2000	*Fluid power systems and components — 16 mm square electrical connector with earth contact — Characteristics and requirements*	ISO/TC 131/SC 5/ WG 3
ISO 15218:2003	*Pneumatic fluid power — 3/2 solenoid valves — Mounting interface surfaces*	ISO/TC 131/SC 5/ WG 3
ISO 15407-1:2000	*Pneumatic fluid power — Five-port directional control valves, sizes 18 mm and 26 mm — Part 1: Mounting interface surfaces without electrical connector*	ISO/TC 131/SC 5/ WG 3
ISO 15407-2:2003	*Pneumatic fluid power — Five-port directional control valves, sizes 18 mm and 26 mm — Part 2: Mounting interface surfaces with optional electrical connector*	ISO/TC 131/SC 5/ WG 3
ISO 15524:2011	*Pneumatic fluid power — Cylinders — Single-rod short-stroke cylinders, 1 000 kPa (10 bar) series, bores from 20 mm to 100 mm*	ISO/TC 131/SC 3
ISO 15552:2018	*Pneumatic fluid power — Cylinders with detachable mountings, 1 000 kPa (10 bar) series, bores from 32 mm to 320 mm — Basic, mounting and accessories dimensions*	ISO/TC 131/SC 3/ WG 2
ISO 16028:1999	*Hydraulic fluid power — Flush-face type, quick-action couplings for use at pressures of 20 MPa (200 bar) to 31,5 MPa (315 bar) — Specifications*	ISO/TC 131/SC 4

REFERENCE	DOCUMENT TITLE	COMMITTEE
ISO 16028:1999/ Amd 1:2006	*Hydraulic fluid power — Flush-face type, quick-action couplings for use at pressures of 20 MPa (200 bar) to 31,5 MPa (315 bar) — Specifications — Amendment 1*	ISO/TC 131/SC 4
ISO 16030:2001	*Pneumatic fluid power — Connections — Ports and stud ends*	ISO/TC 131/SC 4/ WG 9
ISO 16030:2001/ Amd 1:2005	*Pneumatic fluid power — Connections — Ports and stud ends — Amendment 1*	ISO/TC 131/SC 4/ WG 9
ISO 16431:2012	*Hydraulic fluid power — System clean-up procedures and verification of cleanliness of assembled systems*	ISO/TC 131/SC 6
ISO 16589-1:2011	*Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 1: Nominal dimensions and tolerances*	ISO/TC 131/SC 7/ WG 4
ISO 16589-1:2011/ Amd 1:2018	*Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 1: Nominal dimensions and tolerances — Amendment 1*	ISO/TC 131/SC 7/ WG 4
ISO 16589-2:2011	*Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 2: Vocabulary*	ISO/TC 131/SC 7/ WG 4
ISO 16589-3:2011	*Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 3: Storage, handling and installation*	ISO/TC 131/SC 7/ WG 4
ISO 16589-4:2011	*Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 4: Performance test procedures*	ISO/TC 131/SC 7/ WG 4
ISO 16589-5:2011	*Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 5: Identification of visual imperfections*	ISO/TC 131/SC 7/ WG 4
ISO 16656:2016	*Hydraulic fluid power — Single rod, short-stroke cylinders with bores from 32 mm to 100 mm for use at 10 MPa (100 bar) — Mounting dimensions*	ISO/TC 131/SC 3/ WG 1
ISO 16860:2005	*Hydraulic fluid power — Filters — Test method for differential pressure devices*	ISO/TC 131/SC 6/ WG 2
ISO 16873:2011	*Hydraulic fluid power — Pressure switches — Mounting surfaces*	ISO/TC 131/SC 5/ WG 2
ISO 16874:2004	*Hydraulic fluid power — Identification of manifold assemblies and their components*	ISO/TC 131/SC 5/ WG 2
ISO 16889:2008	*Hydraulic fluid power — Filters — Multi-pass method for evaluating filtration performance of a filter element*	ISO/TC 131/SC 6/ WG 2
ISO 16889:2008/ Amd 1:2018	*Hydraulic fluid power — Filters — Multi-pass method for evaluating filtration performance of a filter element — Amendment 1*	ISO/TC 131/SC 6/ WG 2
ISO 16902-1:2003	*Hydraulic fluid power — Test code for the determination of sound power levels of pumps using sound intensity techniques: Engineering method — Part 1: Pumps*	ISO/TC 131/SC 8/ WG 1
ISO 16908:2014	*Hydraulic filter element test methods — Thermal conditioning and cold start-up simulation*	ISO/TC 131/SC 6/ WG 2
ISO 17082:2004	*Pneumatic fluid power — Valves — Data to be included in supplier literature*	ISO/TC 131/SC 5/ WG 3
ISO 17165-1:2007	*Hydraulic fluid power — Hose assemblies — Part 1: Dimensions and requirements*	ISO/TC 131/SC 4/ WG 6
ISO 17559:2003	*Hydraulic fluid power — Electrically controlled hydraulic pumps — Test methods to determine performance characteristics*	ISO/TC 131/SC 8
ISO 18237:2017	*Hydraulic fluid power — Method for evaluating water separation performance of dehydrators*	ISO/TC 131/SC 6/ WG 2
ISO 18413:2015	*Hydraulic fluid power — Cleanliness of components — Inspection document and principles related to contaminant extraction and analysis, and data reporting*	ISO/TC 131/SC 6
ISO 18582-1:2016	*Fluid power — Specification of reference dictionary — Part 1: General overview on organization and structure*	ISO/TC 131/SC 1/ WG 4
ISO 18582-2:2018	*Fluid power — Specification of reference dictionary — Part 2: Definitions of classes and properties of pneumatics*	ISO/TC 131/SC 1/ WG 4
ISO 18869:2017	*Hydraulic fluid power — Test methods for couplings actuated with or without tools*	ISO/TC 131/SC 4/ WG 4
ISO 19879:2021	*Metallic tube connections for fluid power and general use — Test methods for hydraulic fluid power connections*	ISO/TC 131/SC 4/ WG 6
ISO 19973-1:2015	*Pneumatic fluid power — Assessment of component reliability by testing — Part 1: General procedures*	ISO/TC 131/WG 4
ISO 19973-2:2015	*Pneumatic fluid power — Assessment of component reliability by testing — Part 2: Directional control valves*	ISO/TC 131/WG 4
ISO 19973-2:2015/ Amd 1:2019	*Pneumatic fluid power — Assessment of component reliability by testing — Part 2: Directional control valves — Amendment 1*	ISO/TC 131/WG 4
ISO 19973-3:2015	*Pneumatic fluid power — Assessment of component reliability by testing — Part 3: Cylinders with piston rod*	ISO/TC 131/WG 4

List Of Published Standards Developed By ISO/TC 131

as of 2021-05-11 (ISO/TC 131 SC or WG that is responsible for the standard is listed to the right)

REFERENCE	DOCUMENT TITLE	COMMITTEE
ISO 19973-4:2014	*Pneumatic fluid power — Assessment of component reliability by testing — Part 4: Pressure regulators*	ISO/TC 131/WG 4
ISO 19973-5:2015	*Pneumatic fluid power — Assessment of component reliability by testing — Part 5: Non-return valves, shuttle valves, dual pressure valves (AND function), one-way adjustable flow control valves, quick-exhaust valves*	ISO/TC 131/WG 4
ISO 20145:2019	*Pneumatic fluid power — Test methods for measuring acoustic emission pressure levels of exhaust silencers*	ISO/TC 131/SC 5/ WG 5
ISO 20401:2017	*Pneumatic fluid power systems — Directional control valves — Specification of pin assignment for 8 mm and 12 mm diameter electrical round connectors*	ISO/TC 131/SC 5/ WG 3
ISO 21018-1:2008	*Hydraulic fluid power — Monitoring the level of particulate contamination of the fluid — Part 1: General principles*	ISO/TC 131/SC 6/ WG 1
ISO 21018-3:2008	*Hydraulic fluid power — Monitoring the level of particulate contamination of the fluid — Part 3: Use of the filter blockage technique*	ISO/TC 131/SC 6/ WG 1
ISO 21018-4:2019	*Hydraulic fluid power — Monitoring the level of particulate contamination in the fluid — Part 4: Use of the light extinction technique*	ISO/TC 131/SC 6/ WG 1
ISO 21287:2004	*Pneumatic fluid power — Cylinders — Compact cylinders, 1000 kPa (10 bar) series, bores from 20 mm to 100 mm*	ISO/TC 131/SC 3/ WG 2
ISO 23181:2007	*Hydraulic fluid power — Filter elements — Determination of resistance to flow fatigue using high viscosity fluid*	ISO/TC 131/SC 6/ WG 2
ISO 23309:2020	*Hydraulic fluid power systems — Assembled systems — Methods of cleaning lines by flushing*	ISO/TC 131/SC 6/ WG 1
ISO 27407:2010	*Hydraulic fluid power — Marking of performance characteristics on hydraulic filters*	ISO/TC 131/SC 6/ WG 2
ISO 2941:2009	*Hydraulic fluid power — Filter elements — Verification of collapse/burst pressure rating*	ISO/TC 131/SC 6/ WG 2
ISO 2942:2018	*Hydraulic fluid power — Filter elements — Verification of fabrication integrity and determination of the first bubble point*	ISO/TC 131/SC 6/ WG 2
ISO 2943:1998	*Hydraulic fluid power — Filter elements — Verification of material compatibility with fluids*	ISO/TC 131/SC 6/ WG 2
ISO 2944:2000	*Fluid power systems and components — Nominal pressures*	ISO/TC 131
ISO 3019-1:2001	*Hydraulic fluid power — Dimensions and identification code for mounting flanges and shaft ends of displacement pumps and motors — Part 1: Inch series shown in metric units*	ISO/TC 131/SC 2
ISO 3019-2:2001	*Hydraulic fluid power — Dimensions and identification code for mounting flanges and shaft ends of displacement pumps and motors — Part 2: Metric series*	ISO/TC 131/SC 2
ISO 3019-2:2001/ Cor 1:2006	*Hydraulic fluid power — Dimensions and identification code for mounting flanges and shaft ends of displacement pumps and motors — Part 2: Metric series — Technical Corrigendum 1*	ISO/TC 131/SC 2
ISO 3320:2013	*Fluid power systems and components — Cylinder bores and piston rod diameters and area ratios — Metric series*	ISO/TC 131/SC 3
ISO 3601-1:2012	*Fluid power systems — O-rings — Part 1: Inside diameters, cross-sections, tolerances and designation codes*	ISO/TC 131/SC 7/ WG 3
ISO 3601-1:2012/ Amd 1:2019	*Fluid power systems — O-rings — Part 1: Inside diameters, cross-sections, tolerances and designation codes — Amendment 1*	ISO/TC 131/SC 7/ WG 3
ISO 3601-1:2012/ Cor 1:2012	*Fluid power systems — O-rings — Part 1: Inside diameters, cross-sections, tolerances and designation codes — Technical Corrigendum 1*	ISO/TC 131/SC 7/ WG 3
ISO 3601-2:2016	*Fluid power systems — O-rings — Part 2: Housing dimensions for general applications*	ISO/TC 131/SC 7/ WG 3
ISO 3601-3:2005	*Fluid power systems — O-rings — Part 3: Quality acceptance criteria*	ISO/TC 131/SC 7/ WG 3
ISO 3601-3:2005/ Amd 1:2018	*Fluid power systems — O-rings — Part 3: Quality acceptance criteria — Amendment 1*	ISO/TC 131/SC 7/ WG 3
ISO 3601-4:2008	*Fluid power systems — O-rings — Part 4: Anti-extrusion rings (back-up rings)*	ISO/TC 131/SC 7
ISO 3601-5:2015	*Fluid power systems — O-rings — Part 5: Specification of elastomeric materials for industrial applications*	ISO/TC 131/SC 7/ WG 3
ISO 3662:1976	*Hydraulic fluid power — Pumps and motors — Geometric displacements*	ISO/TC 131/SC 2
ISO 3722:1976	*Hydraulic fluid power — Fluid sample containers — Qualifying and controlling cleaning methods*	ISO/TC 131/SC 6/ WG 1
ISO 3723:2015	*Hydraulic fluid power — Filter elements — Method for end load test*	ISO/TC 131/SC 6/ WG 2

List Of Published Standards Developed By ISO/TC 131

as of 2021-05-11 (ISO/TC 131 SC or WG that is responsible for the standard is listed to the right)

REFERENCE	DOCUMENT TITLE	COMMITTEE
ISO 3724:2007	*Hydraulic fluid power — Filter elements — Determination of resistance to flow fatigue using particulate contaminant*	ISO/TC 131/SC 6/ WG 2
ISO 3939:1977	*Fluid power systems and components — Multiple lip packing sets — Methods for measuring stack heights*	ISO/TC 131/SC 7
ISO 3968:2017	*Hydraulic fluid power — Filters — Evaluation of differential pressure versus flow*	ISO/TC 131/SC 6/ WG 2
ISO 4021:1992	*Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system*	ISO/TC 131/SC 6/ WG 1
ISO 4391:1983	*Hydraulic fluid power — Pumps, motors and integral transmissions — Parameter definitions and letter symbols*	ISO/TC 131/SC 2
ISO 4392-1:2002	*Hydraulic fluid power — Determination of characteristics of motors — Part 1: At constant low speed and constant pressure*	ISO/TC 131/SC 8/ WG 13
ISO 4392-2:2002	*Hydraulic fluid power — Determination of characteristics of motors — Part 2: Startability*	ISO/TC 131/SC 8/ WG 13
ISO 4392-3:1993	*Hydraulic fluid power — Determination of characteristics of motors — Part 3: At constant flow and at constant torque*	ISO/TC 131/SC 8/ WG 13
ISO 4393:2015	*Fluid power systems and components — Cylinders — Basic series of piston strokes*	ISO/TC 131/SC 3
ISO 4395:2009	*Fluid power systems and components — Cylinder piston rod end types and dimensions*	ISO/TC 131/SC 3
ISO 4395:2009/Cor 1:2010	*Fluid power systems and components — Cylinder piston rod end types and dimensions — Technical Corrigendum 1*	ISO/TC 131/SC 3
ISO 4397:2011	*Fluid power connectors and associated components — Nominal outside diameters of tubes and nominal hose sizes*	ISO/TC 131/SC 4/ WG 6
ISO 4399:2019	*Fluid power systems and components — Connectors and associated components — Nominal pressures*	ISO/TC 131/SC 4/ WG 6
ISO 4400:1994	*Fluid power systems and components — Three-pin electrical plug connectors with earth contact — Characteristics and requirements*	ISO/TC 131/SC 5/ WG 2
ISO 4401:2005	*Hydraulic fluid power — Four-port directional control valves — Mounting surfaces*	ISO/TC 131/SC 5/ WG 2
ISO 4405:1991	*Hydraulic fluid power — Fluid contamination — Determination of particulate contamination by the gravimetric method*	ISO/TC 131/SC 6/ WG 1
ISO 4406:2021	*Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*	ISO/TC 131/SC 6/ WG 1
ISO 4407:2002	*Hydraulic fluid power — Fluid contamination — Determination of particulate contamination by the counting method using an optical microscope*	ISO/TC 131/SC 6/ WG 1
ISO 4409:2019	*Hydraulic fluid power — Positive-displacement pumps, motors and integral transmissions — Methods of testing and presenting basic steady state performance*	ISO/TC 131/SC 8/ WG 13
ISO 4411:2019	*Hydraulic fluid power — Valves — Determination of differential pressure/flow rate characteristics*	ISO/TC 131/SC 5/ WG 2
ISO 4412-1:1991	*Hydraulic fluid power — Test code for determination of airborne noise levels — Part 1: Pumps*	ISO/TC 131/SC 8/ WG 1
ISO 4412-2:1991	*Hydraulic fluid power — Test code for determination of airborne noise levels — Part 2: Motors*	ISO/TC 131/SC 8/ WG 1
ISO 4412-3:1991	*Hydraulic fluid power — Test code for determination of airborne noise levels — Part 3: Pumps — Method using a parallelepiped microphone array*	ISO/TC 131/SC 8/ WG 1
ISO 4413:2010	*Hydraulic fluid power — General rules and safety requirements for systems and their components*	ISO/TC 131/SC 9
ISO 4414:2010	*Pneumatic fluid power — General rules and safety requirements for systems and their components*	ISO/TC 131/SC 9
ISO 5597:2018	*Hydraulic fluid power — Cylinders — Dimensions and tolerances of housings for single-acting piston and rod seals in reciprocating applications*	ISO/TC 131/SC 7/ WG 2
ISO 5598:2020	*Fluid power systems and components — Vocabulary*	ISO/TC 131/SC 1/ WG 2
ISO 5599-1:2001	*Pneumatic fluid power — Five-port directional control valves — Part 1: Mounting interface surfaces without electrical connector*	ISO/TC 131/SC 5/ WG 3
ISO 5599-1:2001/ Cor 1:2007	*Pneumatic fluid power — Five-port directional control valves — Part 1: Mounting interface surfaces without electrical connector — Technical Corrigendum 1*	ISO/TC 131/SC 5/ WG 3
ISO 5599-2:2001	*Pneumatic fluid power — Five-port directional control valves — Part 2: Mounting interface surfaces with optional electrical connector*	ISO/TC 131/SC 5/ WG 3
ISO 5599-2:2001/ Amd 1:2004	*Pneumatic fluid power — Five-port directional control valves — Part 2: Mounting interface surfaces with optional electrical connector — Amendment 1*	ISO/TC 131/SC 5/ WG 3

List Of Published Standards Developed By ISO/TC 131

as of 2021-05-11 (ISO/TC 131 SC or WG that is responsible for the standard is listed to the right)

REFERENCE	DOCUMENT TITLE	COMMITTEE
ISO 5599-2:2001/ Cor 1:2007	*Pneumatic fluid power — Five-port directional control valves — Part 2: Mounting interface surfaces with optional electrical connector — Technical Corrigendum 1*	ISO/TC 131/SC 5/ WG 3
ISO 5781:2016	*Hydraulic fluid power — Pressure-reducing valves, sequence valves, unloading valves, throttle valves and check valves — Mounting surfaces*	ISO/TC 131/SC 5/ WG 2
ISO 5782-1:2017	*Pneumatic fluid power — Compressed air filters — Part 1: Main characteristics to be included in supplier's literature and product-marking requirements*	ISO/TC 131/SC 5/ WG 5
ISO 5782-2:1997	*Pneumatic fluid power — Compressed-air filters — Part 2: Test methods to determine the main characteristics to be included in supplier's literature*	ISO/TC 131/SC 5/ WG 5
ISO 5783:2019	*Hydraulic fluid power — Code for identification of valve mounting surfaces and cartridge valve cavities*	ISO/TC 131/SC 5/ WG 2
ISO 6020-1:2007	*Hydraulic fluid power — Mounting dimensions for single rod cylinders, 16 MPa (160 bar) series — Part 1: Medium series*	ISO/TC 131/SC 3/ WG 1
ISO 6020-2:2015	*Hydraulic fluid power — Mounting dimensions for single rod cylinders, 16 MPa (160 bar) series — Part 2: Compact series*	ISO/TC 131/SC 3/ WG 1
ISO 6020-3:2015	*Hydraulic fluid power — Mounting dimensions for single rod cylinders, 16 MPa (160 bar) series — Part 3: Compact series with bores from 250 mm to 500 mm*	ISO/TC 131/SC 3/ WG 1
ISO 6022:2006	*Hydraulic fluid power — Mounting dimensions for single rod cylinders, 25 MPa (250 bar) series*	ISO/TC 131/SC 3/ WG 1
ISO 6099:2018	*Fluid power systems and components — Cylinders — Identification code for mounting dimensions and mounting types*	ISO/TC 131/SC 3
ISO 6149-1:2019	*Connections for hydraulic fluid power and general use — Ports and stud ends with ISO 261 metric threads and O-ring sealing — Part 1: Ports with truncated housing for O-ring seal*	ISO/TC 131/SC 4/ WG 1
ISO 6149-2:2006	*Connections for hydraulic fluid power and general use — Ports and stud ends with ISO 261 metric threads and O-ring sealing — Part 2: Dimensions, design, test methods and requirements for heavy-duty (S series) stud ends*	ISO/TC 131/SC 4/ WG 1
ISO 6149-3:2006	*Connections for hydraulic fluid power and general use — Ports and stud ends with ISO 261 metric threads and O-ring sealing — Part 3: Dimensions, design, test methods and requirements for light-duty (L series) stud ends*	ISO/TC 131/SC 4/ WG 1
ISO 6149-4:2017	*Connections for fluid power and general use — Ports and stud ends with ISO 261 metric threads and O-ring sealing — Part 4: Dimensions, design, test methods and requirements for external hex and internal hex port plugs*	ISO/TC 131/SC 4/ WG 6
ISO 6150:2018	*Pneumatic fluid power — Cylindrical quick-action couplings for maximum working pressures of 1 MPa, 1,6 MPa, and 2,5 MPa (10 bar, 16 bar and 25 bar) — Plug connecting dimensions, specifications, application guidelines and testing*	ISO/TC 131/SC 4/ WG 4
ISO 6162-1:2012	*Hydraulic fluid power — Flange connections with split or one-piece flange clamps and metric or inch screws — Part 1: Flange connectors, ports and mounting surfaces for use at pressures of 3,5 MPa (35 bar) to 35 MPa (350 bar), DN 13 to DN 127*	ISO/TC 131/SC 4
ISO 6162-2:2018	*Hydraulic fluid power — Flange connections with split or one-piece flange clamps and metric or inch screws — Part 2: Flange connectors, ports and mounting surfaces for use at a pressure of 42 MPa (420 bar), DN 13 to DN 76*	ISO/TC 131/SC 4/ WG 2
ISO 6164:2018	*Hydraulic fluid power — Four-screw, one-piece square flange connections for use at pressures of 42 MPa, DN 25 to 80*	ISO/TC 131/SC 4/ WG 2
ISO 6194-1:2007	*Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 1: Nominal dimensions and tolerances*	ISO/TC 131/SC 7/ WG 4
ISO 6194-2:2009	*Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 2: Vocabulary*	ISO/TC 131/SC 7
ISO 6194-3:2009	*Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 3: Storage, handling and installation*	ISO/TC 131/SC 7
ISO 6194-4:2009	*Rotary shaft lip-type seals incorporating elastomeric sealing elements — Part 4: Performance test procedures*	ISO/TC 131/SC 7/ WG 4
ISO 6194-5:2008	*Rotary-shaft lip-type seals incorporating elastomeric sealing elements — Part 5: Identification of visual imperfections*	ISO/TC 131/SC 7/ WG 4
ISO 6195:2013	*Fluid power systems and components — Cylinder-rod wiper-ring housings in reciprocating applications — Dimensions and tolerances*	ISO/TC 131/SC 7/ WG 2
ISO 6263:2013	*Hydraulic fluid power — Compensated flow-control valves — Mounting surfaces*	ISO/TC 131/SC 5/ WG 2
ISO 6264:1998	*Hydraulic fluid power — Pressure-relief valves — Mounting surfaces*	ISO/TC 131/SC 5/ WG 2
ISO 6301-1:2017	*Pneumatic fluid power — Compressed-air lubricators — Part 1: Main characteristics to be included in supplier's literature and product-marking requirements*	ISO/TC 131/SC 5/ WG 5
ISO 6301-2:2018	*Pneumatic fluid power — Compressed-air lubricators — Part 2: Test methods to determine the main characteristics to be included in supplier's literature*	ISO/TC 131/SC 5/ WG 5
ISO 6358-1:2013	*Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 1: General rules and test methods for steady-state flow*	ISO/TC 131/SC 5

List Of Published Standards Developed By ISO/TC 131

as of 2021-05-11 (ISO/TC 131 SC or WG that is responsible for the standard is listed to the right)

REFERENCE	DOCUMENT TITLE	COMMITTEE
ISO 6358-1:2013/ Amd 1:2020	*Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 1: General rules and test methods for steady-state flow — Amendment 1: Effective conductance*	ISO/TC 131/SC 5/ WG 3
ISO 6358-2:2019	*Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 2: Alternative test methods*	ISO/TC 131/SC 5/ WG 3
ISO 6358-3:2014	*Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — Part 3: Method for calculating steady-state flow-rate characteristics of systems*	ISO/TC 131/SC 5
ISO 6403:1988	*Hydraulic fluid power — Valves controlling flow and pressure — Test methods*	ISO/TC 131/SC 8
ISO 6432:2015	*Pneumatic fluid power — Single rod cylinders, 1 000 kPa (10 bar) series, bores from 8 mm to 25 mm — Basic and mounting dimensions*	ISO/TC 131/SC 3/ WG 2
ISO 6537:1982	*Pneumatic fluid power systems — Cylinder barrels — Requirements for non-ferrous metallic tubes*	ISO/TC 131/SC 3
ISO 6547:1981	*Hydraulic fluid power — Cylinders — Piston seal housings incorporating bearing rings — Dimensions and tolerances*	ISO/TC 131/SC 7
ISO 6605:2017	*Hydraulic fluid power — Test methods for hoses and hose assemblies*	ISO/TC 131/SC 4/ WG 6
ISO 6952:1994	*Fluid power systems and components — Two-pin electrical plug connectors with earth contact — Characteristics and requirements*	ISO/TC 131/SC 5/ WG 2
ISO 6953-1:2015	*Pneumatic fluid power — Compressed air pressure regulators and filter-regulators — Part 1: Main characteristics to be included in literature from suppliers and product-marking requirements*	ISO/TC 131/SC 5/ WG 5
ISO 6953-2:2015	*Pneumatic fluid power — Compressed air pressure regulators and filter-regulators — Part 2: Test methods to determine the main characteristics to be included in literature from suppliers*	ISO/TC 131/SC 5/ WG 5
ISO 6953-3:2012	*Pneumatic fluid power — Compressed air pressure regulators and filter-regulators — Part 3: Alternative test methods for measuring the flow-rate characteristics of pressure regulators*	ISO/TC 131/SC 5
ISO 7241:2014	*Hydraulic fluid power — Dimensions and requirements of quick-action couplings*	ISO/TC 131/SC 4/ WG 4
ISO 7368:2016	*Hydraulic fluid power — Two-port slip-in cartridge valves — Cavities*	ISO/TC 131/SC 5/ WG 2
ISO 7425-1:2021	*Hydraulic fluid power cylinders — Dimensions and tolerances of housings for elastomer-energized, plastic-faced seals — Part 1: Piston seal housings*	ISO/TC 131/SC 7/ WG 2
ISO 7425-2:2021	*Hydraulic fluid power cylinders — Dimensions and tolerances of housings for elastomer-energized, plastic-faced seals — Part 2: Rod seal housings*	ISO/TC 131/SC 7/ WG 2
ISO 7789:2007	*Hydraulic fluid power — Two-, three- and four-port screw-in cartridge valves — Cavities*	ISO/TC 131/SC 5/ WG 2
ISO 7790:2013	*Hydraulic fluid power — Four-port modular stack valves and four-port directional control valves, sizes 02, 03, 05, 07, 08 and 10 — Clamping dimensions*	ISO/TC 131/SC 5/ WG 2
ISO 7986:1997	*Hydraulic fluid power — Sealing devices — Standard test methods to assess the performance of seals used in oil hydraulic reciprocating applications*	ISO/TC 131/SC 7
ISO 8132:2014	*Hydraulic fluid power — Mounting dimensions for accessories for single rod cylinders, 16 MPa (160 bar) medium and 25 MPa (250 bar) series*	ISO/TC 131/SC 3/ WG 1
ISO 8133:2014	*Hydraulic fluid power — Mounting dimensions for accessories for single rod cylinders, 16 MPa (160 bar) compact series*	ISO/TC 131/SC 3/ WG 1
ISO 8139:2018	*Pneumatic fluid power — Cylinders, 1 000 kPa (10 bar) series — Mounting dimensions of rod-end spherical eyes*	ISO/TC 131/SC 3/ WG 2
ISO 8140:2018	*Pneumatic fluid power — Cylinders, 1 000 kPa (10 bar) series — Mounting dimensions of rod-end clevises*	ISO/TC 131/SC 3/ WG 2
ISO 8426:2008	*Hydraulic fluid power — Positive displacement pumps and motors — Determination of derived capacity*	ISO/TC 131/SC 8/ WG 13
ISO 8434-1:2018	*Metallic tube connections for fluid power and general use — Part 1: 24° cone connectors*	ISO/TC 131/SC 4/ WG 6
ISO 8434-2:2007	*Metallic tube connections for fluid power and general use — Part 2: 37 degree flared connectors*	ISO/TC 131/SC 4/ WG 6
ISO 8434-3:2005	*Metallic tube connections for fluid power and general use — Part 3: O-ring face seal connectors*	ISO/TC 131/SC 4/ WG 6
ISO 8434-6:2009	*Metallic tube connections for fluid power and general use — Part 6: 60 degree cone connectors with or without O-ring*	ISO/TC 131/SC 4/ WG 6
ISO 8778:2003	*Pneumatic fluid power — Standard reference atmosphere*	ISO/TC 131/SC 5/ WG 3

List Of Published Standards Developed By ISO/TC 131

as of 2021-05-11 (ISO/TC 131 SC or WG that is responsible for the standard is listed to the right)

REFERENCE	DOCUMENT TITLE	COMMITTEE
ISO 9110-1:2020	*Hydraulic fluid power — Measurement techniques — Part 1: General measurement principles*	ISO/TC 131/SC 8/ WG 13
ISO 9110-2:2020	*Hydraulic fluid power — Measurement techniques — Part 2: Measurement of average steady-state pressure in a closed conduit*	ISO/TC 131/SC 8/WG 13
ISO 9461:1992	*Hydraulic fluid power — Identification of valve ports, subplates, control devices and solenoids*	ISO/TC 131/SC 5/WG 2
ISO 9974-1:1996	*Connections for general use and fluid power — Ports and stud ends with ISO 261 threads with elastomeric or metal-to-metal sealing — Part 1: Threaded ports*	ISO/TC 131/SC 4/WG 1
ISO 9974-2:1996	*Connections for general use and fluid power — Ports and stud ends with ISO 261 threads with elastomeric or metal-to-metal sealing — Part 2: Stud ends with elastomeric sealing (type E)*	ISO/TC 131/SC 4/WG 1
ISO 9974-3:1996	*Connections for general use and fluid power — Ports and stud ends with ISO 261 threads with elastomeric or metal-to-metal sealing — Part 3: Stud ends with metal-to-metal sealing (type B)*	ISO/TC 131/SC 4/WG 1
ISO 9974-4:2016	*Connections for general use and fluid power — Ports and stud ends with ISO 261 threads with elastomeric or metal-to-metal sealing — Part 4: Dimensions, design, test methods and requirements for external hex and internal hex port plugs*	ISO/TC 131/SC 4/WG 6
ISO/TR 10686:2013	*Hydraulic fluid power — Method to relate the cleanliness of a hydraulic system to the cleanliness of the components and hydraulic fluid that make up the system*	ISO/TC 131/SC 6
ISO/TR 10771-2:2008	*Hydraulic fluid power — Fatigue pressure testing of metal pressure-containing envelopes — Part 2: Rating methods*	ISO/TC 131/SC 8/WG 11
ISO/TR 10946:2019	*Hydraulic fluid power — Gas-loaded accumulators with separator — Selection of preferred hydraulic ports*	ISO/TC 131/ WG 1
ISO/TR 10949:2002	*Hydraulic fluid power — Component cleanliness — Guidelines for achieving and controlling cleanliness of components from manufacture to installation*	ISO/TC 131/SC 6
ISO/TR 15640:2011	*Hydraulic fluid power contamination control — General principles and guidelines for selection and application of hydraulic filters*	ISO/TC 131/SC 6
ISO/TR 16194:2017	*Pneumatic fluid power — Assessment of component reliability by accelerated life testing — General guidelines and procedures*	ISO/TC 131
ISO/TR 16386:2014	*Impact of changes in ISO fluid power particle counting — Contamination control and filter test standards*	ISO/TC 131/SC 6/WG 1
ISO/TR 17209:2013	*Hydraulic fluid power — Two-, three- and four-port screw-in cartridge valves — Cavities with ISO 725 (UN and UNF) threads*	ISO/TC 131/SC 5
ISO/TR 19972-1:2009	*Hydraulic fluid power — Methods to assess the reliability of hydraulic components — Part 1: General procedures and calculation method*	ISO/TC 131/SC 8/WG 11
ISO/TR 22164:2020	*Hydraulic fluid power — Application notes for the optimization of the energy efficiency of hydraulic systems*	ISO/TC 131/SC 9/WG 1
ISO/TR 22165:2018	*Pneumatic fluid power — Application notes for the improvement of the energy efficiency of pneumatic systems*	ISO/TC 131/SC 9/WG 2
ISO/TR 22681:2019	*Hydraulic fluid power — Impact and use of ISO 11171:2016 µm(b) and µm(c) particle size designations on particle count and filter test data*	ISO/TC 131/SC 6/WG 1
ISO/TR 4808:2021	*Hydraulic fluid power – Interpolation method for particle count and filter test data*	ISO/TC 131/SC 6/WG 1
ISO/TR 4813:2021	*Hydraulic fluid power — Background, impact and use of ISO 11171:2020 on particle count and filter test data*	ISO/TC 131/SC 6/WG 1
ISO/TS 11619:2014	*Polyurethane tubing for use primarily in pneumatic installations — Dimensions and specification*	ISO/TC 131/SC 4/WG 9
ISO/TS 11672:2016	*Connectors for fluid power and general use — Designation and nomenclature*	ISO/TC 131/SC 4/WG 6
ISO/TS 11686:2017	*Connectors for fluid power and general use — Assembly instructions for connectors with adjustable stud ends and O-ring sealing*	ISO/TC 131/SC 4/WG 1
ISO/TS 13725:2016	*Hydraulic fluid power — Method for evaluating the buckling load of a hydraulic cylinder*	ISO/TC 131/SC 3/WG 1
ISO/TS 17165-2:2018	*Hydraulic fluid power — Hose assemblies — Part 2: Practices for hydraulic hose assemblies*	ISO/TC 131/SC 4/WG 6
ISO/TS 18409:2018	*Hydraulic fluid power — Hose and hose assemblies — Method of collecting a fluid sample for analyzing the cleanliness of a hose or hose assembly*	ISO/TC 131/SC 4/WG 6

Design Begins Here

POWER TRANSMISSION

SPONSORED BY:

NPP
NEW POWER PROGRESS

POWER
SOURCING GUIDE
2021-2022
www.powersourcingguide.com
THE GUIDE FOR DESIGN ENGINEERS

DIESEL PROGRESS
DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE

khl

POWER TRANSMISSION

POWER
TRANSMISSION

Design Begins Here

POWER TRANSMISSION

SPONSORED BY:

NPP
NEW POWER PROGRESS

POWER
SOURCING GUIDE
2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DIESEL PROGRESS DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE khl

TRANSMISSIONS

Manufacturer	Page Reference	Series/Model	Transmission Type	Max Input Power (kW)	Max Input No Load Speed (rpm)	Input Torque (Nm)	Speeds, Forward/Reverse	Mounting - Engine, Midship, Remote	Configuration - Drop: Short, Intermediate, Long, Inline	Weight (kg)	Application: OH - Off-Highway ON - On-Highway PG - Power Gen ST-IND - Stationary/ Industrial
FLENDER GRAFFENSTADEN	*	TX / TR / TSD / welded and casted casings	Toothing	100000	40000	700000		Mounting	parallel or coaxial shaft line	60000	PG - IND
FUNK DRIVETRAIN	*	HMD 12700	Hydrostatic motor driven	104	2500	407	4		Inline	194	
		HMD 18000	Hydrostatic motor driven	149	4000	949	2		Drop	356	
		HMD 23000	Hydrostatic motor driven	75	3000	271	3F/4R		Inline	151-159	
		HMD 33000	Hydrostatic motor driven	101	2400	407	4		Drop	290	
		HMD HS17000	Hydrostatic motor driven	93	4300	1017	2		Drop	424	
		Powershift 2000 Series	Powershift	168	3000	1627	3F/3R, 4F/3R, 6F/3R	Engine, Midship, Remote		408	
		Powershift DF150	Powershift	112	3000	1288	4F/4R, 8F/4R	Engine, Midship, Remote		567	
		Powershift DF250	Powershift	186	2600	1898	4F/4R, 8F/4R, 11F/4R	Engine, Midship, Remote		680	
NAF NEUNKIRCHENER ACHSENFABRIK AG	*	PTA 87	Planetary Portal Bogie Axle		2700	7000	25				OH
		TAP 89	Planetary Bogie Axle		3300	12200	58				OH
		LAP 4401	Steering Axle directly driven		4000	920	40				OH
		LAP 5401	Steering Axle adjustable for different tyre sizes		3700	1040	40	Oscillating			OH
		LAP 44	Direclty driven Steering Axle		3800	900	40				OH
		SAP 85	Planetary Rigid Axle directly driven		1780	360	8	for hydrostatic or eletric drive			OH
		SAP 77	Planetary Rigid Axle		3600	5000	55				OH
TRANSFLUID S.P.A.	316	Revermatic 11-700	Powershift	95	3000	700	1/1	Engine	Drop	108	OH, ON
		Rangermatic 21-700	Powershift	95	3000	700	2/1	Engine	Drop	117	OH, ON
		Rangermatic 22-700	Powershift	95	3000	700	2/2	Engine	Drop	120	OH, ON
		Rangermatic 31-700	Powershift	95	3000	700	3/1	Engine	Drop	123	OH, ON
		Revermatic 11-700 RBD	Marine	140	3500	560	1/1	Engine	Drop	100	
		Revermatic 11-700 RBD	Industrial	130	3000	560	1/1	Engine	Drop	85	OH, ON
		DP280	Dropbox	130	3500	1700		Remote	Drop	30	OH, ON
		HTV700	Hybrid (industrial)	95	3000	700	3/1	Engine	Drop	245	OH, ON
		HTM700	Hybrid (marine)	140	3500	560	1/1	Engine	Drop	221	

2021-2022 BASIC SPECIFICATIONS

POWER TAKE-OFFS

Manufacturer	Page Reference	Series/Model	Rotation Direction	Torque Rating	Number of Mounting Bolts	Housing Material	Application OH - Off-Highway ON - On-Highway PG - Power Gen ST-IND - Stationary / Industrial
TRANSFLUID S.P.A.	316	HFR	210-318	7750	/	cast iron	ST-IND
		HFO	314	4900	/	cast iron	ST-IND

2021-2022 BASIC SPECIFICATIONS — GEARBOXES & HEADS

Manufacturer	Page Reference	Series/Model	Gear Ratio	Output Torque (Nm)	Max Input Power (kW)	Gearing Arrangement	Max Input Speed (rpm)	Backlash (arcmin)	Mounting Configuration	Shaft Alignment
FUNK DRIVETRAIN	*	F9R	3.27 - 117: 1	8135 - 12,880	27	Planetary	2800			
		F12R	13.2:1-81.31:	10,168 - 16,948	35	Planetary	2800			
		F25R	5.0:1-54.6:1	18,710 - 33,895	71	Planetary	2800			
NAF NEUNKIRCHENER ACHSENFABRIK AG	*	2-Motor-Gearbox (VGZ 76) - 1. motor	4.03	8200		standstill shifting	4500			
		2-Motor-Gearbox (VGZ 76) - 2. motor	1.68	8200		standstill shifting	4500			
		DualSync	1.88	8900		CVT functionality	4750			
		DualSync	5.92	8900		CVT functionality	4750			
		HydroSync	3.58	5000		CVT functionality	3500			
		HydroSync	1.08	5000		CVT functionality	3500			

2021-2022 BASIC SPECIFICATIONS — PUMP DRIVES

Manufacturer	Page Reference	Series/Model	# Pads	Input Power (kW)	Input or Output Max Speed (rpm)	Input Torque (Nm)	Output Torque (Nm) Per Pad	Available Clutch	Mounting - Engine, Remote	Pump adapter sizes	Weight (kg)
FUNK DRIVETRAIN	*	Series 28000 Direct	1	268 (360)	3000	881 (650)	881 (650)	Yes	Engine, Remote	A, B, C, or D	
		Series 28000	1	242 (325)	3000	780 (575)	780 (575)	Yes	Engine, Remote	A, B, C, or D	
		Series 28000	2, 3	268 (360)	3000	1017 (750)	881 (650)	Yes	Engine, Remote	A, B, C, or D	
		Series 59000	2, 3, 4	522 (700)	3000	1695 (1250)	881 (650)	Yes	Engine, Remote	A, B, C, or D	
		Series 56000	2, 3, 4, 5	708 (950)	2500	2712 (2000)	2712 (2000)	Yes	Engine, Remote	B, C, D, E, or F	
		Seriers 57000	4	708 (950)	2500	2712 (2000)	2712 (2000)	Yes	Engine, Remote	C, D, or E	
TRANSFLUID S.P.A.	316	SPD 11	1	270	560	up to 860	168	SAE BB640	Engine, Remote	SAE B	50
		SPD 12	1	270	860	860	382	SAE BB640	Engine, Remote	SAE B	73
		MPD 14	2	545	2000	2000	440	SAE CC650	Engine, Remote	SAE B/C/D/E/BB	195
		MPD 18	4	772	3350	3350	520	SAE CC650	Engine, Remote	SAE B/C/D/E/BB	350
		MPD 22	4	1385	6300	6300	795	SAE CC650	Engine, Remote	SAE B/C/D/E/BB	530

2021-2022 BASIC SPECIFICATIONS — ELECTRIC DRIVETRAINS

Manufacturer	Page Reference	Series/Model	Power Rating (kW	Hydraulic Pump Pad Outputs	Max Output Torque NM	Max Output Speed (rpm)	Output Configuration
JOHN DEERE	178	GPD200-2	100-200	Up to 3			
		EPD200-2	100-200	Up to 3			
		EMD100-1	100		4000	2400	
		EMD200-3	100-200		4200	4500	In-line and 4WD drop

Parallel hybrid for rail tunnel maintenance

The diesel unit delivers a maximum power of 55 kW at 2800 r/min, while the electric motor delivers 35 Kw at 3000 r/min; one hour in electric-only mode

Transfluid was chosen by an Italy-based company specializing in the design and construction of railway vehicles for the supply of its first Parallel-Hybrid system to operate wagons used for tunnel maintenance, where internal combustion engines are less and less accepted. Transfluid said its diesel-electric Parallel-Hybrid system is a plug & play product, which comprehends mechanical and electrical components, including signal and power cables.

The Parallel-Hybrid allows operation in pure electric mode when it is necessary and in diesel mode where it is permitted.

One-hour electric mode

The diesel unit delivers a maximum power of 55 Kw at 2800 r/min, while the electric motor delivers 35 Kw at 3000 r/min. The system's battery has a capacity of 28.8 kWh and for this application, Transfluid reports an autonomy in full electric mode of approximately one hour.

According to Transfluid, with this propulsion system (for which the company can supply also full-electric versions) machinery manufacturers can source their own diesel-electric hybrid or full-electric vehicles with the advantage of a single supplier from design to commissioning as well as a single warranty for all components. The commissioning is fully carried out by Transfluid only, as well as assistance and spare parts procurement.

The Parallel-Hybrid system by Transfluid is suited for a variety of mobile applications, among which industrial vehicles, lifting machinery and marine applications.

Transfluid is a global specialist in industrial and marine transmission and components headquartered in Italy.

The Parallel-Hybrid system by Transfluid, shown here used on a railway tunnel maintenance machine, is suited for a variety of mobile applications.

K & KX Fluid Couplings

Electric Machine

Powershift Transmission

SRBD Single Pump Drive

TPO-TPH Air Actuated Clutch

FUEL INJECTION

SPONSORED BY:

OMT
HEART OF INJECTION

POWER SOURCING GUIDE 2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE

khl

Design Begins Here

FUEL INJECTION

SPONSORED BY:

OMT

HEART OF INJECTION

POWER
SOURCING GUIDE
2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

FUEL INJECTION


OMT
HeArt of Injection
NOODLES®

YOUR PARTNER.

Founded in 1930, OMT has served engine builders with dependable, high precision fuel injection equipment from the early days of large diesel engine development. In the intervening years, OMT has established long term customer relationships as a reliable partner of engine builders serving the global markets for marine propulsion, power generation and rail traction. Using our long experience and comprehensive know-how in the field of injection systems for distillate and heavy fuels, we develop tailored solutions to help our customers optimise their diesel, gas and dual-fuel engines for highest performance and lowest life-cycle costs.

CUSTOMISED SOLUTIONS.

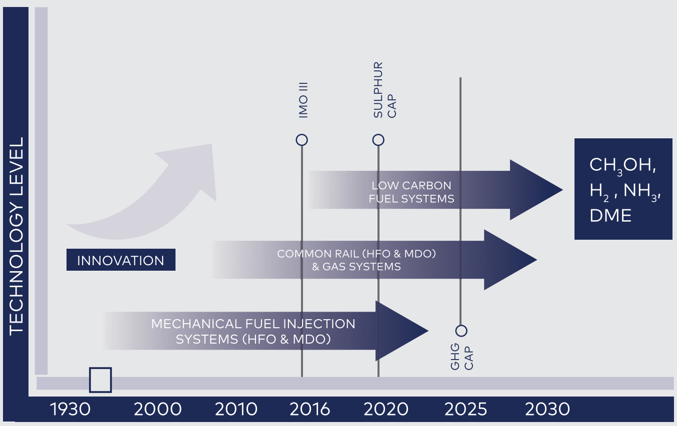
OMT develops and manufactures a wide range of customised fuel injection systems dedicated to fulfilling the specific requirements of medium- and low-speed engines of each customer.
Our products cover a broad range of engine power outputs, from 1,000 to 80,000 kW, and include:

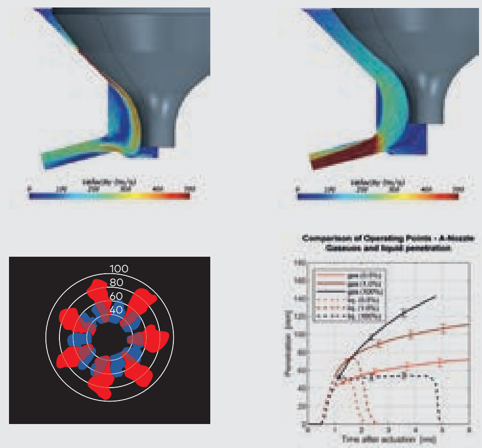
- Mechanical, high pressure «pump-line-nozzle» injection systems for light and heavy fuel oils
- Wide range electronically controlled injectors, for diesel and dual fuel engines
- Electronically controlled injectors for high pressure direct injection of alternative fuels
- Gas prechambers

HeArt of Injection

INNOVATION FOR YOUR BENEFIT. IN FUEL INJECTION...

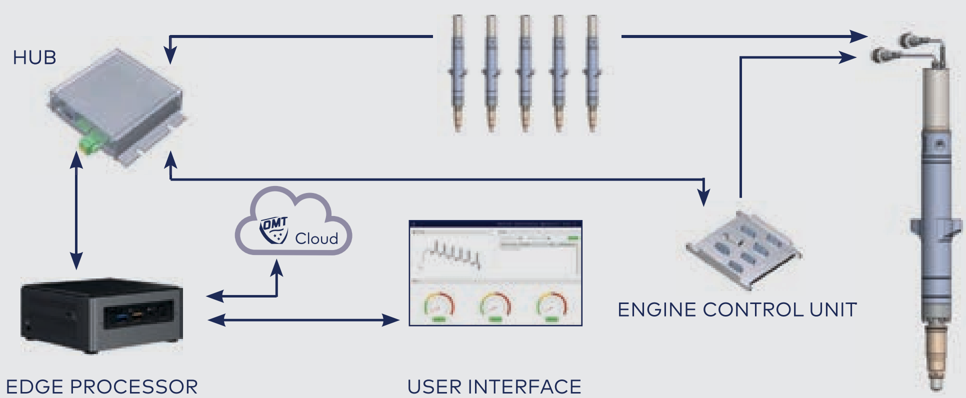
We cooperate closely with engine designers and builders to develop state-of-the-art fuel injection systems capable of meeting the demanding requirements of modern large engines in terms of fuel efficiency, reduced emissions and low life cycle costs. Our latest 2200bar common rail injection system can reduce cost of dual fuel engines as it is capable of delivering both full power in diesel mode and very small pilot injections in gas mode, so that a separate micropilot system is no longer needed. We invest in the green future of large engines by developing injection systems capable of handling low carbon liquid fuels such as methanol and ammonia, as well as high pressure gases, to enable reduction of greenhouse gas emissions.





...AND BEYOND!

Innovation in the large engine business goes beyond the creation of modern fuel systems. Digitalisation can transform engine and ship management by enabling remote monitoring and predictive maintenance. To lead this trend, OMT created OMT Digital, a spin-off company dedicated to the development of new product features and added value service offerings through the power of data analytics. Together, the two companies developed an instrumented injector and an intelligent injection system that enable predictive maintenance and remote monitoring of performance and health status of the injector.



OMT - OFFICINE MECCANICHE TORINO S.p.A. V. Ferrero, 67/A 10090 - Cascine Vica - Rivoli (TO) -ITALY
PHONE: +39 011 95 05 334 (r.a.) **FAX**: +39 011 95 75 474 **E-MAIL:** omt@omt-torino.com **OMT-TORINO.COM**

Consortium to develop medium-speed engine fueled by ammonia

MAN Energy, Woodward L'Orange among partners

MAN Energy Solutions announced the beginning of its 'AmmoniaMot' (Ammonia Engine in German) project with partners from industry, including Woodward L'Orange.

AmmoniaMot aims to define the steps necessary to produce a dual-fuel, medium-speed engine capable of running on diesel fuel and ammonia. Supported by the German Federal Ministry of Economics and Technology (BMWi), and due to run for three years from December 2020, project partners include the University of Munich, Neptun Ship Design and WTZ.

"MAN Energy Solutions views this project as closely aligned with its own strategy for developing sustainable technologies and welcomes the opportunity to work with external partners," said MAN Energy Solutions Dr. Alexander Knafl, head of R&D, Four-Stroke Engineering at MAN in Augsburg. "For us, the path to decarbonizing the maritime economy starts with fuel-decarbonization and, in this context, ammonia is an excellent candidate in that it is carbon-free and eminently green when produced from renewable electricity sources."

Engines by 2024

MAN Energy Solutions Two-Stroke Business has already announced that it will deliver ammonia-fueled engines by 2024.

Christian Kunkel, Head of Combustion Development, Four-Stroke R&D, MAN Energy Solutions, said: "With the DNV classification society forecasting approximately a 30% share of the maritime fuel market for ammonia by 2050, there is a general need for successful engine projects to display ammonia's viability. There is little doubt but that ammonia will become an important carbon-free energy carrier and thus will contribute to decarbonising the maritime sector. The AmmoniaMot project will deliver the base for future, commercial, four-stroke engines, which will be key in legitimising ammonia as a fuel and furthering the maritime energy transition."

Partner roles

The University of Munich (TUM) will employ a rapid-compression expansion machine to establish the fundamentals concerning the combustion of ammonia and will develop, together with MAN, the combustion models necessary for fast adaption of the technology to different engine sizes.

Neptun Ship Design (NSD) will analyze international regulations to ensure technical and safety requirements in a encapsulated, modularized fuel system. Such scalable components are a prerequisite for the introduction of ammonia engines in shipping. A prototype of the fuel system itself will be used on the test engine at WTZ. NSD will work in close cooperation with MAN on a roadmap regarding which steps are necessary to use ammonia engines with all necessary ancillary systems in new ships and conversions.

WTZ is a specialist within the field of energy conversion and will utilize a high-speed test engine to develop a combustion concept for the new engine. This will be done in close collaboration with MAN and will also form the basis for defining any requirements for exhaust gas aftertreatment.

Scaling technology up

Woodward L'Orange, a global manufacturer of injection systems, will produce the injection system for the ammonia tests at TUM and WTZ. Together with MAN, the technology will be scaled up to large, four-stroke engines in the project.

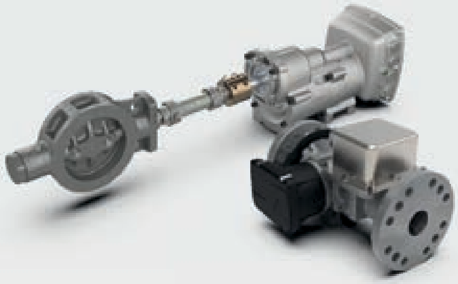
MAN Energy Solutions said it will transfer the technology to large-bore, four-stroke engines and prepare for commercial development and production.

> "There is little doubt but that ammonia will become an important carbon-free energy carrier and thus will contribute to decarbonising the maritime sector."
>
> Christian Kunkel, MAN

PRECISE. INNOVATIVE. LEADING.

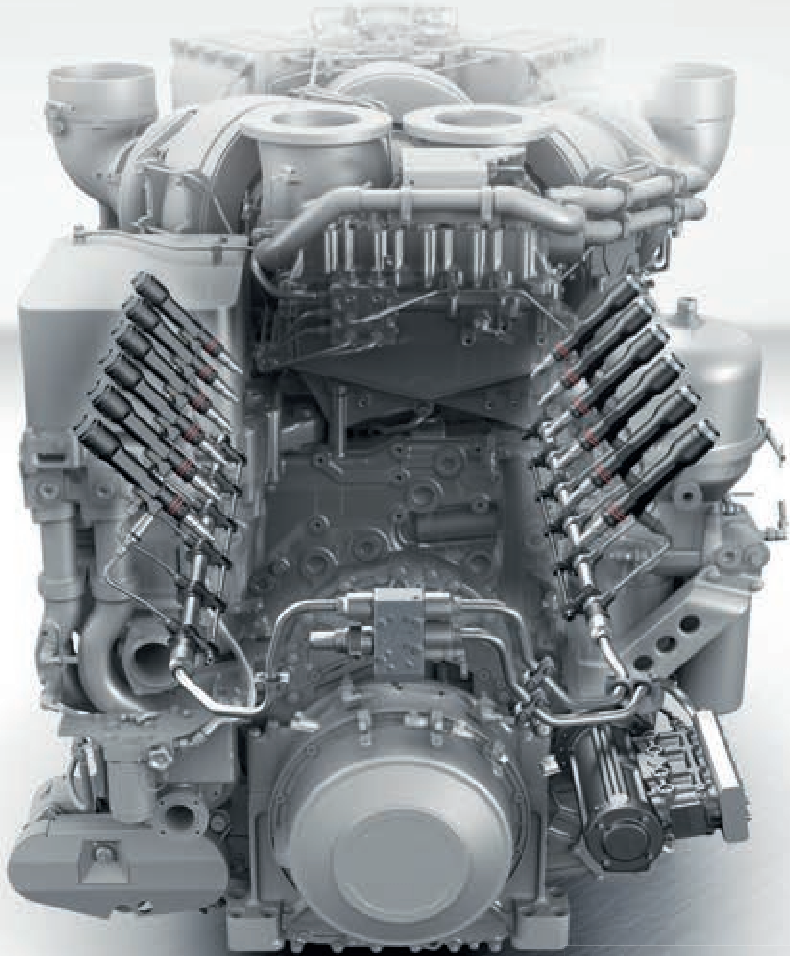
LARGE ENGINE SYSTEM SOLUTIONS

ALWAYS INNOVATING FOR A BETTER FUTURE


AIR EXHAUST AND
FUEL FLOW CONTROLS


SOGAV
GAS VALVES

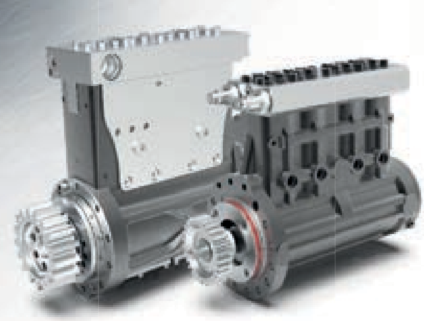

INTELLIGENT
CR INJECTORS




P2X MULTI-FUEL
INJECTORS


SINGLE-NEEDLE
DF INJECTORS


SPARE PARTS


HIGH-PRESSURE
PUMPS

THE ENDLESS PURSUIT OF CLEANLINESS

Parker Filtration reinvents itself and its products to support wide range of customers. By **Chad Elmore**

Adapting to change is an endless pursuit. Fuel filter designs have evolved to keep pace with changes in diesel engine emissions regulations and the chemistry of the fuel. The Filtration Group at Parker Hannifin Corp. has also reinvented itself over the past several years to better serve a wide range of customers as well as incorporate the Clarcor filter business it acquired in 2017. One truth that has remained constant, however, is that heavy-duty on- and off-road equipment still require effective engine filtration to keep working through challenging conditions.

Today, Parker Filtration's original equipment (OE) business is handled by the Engine Mobile OE Division (EMOE), which encompasses the Racor and Fuel Manager brands of fuel, crankcase, oil, air and marine filtration products. The division can draw on the products and expertise of dozens of Parker Hannifin subsidiaries and more than 57,000 employees globally.

"Internally, in support of Parker's WIN Strategy, Parker formalized the 'Simple by Design approach,'" said Wayne Dube, Fuel Filtration product manager, Parker Filtration. "That term has a lot of different meanings within the organization, but an important one is utilizing the strength of Parker as a whole. We are looking across the various Parker organizations and sharing and utilizing as many of the resources as we can.

"For example, Parker designs and manufactures engineered seal products, adhesives and other components used in our filters. Leveraging the strength of Parker for our benefit – and that of our customers – is a key part of the path."

Meanwhile, the 82,000 sq. ft. Parker Filtration Innovation Center in Columbia, Tenn., helps keep an eye where the path is leading. The Innovation Center develops cutting-edge filtration technologies that can then be applied to multiple applications. Parker scientists engineer new media and filter elements that are specific to a customer's product design and filtration requirements. Another advantage of the Innovation Center is the use of computer simulation and modeling to predict performance as well as testing harsh environments before products are used in real-world scenarios. "They look at what's going on in the market and what we can do with media to improve our filtration capabilities," said Brad Fleming, Engineering Market leader, Construction & Mining, Parker Filtration. "The Innovation Center is looking long-term at future trends and the future of filter media, where our divisions are focused on immediate customer needs."

"Our team is now comprised of engineers in five locations led by Division

The 82,000 sq. ft. Parker Filtration Innovation Center in Columbia, Tenn.

Engineering Manager Chris Van Lewen," said Dube. "But we work as one team and we're cross-functional. We have engineers that sit in Mississippi, Connecticut, and California. We are not necessarily working on location-specific projects at each center, because we're a blended team that works together to create solutions for our customer's filtration needs."

In addition to the Innovation Center, which is located in Tennessee, engineers are also located in Nebraska.

Dube said new products are developed with an eye toward ease of manufacturing. "As the success of a product continues to grow, we want to be able to manufacture it closer to where our customers are located. That means having a design that is easily manufactured in multiple locations globally."

FIFTH GENERATION FILTRATION

One of the most innovative products to come from Parker Filtration's EMOE Division is the Fuel Manager Gen V fuel filter/water separator. The modular filters are designed for agricultural, industrial and construction equipment, as well as generators and commercial vehicles.

The Fuel Manager Gen V filter from Parker Filtration was designed for equipment in markets that need to minimize downtime.

The true genesis of the project was during conversations with engineers at engine and equipment manufacturers as well as dealer service departments and the end-user – the latter group of people "who really see the challenges day-to-day and will tell you, quite frankly, what you need to do to make the product better," said Dube.

Based on those conversations, "we made sure the new product is designed in such a way that it improves the end-user experience," said Dube. "A machine is only valuable if it's operating, so we want to make sure that our product provides the maximum amount of up time and actually improves productivity for the operator."

Equipment manufacturers wanted to extend service intervals from a norm of 500 hours to 750 and even beyond 1000 hours, which suggested larger filters to make room for higher performing media. Simply making bigger fuel filters did not appear to be an option, however.

"More and more, we're hearing that customers want improved water separation," said Dube. "The concern is that more biodiesel is being used in blends with diesel fuel and that does make water separation more difficult. With a traditional fuel filter that separates water by rejecting it on the surface, as that filter loads up with particulate contaminants over its life, the media's ability to separate water can be reduced. Customers want water separation performance to be maintained at a certain efficiency throughout the life of the filter, so that means using a media pack that coalesces water."

"Our customers around the world are also looking for more biodiesel compatible products," said Raj Kurri, Engineering Market leader, Ag & Power Generation, Parker Filtration. "We made sure the Gen V product was biodiesel compatible in terms of improved water separation."

"With the Tier 4 emissions level, we heard pretty much the same thing from all of the major OEs," said Dube. "Customers wanted smaller filters that captured more particles and pulled out more water and they wanted the filters to last longer. That was a big challenge." Rather than limiting their focus on the dimensions of a filter, the product development team stepped back for a broader picture. The envelope that a filter needs on a machine is not limited to its physical size. "We also looked at the serviceability aspect," said Dube. "By making the new filter easily serviced without tools and using only one hand, we could make the filter bigger because the overall space claim was smaller. That helped move us in the direction of lasting longer, because we could make the filter bigger so that it would hold more media, which in turn holds more particles and separates water better over time. The serviceability aspect led to the real engineering breakthrough in this product."

Servicing the filter is simple, said the company, and only requires one-half turn to remove and install. Also, when the service element is fully installed, it provides three forms of sensory feedback. There is an audible click, the engagement is felt by the hand and the customer's logo and part number face forward.

Ultimately, the Fuel Manager Gen V filter was designed for "any market that needs to really minimize their downtime," said Fleming. "You can change this filter out in under a minute. Some people like that for convenience. Others require it, such as if you're running a generator and for whatever reason the filter clogs up. You can quickly change this filter out with no tools, click the other one in and you're up and running again." ■

www.parker.com/emoe

Reprinted from May 2021 **Diesel Progress**

DOCUMENTING DESTRUCTIVE DEPOSITS

Southwest Research Institute develops new test for internal diesel injector contamination.

By **Mike Brezonick**

Researchers at Southwest Research Institute (SwRI) have developed a new test methodology to assess the deposit-forming tendencies of diesel fuel. SwRI's test combines a specialized injector test rig with a variable angle spectroscopic ellipsometer (VASE) that can measure the thickness of deposits in fuel injectors.

High pressure direct fuel injection is a fundamental technology for the modern diesel engine, bringing with it better fuel economy, better performance and helping achieve lower exhaust emissions through more precise control and shaping of fuel spray into engine cylinders.

With this increased precision comes a requirement for improved fuels, fuel additives and filtration, as internal diesel injector deposits (IDID) can seriously affect injector and ultimately, engine operation. Deposits formed inside fuel injectors, can disrupt fuel delivery by causing injector mechanisms to be sluggish or even stick, which can impact engine performance and could even result in engine failure.

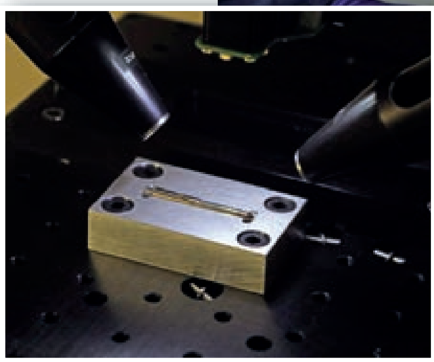
Southwest Research Institute (SwRI), a global specialist in fuels and lubricants research, recently completed a project, sponsored by the Coordinating Research Council, to develop and evaluate a new test methodology to assess the deposit-forming tendencies of a given test fuel.

IDID testing has been used for several decades to study the formation of deposits and some tests have been used to determine if certain additives can prevent deposits or help remove them once they have formed.

"Deposits can slow down or even plug an injector, which can stop the engine from working," said Doug Yost, staff engineer in SwRI's Fuels and Lubricants Division. "For many years, the most common IDID test methods involved some combination of full-size engines and test fuels, perhaps doped with excessive levels of additives or contaminants, which would ultimately yield deposits that can be characterized with the naked eye.

"But the need to visually rate the deposits meant that abnormally high levels of deposit were required. Obtaining the high levels of deposit meant using higher than typical amounts of additives or contaminants. These test conditions were not representative of usual engine operation."

SwRI's test combines a specialized injector test rig with an instrument to measure the thickness of deposits in the injector. That instrument is a variable angle spectroscopic ellipsometer (VASE), a device that came from the computer industry, where it is used most frequently to measure the thickness of microchip layers during assembly. "Instead of microchip layers, our VASE measures the thickness of deposits in the fuel injector," Yost said.



In testing, injector pintles are placed in a custom fixture in the VASE. Light from a laser and a quartz tungsten halogen lamp is passed through the deposit, is reflected off the pintle and is measured by a detector. This technique can measure deposits that are as thin as 10 nanometers and as thick as 1000 nanometers, regardless of the color of the deposit.

INJECTOR DEPOSITS TEST RIG

Under the method developed at SwRI, a single, new diesel injector is installed in the test rig. The test fuel is flowed through the injector, under controlled conditions, for a fixed period of time. After that, the injector is removed, disassembled, and visually inspected. The visual inspection looks for signs of injector sticking and visual deposits on internal parts.

IDID can result from specific fuel chemistries, additive interactions, contaminants and other factors. The deposits are thin, measuring from tens to hundreds of nanometers thick. The thickness often makes them difficult to see with the unaided eye. Additionally, some deposits have little or no visible color, so even thick deposits can be difficult to visualize.

Until now, the only solution to assessing IDID was to run large amounts of fuel through the injector or dope the test fuel with extra-high levels of additives and contaminants. Doing so usually resulted in IDID that could be ranked visually, but most researchers agreed that these were not realistic results compared to standard engine operation.

SwRI incorporated spectroscopic ellipsometry technology that had been used primarily by computer chip manufacturers. IDID testing, which previously took hundreds of hours and required several hundred gallons of fuel, has been reduced to a seven-hour process that uses under 2 gal. (7 L) of fuel.

MEASURING DEPOSIT THICKNESS

Once the test injector has been disassembled and inspected, the injector pintle is placed in a custom fixture in the VASE. A laser in the VASE is aimed at the deposit. Conditioned light from a quartz tungsten halogen lamp in the VASE is focused at the deposit. The collimated and polarized light passes through the deposit, reflects off the surface of the pintle, and passes back through the deposit to the detector.

The light that passes through the deposit undergoes a shift in the azimuth of polarization. The change describes an ellipse with the polarity of the original light that is related to the thickness of the deposit. This technique can measure deposits that are as thin as 10 nanometers and as thick as 1000 nanometers, regardless of the color of the deposit.

"There's no more measuring with the naked eye," he said. "We run the fuel test, and the VASE measures the thickness of the deposits on the injector parts."

THE POWER OF ELLIPSOMETRY

Ellipsometry's ability to measure these very thin films allow the SwRI IDID method to evaluate deposit formation at a much more subtle level than previous test methods for evaluating system deposition. Previous methodologies required significant overdosing of additive or contaminants to develop sufficient deposits for visual analysis – levels completely uncharacteristic of typical operations. The VASE enables SwRI to perform testing with realistic challenges, thus ensuring a truer evaluation of additive performance or contaminant effects. SwRI began offering its IDID testing in late 2019.

SwRI performs a wide range of other research, development, and testing on diesel engines, pumps, injectors, and fuels and lubricants at its San Antonio, Texas, headquarters. Founded in 1947, it is one of the oldest independent non-profit research organizations in the world, providing engineering services to government and commercial clients globally.

www.swri.org

Reprinted from June 2020 Diesel Progress

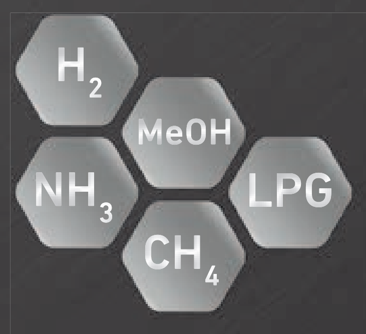
HEINZMANN – SOLUTION PROVIDER FOR ALTERNATIVE FUELS

Gas Admission Valve

Methanol Injector

Increasing global environmental awareness determines local and international regulatory initiatives. This unique impetus of worldwide efforts addressing decarbonisation offers a great opportunity for making decisive steps towards a sustainable future. This involves all industries where internal combustion engines are in operation.

Just make your alternative fuel choice - HEINZMANN will deliver the best suitable injection system solution for it!



HEINZMANN Engine & Turbine Management
www.heinzmann.com

HEINZMANN®
thinking in drive and control

2020 Stationary Emissions At-A-Glance

UNITED STATES

Environmental Protection Agency (EPA)

Existing stationary diesel engines

TABLE 1
NESHAP EMISSION REQUIREMENTS FOR EXISTING STATIONARY CI ENGINES

ENGINE CATEGORY	EMISSION STANDARD	ALTERNATIVE CO REDUCTION
Area Sources		
Non-Emergency 300 < hp ≤ 500	49 ppm CO	70%
Non-Emergency > 500 hp	23 ppm CO	70%
Major Sources		
Non-Emergency 100 ≤ hp ≤ 300	230 ppm CO	-
Non-Emergency 300 < hp ≤ 500	49 ppm CO	70%
Non-Emergency > 500 hp	23 ppm CO	70%

Standards for spark ignition, gas-fired stationary engines are summarized in Table 2. The engine designations indicate two- or four-stroke (2S/4S) lean- or rich-burn (LB/RB) natural gas or landfill/digester gas (LFG/DG) engines.

TABLE 2
NESHAP EMISSION REQUIREMENTS FOR EXISTING STATIONARY SI ENGINES

ENGINE CATEGORY	EMISSION STANDARD	ALTERNATIVE CO/HCHO REDUCTION
Area Sources†		
4SLB, Non-Emergency > 500 hp	Install OC[a]	
4SRB, Non-Emergency > 500 hp	Install NSCR[b]	
Major Sources		
2SLB, Non-Emergency 100 ≤ hp ≤ 500	225 ppm CO	-
4SLB, Non-Emergency 100 ≤ hp ≤ 500	47 ppm CO	-
4SRB, Non-Emergency 100 ≤ hp ≤ 500	10.3 ppm HCHO	-
LFG/DG, Non-Emergency 100 ≤ hp ≤ 500	177 ppm CO	-
4SRB, Non-Emergency > 500 hp	350 ppb HCHO	76% HCHO[c]

† Standards applicable only to engines operated > 24 hr/yr and installed in locations that are not "remote areas". Remote areas include (1) offshore locations along that portion of the coast that is in direct contact with the open seas, (2) pipeline segments with 10 or fewer buildings intended for human occupancy and no buildings with four or more stories within 660 ft. (220 yards) on either side of the centerline of any continuous 1 mile (1.6 km) length of pipeline, or (3) non gas-pipeline locations that have five or fewer buildings intended for human occupancy and no buildings with four or more stories within a 0.25 mile (0.4 km) radius around the engine.
[a] The oxidation catalyst must provide a 93% CO emission reduction or a 47 ppm CO concentration.
[b] The NSCR catalyst must provide a 75% CO reduction or a 30% THC reduction or a CO concentration of 270 ppm.
[c] Alternative option: 30% THC reduction.

NEW ENGINES. NESHAP standards are also applicable to certain categories of new CI and SI engines located at major sources, Table 3. Note that "new" engine does not mean newly built engine – see the definitions above.

TABLE 3
NESHAP EMISSION REQUIREMENTS FOR NEW CI AND SI ENGINES AT MAJOR SOURCES

ENGINE CATEGORY	EMISSION STANDARD	ALTERNATIVE CO/ HCHO REDUCTION
CI Engines		
Non-Emergency > 500 hp	580 ppb CH_2O	70% CO
SI Engines		
2SLB, Non-Emergency > 500 hp	12 ppm CH_2O	58% CO
4SLB, Non-Emergency > 250 hp	14 ppm CH_2O	93% CO
4SRB, Non-Emergency > 500 hp	350 ppb CH_2O	76% CH_2O

Note: New limited use engines > 500 hp at major sources do not meet any emission standards under the NESHAP.

New and reconstructed engines of lower horsepower (< 500 hp; 4SLB < 250 hp) located at major sources, as well as new engines located at area sources must meet the applicable NSPS CI or NSPS SI emission standards.

Other provisions

DIESEL FUEL. Certain categories of diesel engines are required to use ultra-low sulfur diesel (ULSD, max. 15 ppm S) fuel:

- Stationary non-emergency engines greater than 300 hp (223.7 kW) with a displacement of less than 30 L per cylinder, fully effective from 2013.
- Stationary emergency engines ≥ 100 hp (74.6 kW) that operate for more than 15 hours per year for emergency demand response, effective from 2015.

CRANKCASE FILTRATION. Stationary engines—including CI ≥ 100 hp (74.6 kW) at major source, CI > 300 hp (223.7 kW) at area source, and SI 100 to 500 hp (74.6 to 372.8 KW) at major source — must be equipped with closed or open crankcase filtration system in order to reduce metallic HAP emissions.

CATALYST TEMPERATURE. If catalysts are used, engines must be equipped with high temperature engine shutdown or continuous temperature monitoring systems to ensure that the catalyst inlet temperature remains between 450° to 1350°F (232° to 732°C) for lean burn engines and between 750° to 1250°F (399° to 677°C) for rich-burn engines.

EMISSION REQUIREMENTS FOR NON-EMERGENCY STATIONARY ENGINES

DISPLACEMENT (D)	POWER	YEAR	EMISSION CERTIFICATION
D < 10 L per cylinder	≤ 3000 hp	2007+	Nonroad Tier 2/3/4
	> 3000 hp	2007-2010	Nonroad Tier 1
		2011+	Nonroad Tier 2/4
10 ≤ D < 30 L per cylinder	All	2007+	Marine Cat. 2 Tier 3/4/3/4
D ≥ 30 L per cylinder	All	2010-2011	Marine Cat. 3 Tier 1
		2012+	Marine Cat. 3 Tier 2/3

Nonroad diesel engines

TABLE 4
TIER 4 EMISSION STANDARDS—ENGINES ABOVE 560 KW, G/KWH (G/BHP-HR)

YEAR	CATEGORY	CO	NMHC	NO_x	PM
2011	Generator sets > 900 kW	3.5 (2.6)	0.40 (0.30)	0.67 (0.50)	0.10 (0.075)
	All engines except gensets > 900 kW	3.5 (2.6)	0.40 (0.30)	3.5 (2.6)	0.10 (0.075)
2015	Generator sets	3.5 (2.6)	0.19 (0.14)	0.67 (0.50)	0.03 (0.022)
	All engines except gensets	3.5 (2.6)	0.19 (0.14)	3.5 (2.6)	0.04 (0.03)

EUROPEAN UNION
Stage 3/4 Standards

Stage 3 standards – which are further divided into two sub-stages: Stage 3 A and Stage 3 B – and Stage 4 standards for nonroad diesel engines are listed below. These limit values apply to all nonroad diesel engines of indicated power range for use in applications other than rail traction and inland waterway vessels. (See ww.dieselnet.com for more details and inland waterway vessel data).

The implementation dates in the following tables refer to the market placement dates. For all engine categories, a sell-off period of two years is allowed for engines produced prior to the respective market placement date. The dates for new type approvals are, with some exceptions, one year ahead of the respective market placement date.

STAGE 3 A/B EMISSION STANDARDS FOR NONROAD DIESEL ENGINES

CAT.	NET POWER kW	DATE†	CO g/kWh	HC	HC+NOX	NO_x	PM
Stage 3 A							
H	$130 \le P \le 560$	2006.01	3.5	-	4.0	-	0.2
I	$75 \le P < 130$	2007.01	5.0	-	4.0	-	0.3
J	$37 \le P < 75$	2008.01	5.0	-	4.7	-	0.4
K	$19 \le P < 37$	2007.01	5.5	-	7.5	-	0.6
Stage 3 B							
L	$130 \le P \le 560$	2011.01	3.5	0.19	-	2.0	0.025
M	$75 \le P < 130$	2012.01	5.0	0.19	-	3.3	0.025
N	$56 \le P < 75$	2012.01	5.0	0.19	-	3.3	0.025
P	$37 \le P < 56$	2013.01	5.0	-	4.7	-	0.025

† *Dates for constant speed engines are: 2011.01 for categories H, I and K; 2012.01 for category J.*

STAGE 4 EMISSION STANDARDS FOR NONROAD DIESEL ENGINES

CAT.	NET POWER kW	DATE	CO g/kWh	HC	NO_x	PM
Q	$130 \le P \le 560$	2014.01	3.5	0.19	0.4	0.025
R	$56 \le P < 130$	2014.10	5.0	0.19	0.4	0.025

STAGE 3 B EMISSION STANDARDS FOR RAIL TRACTION ENGINES

CAT.	NET POWER kW	DATE	CO g/kWh	HC	HC+NOX	NO_x	PM
Stage 3 B							
RC B	$P > 130$	2012	3.5	0.19	-	2.0	0.025
R B	$P > 130$	2012	3.5	-	4.0	-	0.025

Stage 5 Standards

Stage 5 emission limits for engines in nonroad mobile machinery (category NRE) are shown below. These standards are applicable to diesel (CI) engines from 0 to 56 kW and to all types of engines above 56 kW. Engines above 560 kW used in generator sets (category NRG) must meet standards shown in Category NRG-v/c-1[a].

STAGE 5 EMISSION STANDARDS FOR NONROAD ENGINES

CATEGORY	IGN.	NET POWER kW	DATE	CO	HC g/kWh	NO_x	PM	PN 1/kWh
NRE-v/c-1	CI	$P < 8$	2019	8.00	7.50[a,c]		0.40[b]	-
NRE-v/c-2	CI	$8 \le P < 19$	2019	6.60	7.50[a,c]		0.40	-
NRE-v/c-3	CI	$19 \le P < 37$	2019	5.00	4.70[a,c]		0.015	1×10^{12}
NRE-v/c-4	CI	$37 \le P < 56$	2019	5.00	4.70[a,c]		0.015	1×10^{12}
NRE-v/c-5	All	$56 \le P < 130$	2020	5.00	0.19[c]	0.40	0.015	1×10^{12}
NRE-v/c-6	All	$130 \le P \le 560$	2019	3.50	0.19[c]	0.40	0.015	1×10^{12}
NRE-v/c-7	All	$P > 560$	2019	3.50	0.19[d]	3.50	0.045	-

[a] HC+NOx [b] 0.60 for hand-startable, air-cooled direct injection engines
[c] A = 1.10 for gas engines [d] A = 6.00 for gas engines

GOTHENBURG PROTOCOL
Stationary engine guidelines

NO_x emissions limits for new stationary engines specified by the Gothenburg Protocol are listed. (applicable to all parties other than Canada and the United States).

NO_x EMISSION LIMITS FROM NEW STATIONARY ENGINES

DESCRIPTION	NO_x LIMIT, MG/NM³
Spark ignition (Otto) engines, 4-stroke, >1 MW	
Lean-burn engines	250
All other engines	500
Compression ignition (Diesel) engines, >5 MW	
Fuel: natural gas (jet ignition engines)	500
Fuel: heavy fuel oil	600
Fuel: diesel oil or gas oil	500

NO_x is specified as NO_2 equivalent. Concentrations are expressed at standard temperature and pressure conditions (273.15 K, 101.3 kPa) and at an oxygen reference content of 5%.

The limits do not apply to engines running less than 500 hr/yr. Startup, shutdown and maintenance of equipment are also excluded. Meeting the limits by lowering exhaust concentrations through dilution is not permitted.

The Protocol also specifies emission monitoring and reporting requirements.

WORLD BANK GUIDELINES
Stationary engines

The maximum emission levels are expressed as concentrations, to facilitate monitoring. The emission limits are to be achieved through a variety of control and fuel technologies, as well as through good maintenance practice. Dilution of air emissions to achieve the limits is not acceptable.

The following are emission limits for engine driven power plants:

PARTICULATE MATTER PM emissions (all sizes) should not exceed 50 mg/Nm³.

SULFUR DIOXIDE Total SO_2 emissions should be less than 0.20 metric tons per day (tpd) per MWe of capacity for the first 500 MWe, plus 0.10 tpd for each additional MWe of capacity over 500 MWe. In addition, the SO_2 concentration in flue gases should not exceed 2,000 mg/Nm³, with a maximum emissions level of 500 tpd.

NITROGEN OXIDES Provided that the resultant maximum ambient levels of nitrogen dioxide are less than 150 μg/m³ (24-hour average), the NO_x emissions levels should be less than 2,000 mg/Nm³ (or 13 g/kWh, dry at 15% O_2). In all other cases, the maximum NO_x emission level is 400 mg/Nm³ (dry at 15% O_2).

Liebherr's LiView position transducer

LiView provides cylinder measurement data for driver assistance systems in Liebherr crawler loader

LiView, an intelligent position transducer for hydraulic cylinders, is mounted in the new Liebherr LR 636 G8 crawler loader.

Liebherr announced that LiView, the intelligent position transducer for hydraulic cylinders, is mounted in the new Liebherr LR 636 G8 crawler loader and allows for reliable control of the bucket using precise measurement data, even under the most demanding conditions.

In mobile machines, assistance systems relieve the driver and can significantly increase efficiency. When hydraulic cylinders are involved, assistance systems require precise measurement data on the exact position of the cylinder.

"For our new generation of crawler loaders, it was important for us to have a position transducer that is on a par with the performance of our crawler loader," said Wolfgang Schulz, Product Line manager for crawler loaders at Liebherr-Werk Telfs GmbH. "Work with the crawler can sometimes release enormous forces.

"LiView has proven to be a reliable and, above all, robust solution here – thanks to its unique measuring principle and the great flexibility in the positioning of the electronics module."

Precise measurements

In the new LR 636 G8 crawler, the LiView position transducer provides precise measurement data on the tipping and lifting cylinders. This allows the driver to, among other things, activate automatic lifting and lowering of the bucket. This function is intended for loading work, where the lifting gear is to be repeatedly raised or lowered to a certain height. Once the set position is reached, the lifting or lowering stops automatically.

Likewise, a position can also be stored for tipping of the loading bucket in and out, which can be automatically controlled via the hydraulic sensor.

The position transducer consists of the processing electronics and two probes. LiView measures the cylinder's parameters using signals at different frequencies injected onto the cylinder itself. Piston position and speed are calculated in real-time by the processing electronics.

The LR 636 G8's areas of application include earthworks and landfill sites. It is suitable for applications that require extremely high breakout forces. Liebherr explained that the LiView position transducer uses the cylinder itself as an extremely robust sensing element, making it ideally suited to the high demands of the LR 636 G8.

With LiView the processing electronics can be installed either directly on the outside of the cylinder or at any location near the cylinder; in the LR 636 G8, the LiView electronics module is installed under the cab.

Cylinder compatibility

In the LR 636 G8 crawler, LiView measures the position of the Liebherr cylinders for which the company employs a manufacture that guarantees high quality and durability. OEMs receive a fully tested cylinder and can connect the electronics module directly.

Liebherr hydraulic cylinders from the 380 bar series production range can be ordered with the position transducer already integrated. In addition to Liebherr's own cylinders, LiView is also suitable for numerous other cylinder types. Compatibility with new cylinders can be checked rapidly based on drawings and 3D models. ■

Design Begins Here

CONTROLS & INSTRUMENTATION

SPONSORED BY:

HEINZMANN®

POWER
SOURCING GUIDE
2021-2022
www.powersourcingguide.com
THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS DPI DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

khl

Design Begins Here

CONTROLS & INSTRUMENTATION

SPONSORED BY:

HEINZMANN®

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DIESEL PROGRESS DIESEL PROGRESS INTERNATIONAL Diesel & Gas Turbine WORLDWIDE

khl

CONTROLS & INSTRUMENTATION

Heinzmann's new data logger

Heinzmann's new data logger

Heinzmann launched a data logger for the monitoring of exhaust gas emissions, together with CPK Automotive, both members of the Heinzmann Group.

The device, called NOx Control Box, monitors emissions according to the requirements of the German Federal ordinance 44th BImSchV for medium-sized combustion plants and internal combustion engines.

According to Heinzmann though, it also offers additional functionalities that other data loggers available on the market do not feature, as for example the monitoring of the efficiency of oxidation catalysts. Additional measurements and data which are not required by the German ordinance, are saved in a separate archive.

NOx Control Box from group company CPK Automotive desinged to monitor exhaust gas emissions from combustion plants and internal combustion engines

Used with any engine

The data logger can be used with any type of internal combustion engine and retrofitted with minimum effort in existing installations. The signal from an existing NOx sensor after the SCR system can also be used thus avoiding the need for an additional sensor.

Open in- and out- channels allow the connection of the NOx data logger to the existing machine's control box; a CAN or analog communication with control systems is available as an option.

Collected data can be visualized and evaluated through Heinzmann's versatile Terminal NOx software.

Heinzmann and CPK Automotive market the NOx Control Box together (Heinzmann under the brand name NOx Secure). CPK Automotive is concentrated on service companies, utilities and final customers, while Heinzmann serves engine manufacturers and cogeneration plants.

Heinzmann makes strategic investment in Bright Sensors

In mid-2020, the Heinzmann Group announced a strategic investment in the Swiss based gas sensor and analyzer manufacturer Bright Sensors SA.

Through this step, Bright Sensors SA will be in the position to accelerate product development, marketing and sales of advanced gas sensors. The sensors are designed to reliably determine the quality characteristics of various gas compositions in gas grids and in the area of engine applications, which is particularly important for Heinzmann.

The investment provides Bright Sensors access to Heinzmann's more than 120 years of technical expertise in product development and manufacturing whilst simultaneously obtaining access to Heinzmann's global sales network.

Heinzmann obtained access to Bright Sensors propriety gas sensor technology allowing for ultra-low cost, real-time and accurate gas quality measurement which enable efficiency increases and make the use of gaseous fuels with various compositions – biomethane, hydrogen containing gas blends, etc. –technically and economic possible today.

The compact portable gas analyzer BlueEye Mobile.

"We are extremely proud to welcome Heinzmann as a strategic investor in our company since it demonstrates our technology is essential in a world that needs to decarbonize rapidly," Bright Sensors CEO Bart Riemens stated. "The support and expertise of Heinzmann is exactly what we need in the current phase of our young company."

"On the way to decarbonization, it is to be expected that the composition and consequent quality of the gaseous energy carriers offered will vary greatly," Heinzmann Group CEO Markus Gromer said. "With this strategic investment, Heinzmann is going to assist Bright Sensors in further development of technology for gas quality measurement which will become absolutely necessary in gas, combustion engines and gas turbine industries for achieving future environmental goals by use of "green" fuels."

The high-end explosion-proof BlueEye EX-D certified gas analyzer.

Bright Sensors SA, founded in 2014 as a spin-off of EPFL (Swiss Federal Institute of Technology Lausanne) develops, manufactures, and sells natural gas quality sensors that allow real-time monitoring of natural gas quality.

Engine Controls

Hydraulic Governors & Actuators

Gas Engine Systems

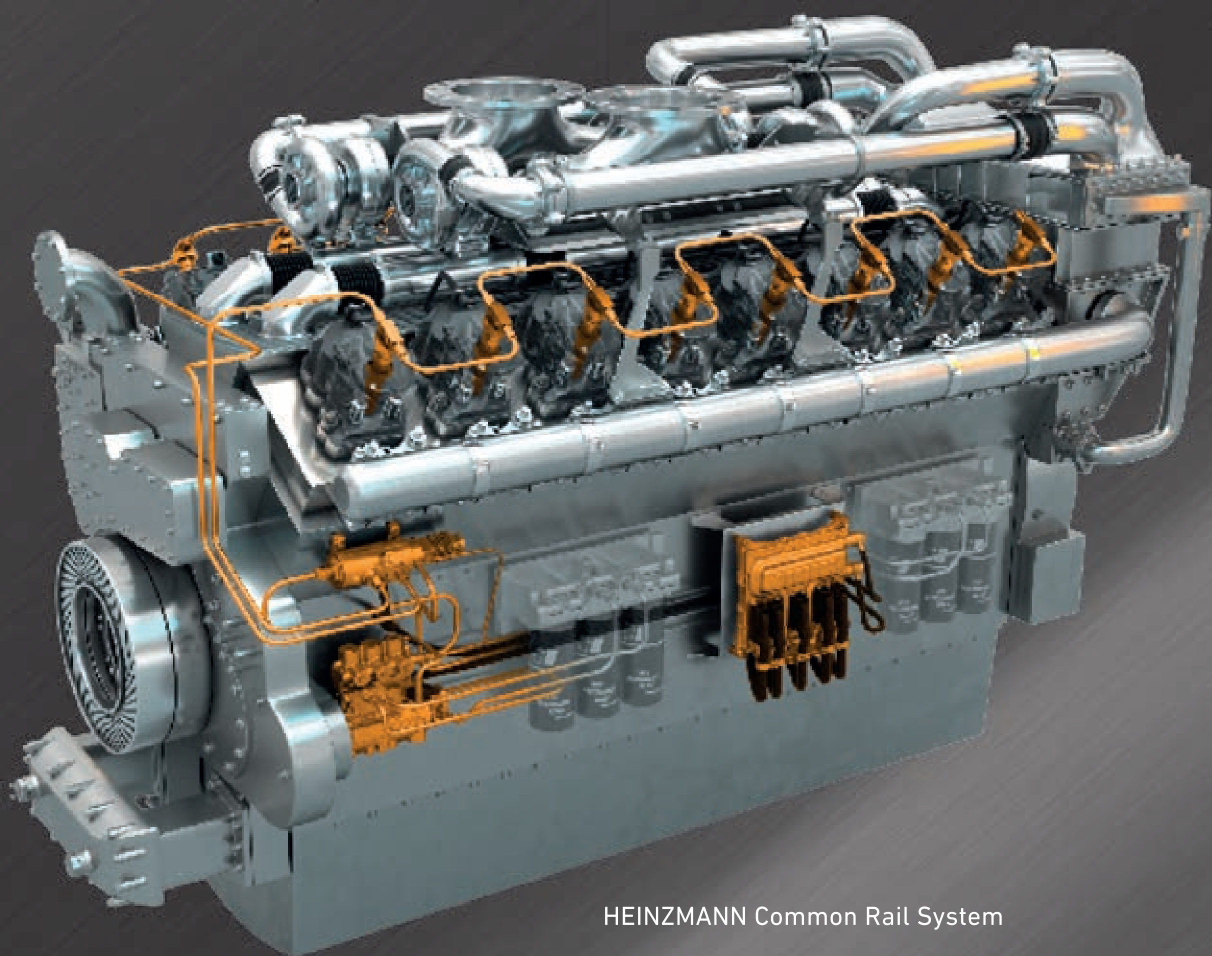
Ignition Control Systems

Injection Systems for Alternativ Fuels

High-Pressure Pipes & Rail Solutions

Dual-Fuel Systems

Air Path Control



HEINZMANN Common Rail System

HEINZMANN®
thinking in drive and control

AVAT

ENGINE CONTROL
One solution for CHP plant and marine engines

With our modular and highly flexible engine control system openECS, we are the independent energy engineering partner for complete control systems and dynamic technology modules for actuator control, knock and misfire detection as well as for cylinder pressure measurement and remote maintenance.

Large Engine Manufacturers

Cogeneration Plant Manufacturers

Industry and Public Contracting Authorities

Municipal and Utility Power Producers

Power Distributors

Engine Control Systems
- Highly flexible engine controls
- Dynamic technology modules
- Attractive visualizations
- Future proof remote service solutions
- Cooperations with research partners

Consulting & Engineering
- Gas / DF engine controllers
- Technology modules
- Individual concepts
- Tailor-made solutions

Training
for operators
- Gas / DF engine operations
- Gas / DF engine troubleshooting
- Gas / DF advanced

for developers
- Bachmann M-PLC
- AVAT openECS platform
- Engine control (Basic / Advanced)

Service & Support
- Hotline support
- On-site assistance
- Prompt spare part supply

Energy Automation Solutions
- Smart energy concepts and solutions
- Far-sighted plant automation concepts
- Virtual power plants and power storages
- General contractor for plant construction
- Partnerships with universities

HIGH PERFORMANCE PARTNER

With our 25 years of experience and expertise in the development of more than 10,000 landbased or offshore engine control systems, we have repeatedly revolutionized the control of large gas and dual fuel engines. Among other things, as developer and manufacturer of the 1000-times built TEM-Evo controls and single components.

The world's leading engine manufacturers, plant builders and service providers profit decisively from this broad know-how and rely on our advanced applications in the stationary and maritime sectors. In doing so, we are confident we will also find the optimum solution for you.


Our products for your individual solution.

Based on openECS, our open and flexible system integration platform, controllers can be created for nearly all engines, all gas and plant types, or fields of application. Functions, modules, sub-systems and user interfaces form a single unit.

E^2CORE
Highly dynamic multi variable speed and load governor, including actuator drivers for e.g. throttle valve and gas mixer.

E^2KNOCKCON-c
Reliable detection of cylinder individual knocking combustion and misfire from established piezo sensor signals.

E^2PRECON-c
Offers comprehensive real-time cylinder pressure analysis in a compact size. Wide range of cylinder pressure sensors from various manufacturers.

E^2PILOT
Operator terminal adapted to the plant operator's needs. Rapid overview of engine and peripherals. Interactive operating log and configurable trending function.

Remote Services
AVAT VPN ROUTERS guarantee fast and secure remote access via Internet for remote assistance, reportings and smartphone based alarm.

E^2KNOCKCON-M
Reliably detects combustion knock and misfire in rough conditions. Our M-Series comes with Marine Type Approvals ABS, BV, DNV GL, LR.

E^2PRECON-M
Offers comprehensive real-time cylinder pressure analysis in heavy duty applications and comes already with Marine Type Approvals ABS, BV, DNV GL, LR.

E^2SERVICE
Service tool for highly specialized service engineers. Task orientated graphical user interface for: Commissioning, optimization of controller settings, diagnostics, maintenance and many more.


www.euromot.eu
HAVE YOUR SAY.
BE HEARD.
MAKE A DIFFERENCE.

Design Begins Here

MANUFACTURERS' DISTRIBUTION GUIDE

SPONSORED BY:

khl

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DP DIESEL PROGRESS
DPI DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE

khl

MANUFACTURERS' DISTRIBUTION GUIDE

Design Begins Here

MANUFACTURERS' DISTRIBUTION GUIDE

SPONSORED BY:

khl

POWER SOURCING GUIDE

2021-2022

www.powersourcingguide.com

THE GUIDE FOR DESIGN ENGINEERS

DIESEL PROGRESS
DIESEL PROGRESS INTERNATIONAL
Diesel & Gas Turbine WORLDWIDE
khl

A

ABC - ANGLO BELGIAN CORPORATION N.V.

ABC - Anglo Belgian Corporation N.V.
43 Wiedauwkaai
9000Gent
BELGIUM
Tel: +32 9 267 00 00
Fax: +32 9 267 00 67
EMAIL: info@abc-engines.com
WEB: www.abc-engines.com

Anglo Belgian Corporation
Wiedauwkaai 43
9000Ghent
BELGIUM
Tel: +32 0 9 267 00 00
Fax: +32 0 9 267 00 67
EMAIL: info@abc-engines.com
WEB: www.abc-engines.com

C

CUMMINS GENERATOR TECHNOLOGIES

Cummins Generator Technologies
Fountain Court
Lynch Wood
Peterborough PE2 6FZ
U.K.
Tel: +44 0 1733 395300
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com

Cummins Generator Technologies, Lebanon
Zouk Mosbeh, 7th Floor
Main Highway Building Christ le Roi
LEBANON
Tel: +961 922 0759
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com

Cummins Generator Technologies, Russia
Park Place, Office B 200
113/1 Leninskiy Prospect
Moscow 117198
RUSSIAN FEDERATION
Tel: +7 499 956 2675
Fax: +7 499 956 5362
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com

Cummins Generator Technologies, South Africa
Harrowdene Office Park
Block 8, First Floor
Western Service Road
Woodmead, Private Bag X7,
Wendywood 2144
SOUTH AFRICA
Tel: +27 11 451 3400
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com

Cummins Generator Technologies, Spain
Av. del Sistema Solar, 27. Naves -1-2
San Fernando de Henares
28830Madrid
SPAIN
Tel: +34 91 6787600
Fax: +34 91 6787604
EMAIL: stamford-avk@cummins.com
WEB: www.stamford-avk.com

Daihatsu Diesel Mfg. Co. Ltd.
1-30, Oyodo Naka 1-chome
Kita-ku, Osaka 531-0076
JAPAN
Tel: +81 6 6454 2393
Fax: +81 6 6454 2686
EMAIL: kyoji.masutani@dhtd.co.jp
WEB: www.dhtd.co.jp/en/index.html

D

DAIHATSU DIESEL MFG. CO. LTD.

ACME INDUSTRIAL, INC.
326-328 Front Street
Staten Island, New York 10304
U.S.A.
Tel: +1 718 720-5522
Fax: +1 718 273-6942
EMAIL: info@acmerepair.com
WEB: www.acmerepair.com

ALEXANDRIA MARITIME CONSULTATIVE OFFICE (AMCO)
10 Ahmed Yehya Pasha St., Gleem
Alexandria
EGYPT
Tel: +20 3 5858570
Fax: +20 3 5828587
EMAIL: amco.alex@amcoeg.com
WEB: www.amcoeg.com

COMERCIAL BIERGES LTDA.
Rua Maria Rodrigues, 43-Olaria-Cep:
Rio de Janeiro, RJ 21031-490
BRAZIL
Tel: +55 21 3885-1150
Fax: +55 21 3885-1176
EMAIL: bierges@bierges.com.br
WEB: www.bierges.com.br

DAIKAI ENGINEERING (INDIA) PVT. LTD.
Sagar Tech Plaza, B-902, 9th Fl,
Andheri-Kurla Rd
Sakinaka, Andheri (E)
Mumbai 400072
INDIA
Tel: +91 22 2850-9686
Fax: +91 22 2850-9713
EMAIL: india@daikai.com
WEB: www.daikai.com

DAIKAI ENGINEERING (THAILAND) PTE., LTD.
Unit 11B, 11th Floor, President Tower 971
973, Ploenchit Road
Bangkok, Kwaeng Lumphini,
Khet Pathumwan 10330
THAILAND
Tel: +66 85247-8477
Fax: +66 2181-4179
EMAIL: sales@daikai.com
WEB: www.daikai.com

DAIKAI ENGINEERING PTE. LTD.
128 Pioneer Road
639586
SINGAPORE
Tel: +65 6863 2856
Fax: +65 6863 2876
EMAIL: sales@daikai.com.sg
WEB: www.daikai.com

DAIKAI ENGINEERING PTE. LTD. VIETNAM OFFICE
Room 704, TD Business Center,
No. 4&5 Lot 20A , Le
Le Hong Phong Street
Haiphong, Ngo Quyen District
VIETNAM
Tel: +84 313 826767
Fax: +84 313 826777
EMAIL: sales@daikai.com
WEB: www.daikai.com

DAIKAI PHILIPPINES CORPORATION
Unit 3B New Wealth Properties Corp.,
Joseph Sitt(3rd Avenue),
Bagumbayan
Taguig City 1630
PHILIPPINES
Tel: +63 2 814-0369
Fax: +63 2 817-1285
EMAIL: sales@daikai.com
WEB: www.daikai.com

GOLTENS ROTTERDAM B.V.
Lorentzweg 29
3208 LJSpijkenisse
NETHERLANDS
Tel: +31 181 465100
EMAIL: petra.engel@goltens.com
WEB: www.goltens.nl

HASSEI TRADING (CANADA) LTD.
Suite 785, 1111 West Hastings Street
Vancouver, BC V6E 2J3
CANADA
Tel: +1 604 801-9988
Fax: +1 604 801-9966
EMAIL: hasseivcr@can.rogers.com

JAMES TROOP & CO LIMITED
4 Davy Road, Astmoor Industrial Estate
Runcorn, Cheshire WA7 1PZ
U.K.
Tel: +44 1928 566170
Fax: +44 1928 577314
EMAIL: sales@jamestroop.co.uk
WEB: www.jamestroop.co.uk

JONGHAP MARITIME INC.
199, 2-ka, Daepyung-Dong,
Young Do-ku
Busan
KOREA (REPUBLIC)
Tel: +82 51-413-6007
WEB: www.jonghap.co.kr

KEITOKU MIDDLE EAST LLC.
Al Quoze Industrial Area, Office No.2
Dubai
UAE
Tel: +971 4 3479181
Fax: +971 4 3406518
EMAIL: sales@keitoku.com

KEX-SUN SHINE ENGINEERING & TRADING CO., LTD.
8F 315 Sec. 1, Tung Hwa South

Road
Taipei
TAIWAN
Tel: +886 2 2704-4085
Fax: +886 2 2705-8194

KIND JOHN TRADING CO., LTD.
Tai Chi Building, 5th Floor 10,
Chungking S. RD. Sec. 1
Taipei
TAIWAN
Tel: +886 2 2311-4651
Fax: +886 2 2314-4625
EMAIL: kindjohn@ms22.hinet.net

MARCO MARINE A/S
Tinvej 16
DK-3060Espergaerde
DENMARK
Tel: +45 49 136900
Fax: +45 49 136902
EMAIL: denmark@marcomarine.com
WEB: www.marcomarine.com

MARINE INDUSTRIAL & COMMERCIAL LTD.
12, Karaoli Dimitriou Street Neo. Faliro
185 47Piraeus
GREECE
Tel: +30 210 4526912
Fax: +30 210 4285900
EMAIL: spares@micltd.eu
WEB: www.micltd.eu

MARINE TECH IND. LTD.
12628-82nd Avenue
Surrey, BC V3W 3G1
CANADA
Tel: +1 604 507-0880
Fax: +1 604 507-0881
EMAIL: andrew@marine-tech.com
WEB: marine-tech.com

MARINE TECHNICAL & INDUSTRIES CO., LTD.
No.14 Tai-Tang RD. Lin-Hai Industrial Zone
Kaohsiung 812
TAIWAN
Tel: +886 7 802-1212
Fax: +886 7 801-9179

MOTOR-SERVICES HUGO STAMP, INC.
3190 SW 4th Ave
Fort Lauderdale, Florida 33315
U.S.A.
Tel: +1 954 763-3660
Fax: +1 954 763-2872
EMAIL: service@mshs.com
WEB: www.mshs.com

NORDWEG JSC
16, Building 2, Dvinskaya Street
St. Petersburg 198035
RUSSIAN FEDERATION
Tel: +7 812 320-2771
Fax: +7 812 320-2770
EMAIL: shiprepair@nordweg.ru
WEB: www.nordweg.ru

DAIHATSU DIESEL

P.T. OYAMA LTD.
Jl. Gajah Meda No.115-116
Jakarta 11130
INDONESIA
Tel: +62 21 6297838
Fax: +62 21 639447
EMAIL: yama-115@dnet.net.id

SKAMEK POWER AS
Sorenskriver Bullsgt 9C
6002Alesund
NORWAY
Tel: +47 7010 1930
Fax: +47 7010 1931
EMAIL: power@skamek.no
WEB: www.skamek.com

VESMEC LTD.
Aydintepe Mahallesi, Akyildiz Cikmazi Sokak, No:3
Icmeler-Tuzla, Istanbul 34947
TURKEY
Tel: +90 216 4932973
Fax: +90 216 4932962
EMAIL: info@vesmec.com
WEB: www.vesmec.com

WILHELM RUMP KG (GmbH & Co.)
Witterstrasse 20
21107Hamburg
GERMANY
Tel: +49 40 3178420
Fax: +49 40 3194841
EMAIL: spares@rump-kg.de
WEB: www.rump-kg.de

ZEPHYR TRADING S.R.L.
Via Valdilocchi, 2
19126La Spezia
ITALY
Tel: +39 0187 502341
Fax: +39 0187 503335
EMAIL: info@zephyrtrading.com
WEB: www.zephyrtrading.com

H

HEINZMANN GMBH & CO. KG

Heinzmann GmbH & Co. KG
Am Haselbach 1
79677 Schoenau, Baden-Wuerttemberg
GERMANY
Tel: +49 7673 8208-0
Fax: +49 7673 8208-188
EMAIL: info@heinzmann.de
WEB: www.heinzmann.com
Contact: Markus Gromer

DVC Resource company
Ropshinskoe highway, 19
Valigonta village, Leningrad region
St. Petersburg
RUSSIAN FEDERATION
Tel: +7 812 643 66-67
EMAIL: dvsr@dvsr.ru
WEB: www.heinzmann.com

Elettrosystem s.r.l.
Via Dell Artigianato, 64 z.i.
35010Vigodazere (PD)
ITALY
Tel: +39 049 88 41 990
EMAIL: heinzmann@elettrosystempd.it
Contact: Mrs. Marika Vittadello

FG Governors & Engine Parts B.V.
Wijkermeerstraat 4
2131 ATHoofddorp
NETHERLANDS
Tel: +31 0 23 557 2629
Fax: +31 0 23 557 3662
EMAIL: info@fg-governors.nl
WEB: www.heinzmann.com
Contact: Mr. Frank Aarnts

Goltens Houston
7214 Clinton Drive
Houston, Texas 77020
U.S.A.
Tel: +1 713 487 4900
EMAIL: houston@goltens.com

Goltens Miami
2323 NE Miami Court
Miami, Florida 33137
U.S.A.
Tel: +1 305 576 4410
EMAIL: miami@goltens.com
WEB: www.heinzmann.com

HANS Tech Solutions LLP
F3/7 Salunke Vihar
PO SRPF
Pune 411048
INDIA
Tel: +91 982 381 3805
EMAIL: sourabh@hanstech.solution
WEB: www.heinzmann.com
Contact: Mr. Sourabh Shastri

Heinzmann / Regulateurs Europa Kiev
Office 910
11-A, Evgena Sverstuka str.,
Kiev 02002
UKRAINE
Tel: +38 44 331 9675
Fax: +38 44 281 2350
EMAIL: hzm-kiev@hzm.com.ua
WEB: www.heinzmann.com
Contact: Mrs. Elena Galperina

Heinzmann / Regulateurs Europa Korea Pte. Ltd.
49, Sangnam-gil
Chungryang-myun, Ulju-Gun
Ulju-Gun
Ulsan 689-932
KOREA (REPUBLIC)
Tel: +82 52 227 7673
Fax: +82 52 227 7674
EMAIL: heinzmann@korea.com
WEB: www.heinzmann.com
Contact: Mr. Maengshuk Chung

Heinzmann Representative for Russia
11-A, Mariny Raskovoy str
02002Kiev
UKRAINE
Tel: +38 674097448
EMAIL: hzm-russia@heinzmann.com
WEB: www.heinzmann.com
Contact: Mrs. Elena Galperina

Heinzmann South Africa
83 Jonkershoek Road
Mostertsdrift
Stellenbosch, Western Cape 7600
SOUTH AFRICA
Tel: +27 82 6898 100
Fax: +27 21 88 666 53
EMAIL: diemont@worldonline.co.za
WEB: www.heinzmann.com
Contact: Mrs. Stefanie Gromer

I.R.M. DIESELPARTS
Village d'entreprises Michel Naels
2 rue Gérard Plessiet - Bâtiment B1
SAINT POL SUR MER
59430Saint-Pol-Sur-Mer Nord
FRANCE
Tel: +33 03 28 29 28 10
Fax: +33 03 28 61 61 61
EMAIL: contact@irmdieselparts.fr
WEB: www.heinzmann.com

INDOP, d.o.o.
Primorska cesta 6a
3325Sostanj
SLOVENIA
Tel: +386 3 899 22 15
EMAIL: tjasa.nadveznik@gorenje.si
WEB: www.gorenje-indop.si
Contact: Mrs. Nadveznik Tjasa

INJEGOV Ltd
VI.PA. Schistou
Block 3 - Str No 2
18863Perama, Piraeus
GREECE
Tel: +30 210 4323 600 12
Fax: +30 210 4312 770
EMAIL: technical@injegov.gr
WEB: www.heinzmann.com

Kraft Power Corporation
199 Wildwood Ave.
Woburn, Massachusetts 01801-2024
U.S.A.
Tel: +1 781 938 9100
Fax: +1 781 933 7812
EMAIL: info@kraftpower.com
WEB: www.kraftpower.com

LLC "MiT Power Systems"
Building 1
Nezhinskaya St., 5
Moscow 119501
RUSSIAN FEDERATION
Tel: +7 495 115-50-65
EMAIL: info@mitps.ru
WEB: mitps.ru

LLC "Motors and Transmission"
Betonny passage 6
Minsk 220036
BELARUS
Tel: +375 17 207 34 40
EMAIL: info@mit.by
WEB: mit.by

Märkisches Werk Japan K.K.
E-3 8F
Must Building, 17-1 Dal-machl
Yokohama, Kanagawa
221-0834
JAPAN
Tel: +81 45 328 3148
Fax: +81 45 328 3149
EMAIL: c.watanabe@mwh.de
WEB: www.heinzmann.com
Contact: Mrs. Watanabe

MOBITRON AB
Hunneryds Gård
56146Huskvarna
SWEDEN
Tel: +46 36 512 25
Fax: +46 36 511 25
EMAIL: soo@mobitron.se
WEB: www.mobitron.com
Contact: Mr. Sven Olof Olsson

MOTORGAS s.r.o.
Oderska 333/5
196 00Praha 9
CZECH REPUBLIC
Tel: +420 266199777
Fax: +4 20 266199780
EMAIL: petr@motorgas.cz
WEB: motorgas.cz
Contact: Mr. Jan Petr

MOTORGAS sp z o.o.
Aleja Niepodleglosci 606/610
81-789Sopot
POLAND
Tel: +48 58 7635376
Fax: +48 58 7635377
EMAIL: motorgas@motorgas.pl
WEB: www.motorgas.pl
Contact: Mr. Radoslaw Olszewski

Normandy Control Group
Seri Parc, avenue du Cantipou
76700Harfleur
FRANCE
Tel: +33 02 35197480
EMAIL: info@ncgroup.fr
WEB: www.ncgroup.fr

OGAN TEKNIK HIZMETLER A.S.
Giptas Sanayi Sitesi F Blok, No:11
Evliya Celebi Mh. Genc Osman Cad.
Tuzla
Istanbul 34944
TURKEY
Tel: +90 216 395 95 75
Fax: +90 216 395 95 76
EMAIL: info@ogantek.com
WEB: www.ogantek.com

Optimum Engineering and Trading
6/5G Laselky St
New Maadi
Cairo 114 35
EGYPT
Tel: +20 2 27045141
Fax: +20 2 27041587
EMAIL: info@optimumeng.com
WEB: www.optimumeng.com
Contact: Mr. Mohamed Hassan

PirDanesh Arya Pasargad Co. Ltd.
Unit 501, 5th floor
No. 77, Mahram (Modabber) Ave.
Yousef Abad
Tehran
IRAN
Tel: +98 21 8803 6484
Fax: +98 21 8803 6495
EMAIL: info@heinzmann.ir
WEB: www.heinzmann.com
Contact: Mr. Arastoo Sepehri

Resource Power Group
Avenida Edzna No. 1
Colonia Parque Industrial
Ciudad del Carmen
Campeche C.P. 24157
MEXICO
Tel: +52 1 229 265 0345
EMAIL: amrando.martin@rpgmarine.com
Contact: Mr. Armando Martin

Resource Power Group (Houston)
901 W 13th Street
Deer Park, TX 77536, Texas 77536
U.S.A.
Tel: +1 281 241 1252
EMAIL: chandler.cleveland@rpgmarine.com
WEB: www.heinzmann.com
Contact: Mr. Chandler Cleveland

RPG Energy S. DE R.L.
Building 9121, Warehouse 12 and 13, PanAmerica C
Panama Pacifico, Veracruz
Arraijan
Panama, Panama
PANAMA
Tel: +507 3205075
EMAIL: ezequiel.castro@rpgmarine.com
Contact: Mr. Ezequiel Castro

RPM Controles
Alfredo do Costa Figo, 347C
Fazenda Santa Cândida
Campinas, São Paulo 13087-534
BRAZIL
Tel: +55 19 3037 5812
EMAIL: rpmcontroles@rpmcontroles.com.br
WEB: www.rpmcontroles.com.br

RS Motor Power Solutions
Rúa B, Parcela 13 A-4
36475Porrino Pontevedra
SPAIN
Tel: +43 0 986 46 1801
Fax: +43 0 986 46 1800
EMAIL: rsmotor@rsmotor.es
WEB: www.rsmotor.es
Contact: Mr. Ramón Gómez Rúa

SIA "NEOTEN"
Piedrujas iela, 30
1073Riga
LATVIA
Tel: +371 671 38-390
EMAIL: info@neoten.lv
WEB: www.neoten.lv

Sigma Power Control Systems Pvt. Ltd.
78/1 Shed No. 3, ShivKamal Industrial Estate
Shivane, Pune 411023. MH
INDIA
Tel: +91 20 25290339
Fax: +91 20 25290382
EMAIL: sumeet.undirwadkar@spcspl.com
WEB: www.heinzmann.com
Contact: Mr. Sumeet Undirwadkar

Sirtec Srl
Via Borzoli, 39/122U
16153Genova
ITALY
Tel: +39 0 106503836
EMAIL: info@sirtecsrl.com
Contact: Mr. Guglielmo Traxino

SpareNav. I. & Services Srl
Zona Riparazioni Navali
Via Molo Giano
16128Genova
ITALY
Tel: +39 010 247 0197
Fax: +39 010 247 3556
EMAIL: alessandro.morgia@sparenaviservices.it
WEB: www.heinzmann.com
Contact: Mr. Alessandro Morgia

SWTS Pte Ltd.
10, Gul Avenue
Jurong
Singapore 629654
SINGAPORE
Tel: +65 6 861 4466
Fax: +65 6 863 1736
EMAIL: leongmeng.sin@swtspl.com
WEB: www.swtspl.com
Contact: Mr. Sin

ULMATEC Services LLC
Maritime Business Centre
Office 604
Dubai Maritime City
UAE
Tel: +971 0 52-928-088
Fax: +971 0 4 3688 526
EMAIL: dubai@ulmatec.no
WEB: www.heinzmann.com
Contact: Mr. Kjetil Leine

Wartsila Canada Inc.
Unit 3
90 Cutler Avenue
Nova Scotia
Dartmouth B3B 0J6
CANADA
Tel: +1 902 4681264
EMAIL: duane.wong@wartsila.com
WEB: www.wartsila.com
Contact: Mr. Duane Wong

I

INNIO JENBACHER GMBH & CO OG

INNIO Jenbacher GmbH & Co OG
Achenseestr. 1-3
A-6200Jenbach, Tyrol
AUSTRIA
Tel: +43 0 5244 600
Fax: +43 0 5244 600-527
EMAIL: communications@innio.com
WEB: www.innio.com
Contact: Susanne Reichelt

Asesorias Y Representaciones Comerciales Arcolands
Centro de Negocios "Paseo San Francisco"
Av. Interoceánica E-28C y Francisco de Orellana
Cumbaya
Quito
ECUADOR
Tel: +593 2 226 1226
Fax: +59 399 739181
EMAIL: careyes@arcolands.com

Camda New Energy Equipement Co. Ltd.
Tangchun Industrial Zone,
Liaobu Town
W. Bejaia 511700
CHINA
Tel: +86 769 88996235
Fax: +86 769 88996282
EMAIL: ared@camda.cc

China Diesel Support Services Ltd.
6A Gandion Plaza
932 Cheung Shan Wan Road
Cheung Sha Wan
Hong Kong
CHINA
Tel: +852 2745 8085
Fax: +852 2743 1419
EMAIL: bettywong@cdss.net.cn

China Diesel Support Services (Chengdu) Co. Ltd.
Tangchun Industrial Zone,
Liaobu Town
Dongguan
Guangdong 511700
CHINA
Tel: +86 2885 880241
EMAIL: charliezong@cdss.net.cn

China Diesel Support Services (Shanghai) Co. Ltd.
No. 588 Yingkou Road
, Shanghai 200433
CHINA
Tel: +86 2155 230932
EMAIL: dalefan@cdss.net.cn

Clarke Energy Australia PTY Ltd.
Building 1, 2-4 Stirling Street
Thebarton SA 5031
AUSTRALIA
Tel: +61 8 8290 2100
Fax: +61 8 8443 5848
EMAIL: greg.columbus@clarke-energy.com
WEB: www.clarke-energy.com

Clarke Energy Bangladesh Ltd.
Gulshan South Avenue, Gulshan -1
Dhaka 1212
BANGLADESH
Tel: +880 2 9841637
EMAIL: nachiket.bhishikar@clarke-energy.com
WEB: www.clarke-energy.com

Clarke Energy France SAS
Z.A. de la Malle, RD 6
13320Bouc Bel Air
FRANCE
Tel: +33 442 907570
EMAIL: didier.lartigue@clarke-energy.com

Clarke Energy India Private Limited
"Shivkiran", Lane no. 4,
Dahanukar Colony, Kothrud
Kothrud, Pune 411 038
INDIA
Tel: +91 20 30241777
EMAIL: punit.garg@clarke-energy.com
WEB: www.clarke-energy.com

Clarke Energy Ireland Ltd.
Unit 7, Newtown Business Park
Newtownmountkennedy, Co. Wicklow
IRELAND
Tel: +353 1 281 0010
Fax: +353 1 281 0520
EMAIL: john.curley@clarke-energy.com
WEB: www.clarke-energy.com

Clarke Energy Ltd. (UK)
Power House, Senator Point
South Boundary Road, Knowsley Industrial Park
Liverpool L33 7RR
U.K.
Tel: +44 151 546 4446
Fax: +44 151 545 5714
EMAIL: peter.holliday@clarke-energy.com
WEB: www.clarke-energy.com

Clarke Energy Nigeria Ltd.
No.28 Joel Ogunnaike Street GRA
IKEJA
Lagos 101001
NIGERIA
Tel: +234 8022241545
EMAIL: patrick.nzekwe@clarke-energy.com
WEB: www.clarke-energy.com

Clarke Energy South Africa (PTY) LTD
Link Hills, 3652
Tunis
SOUTH AFRICA
Tel: +27 31 7633222
EMAIL: paul.demattos@clarke-energy.com
WEB: www.clarke-energy.com

Clarke Energy Tanzania Ltd
Ground Floor 369 Kilwa House
Toure Drive
Dar-es-salaam
TANZANIA
Tel: +255 22 229 6419
EMAIL: alanf@clarke-energy.com

Clarke Energy Tunisie SARL
Du Lacles Berges Du Lac
Tunis 1053
TUNISIA
Tel: +216 71 190 006
EMAIL: didier.lartigue@clarke-energy.com

Clarke Energy USA, Inc.
2100 Pewaukee Road,
Waukesha, Wisconsin 53188
U.S.A.
Tel: +1 262 5655020
EMAIL: alanf@clarke-energy.com

Dana Engineering International, Limited
Road 13 & 15 Block D,
Banani
BANGLADESH
Tel: +880 2 9887085
08802 58813108
EMAIL: salman@agni.com

DESCO Incorporated
Lot 2 Block 3, Interstar Street
Binan City 4024
PHILIPPINES
Tel: +63 2 520 8149
EMAIL: sherwin@desco.ph

Distributed Power Canada Company
200 Buchner Road
Welland, Ontario L3B 5N4
CANADA
Tel: +1 289 932 3537
EMAIL: communications@innio.com
WEB: www.innio.com

Dome Trading & Contracting Co Ltd.
Street Nr. 38
Sanaa
YEMEN
Tel: +967 1 413629
EMAIL: azizdaer@domeyemen.com

Ecogen Energy Systems bvba
Vaart Rechteroever 225
9800Deinze
BELGIUM
Tel: +32 938 64860
Fax: +32 938 61134
EMAIL: jd@ecogen.be

Energas BHKW GmbH
Wilhelm-Brielmayer-Straße 7
88213Ravensburg
GERMANY
Tel: +49 751 88833330
EMAIL: joachim.maier@energas-gmbh.de

Energotechservice LLC
14 Gilevskaya Roscha Str.
Tyumen 625019
RUSSIAN FEDERATION
Tel: +7 3452 54 64 48 36
EMAIL: sverginaa@tmenergo.ru

Energy and Contracting Solutions Company ECS
El Mahata Square
Cairo
Maadi
EGYPT
Tel: +20 2 25197240
EMAIL: ossama_guenedy@ecseg.com

Ferox Energy Systems Sp. z o.o.
ul. Zeliwna 38
Katwoice
POLAND
Tel: +48 322 546169
EMAIL: kordian.lisiecki@ferox.pl

Filter AS
Läike tee 9
Peetri, Rae vald
75312Harjumaa
ESTONIA
Tel: +372 606 6666
EMAIL: bert.louke@filter.eu
WEB: www.filter.ee/en/

Filter CJSC
Minsky district Administrative Bldg.
Minsk 223053
BELARUS
Tel: +375 17 237 93 63
EMAIL: evgeny.shakovets@filter.by

Filter OOD
7 Iskarsko shose Blvd.
1528Sofia
BULGARIA
Tel: +359 2 9745085
EMAIL: michael.kostadinov@filter.eu

Filter SIA
Ulbrokas str. 23
1021Riga
LATVIA
Tel: +371 6755 6765
Fax: +371 6755 0224
EMAIL: agris.sipkovs@filter.lv
WEB: www.filter-group.com

Filter UAB
Lakunu Pl. 77
46294Kaunas
LITHUANIA
Tel: +37 037 400370
EMAIL: dalius.simkunas@filter.eu

GENELCO Power Systems Ltd.
Irinis Street
17121Nea Smyrni, Athens
GREECE
Tel: +30 2109346994
EMAIL: okantaridis@genelco.gr

Guangzhou Shenfa ME Industry Development Co, LTD
Huaqiang Rd.

Guangzhou
CHINA
Tel: +86 20 835 59493
EMAIL: billy.lai@sf-power.com.cn

HCH Supply Co for import & export and supplies
29, St. No 269,
New Maadi, Cairo
EGYPT
Tel: +20 2 29703919
EMAIL: karim.greiss@hch-supply.com

Heliostat Ltd.
6 Agissilaou Str.
15125Maroussi
GREECE
Tel: +30 210 6851159
EMAIL: ckorres@heliostat.gr

Hitachi Engineering & Services Co. Ltd.
7, Kandamitoshiro-cho, Chiyoda-ku
Tokyo 101-0053
JAPAN
Tel: +81 294 36 7900
Fax: +81 3 5297 0517
EMAIL: kosei.yumita.en@hitachi.com

Hoerbiger (Canada) Ltd.
441 South Avenue
Spruce Grove T7X3A7
CANADA
Tel: +1 780 9606656
EMAIL: john.chapman@hoerbiger.com

Hoerbiger de Argentina Sa Sucursal Peru
Calle El Boulevard 162
Santiago de Surco
PERU
Tel: +51 14 363505
EMAIL: henry.carrera@hoerbiger.com

Hoerbiger de Mexico, SA DE CV
Calz. De La Naranja No. 166 Alce Blanco
Naucalpan de Juarez 53370
MEXICO
Tel: +52 55 5576 6725
EMAIL: gabriel.davila@hoerbiger.com

Hoerbiger de Venezuela SA
Av Principal Los Cortijos De Lourdes
Caracas Oficina PH4-A
VENEZUELA
Tel: +58 212 2385934
EMAIL: diego.bolanos@hoerbiger.com

Hoerbiger Ltd.
Nastavnichesky Lane 17
Moscow 105120
RUSSIAN FEDERATION
Tel: +7 495 221-06-78
EMAIL: denis.pestov@hoerbiger.com

Hoerbiger Service Hungaria Kft.
Bagoly u.7
2120Dunakeszi
HUNGARY
Tel: +36 27540845
EMAIL: peter.csirmaz@hoerbiger.com

Hoerbiger South Africa (Pty) Ltd
9 Fuchs Street
Alrode
SOUTH AFRICA
Tel: +27 11 864 17 36
EMAIL: danny.fournel@hoerbiger.com

Hoerbiger Zandov S.R.O.
Nadrazni 10
47101Zandov
CZECH REPUBLIC
Tel: +420 284028973
EMAIL: jan.riegert@hoerbiger.com

Höyrytys Oy
Palokorvenkatu 2
Kerava
FINLAND
Tel: +358 46 850 80 70
Fax: +358 9 41746 100
EMAIL: risto.nupponen@hoyrytys.fi

IGF Gasprodukter AB
Byangsgrand 14
120 40Arsta
SWEDEN
Tel: +46 8 742 22 80
EMAIL: kristian.jarheim@igfgas.se

Ingenieria Sima S.A.
C.C. 874 Parque Industrial Este
Manzana R Lote M1
Neuquén Q8300
ARGENTINA
Tel: +54 299 4490999
EMAIL: dmanfio@sima.com.ar

INNIO Jenbacher Gmbh & Co OG
Achenseestr. 1-3
A-6200Jenbach, Tyrol
AUSTRIA
Tel: +43 5244 600 2077
EMAIL: communications@innio.com
WEB: www.innio.com

IWK Integrierte Wärme und Kraft AG
Aspstrasse 11
8472Oberohringen / Seuzach
SWITZERLAND
Tel: +41 41 6621866
Fax: +41 52 320 00 01
EMAIL: daniel.dillier@iwk.ch
WEB: www.iwk.ch

Jenbacher A/S
Samsøvej 10
8382Hinnerup
DENMARK
Tel: +45 86 966 788
EMAIL: communications@innio.com
WEB: www.innio.com

Jenbacher B.V.
Kelvinring 58
2952BG Ablasserdam
NETHERLANDS
Tel: +31 88 0019700
EMAIL: communications@innio.com
WEB: www.innio.com

Jenbacher GmbH
Carl-Benz-Str. 25
67227Frankenthal
GERMANY
Tel: +49 6233 5110 150
EMAIL: communications@innio.com
WEB: www.innio.com

Jenbacher International B.V.
Level 9, The Metropolis Tower 2
11 North Buona Vista Drive
Singapore 138589
SINGAPORE
Tel: +65 326 2014
EMAIL: communications@innio.com
WEB: www.innio.com

Jenbacher Rus LLC
Presnenskaya Naberezhnaya 10A
1233112
Moscow
RUSSIAN FEDERATION
Tel: +7 495 933 0187
EMAIL: communications@innio.com
WEB: www.innio.com

Jenbacher S. de R.L. de C.V.
Antonio Dovali Jaime 70
Piso 4, Torre B
Ciudad de Mexico, CP 01210
MEXICO
Tel: +52 33 3164 1237
EMAIL: communications@innio.com
WEB: www.innio.com

Jenbacher S.L.
Josefa Valcarcel 26
Edificio Merrimack III
28027Madrid
SPAIN
Tel: +34 91 587 05 00
EMAIL: communications@innio.com
WEB: www.innio.com

Jenbacher Srl
Via Staffali 1
37062Dossobuono
ITALY
Tel: +39 045 6760211
EMAIL: communications@innio.com
WEB: www.innio.com

JeWa (Shanghai) Engines Co., Ltd.
No.1 Huatuo Road, Zhangjiang Hi-Tech Park
Pilot Free Trade Zone
Shanghai 201203
CHINA
Tel: +86 21 38771888
EMAIL: communications@innio.com
WEB: www.innio.com

MADEI TAAS Ltd.
6 Yad Harutzim
Kfar-Saba 4464103
ISRAEL
Tel: +972 9 7669903
Fax: +972 9 7669904
EMAIL: elimatz@mdts.co.il
WEB: www.madeitaas.co.il

Max Motors LLC
6 Pushkina Prospect
Sochi 354002
RUSSIAN FEDERATION
Tel: +7 862 262 77 99 (multichannel)
Fax: +7 862 262 61 16
EMAIL: alex@max-motors.ru
WEB: www.max-energo.ru

MSI, TOO
Pervomayskaya street 82
Aktobe 3005
KAZAKHSTAN
Tel: +7 7132 775551
EMAIL: gdam@msikaz.com

Nine-Tech Corporation
11-9 Sincheon-Dong
Teukbyeolsi
Seoul 05510
KOREA
Tel: +82 24250940
EMAIL: dsissh@nate.com

Nixon Power Services, LLC
5038 Thoroughbred Lane
Brentwood, Tennessee 37027-4225

U.S.A.
Tel: +1 615 309 5823
EMAIL: rstanley@nixonpower.com

NME s.r.L
Via Ferruccio DellOrto 8
24126Bergamo
ITALY
Tel: +39 035 320030
EMAIL: msturly@nmesrl.it

Orient Energy Systems (Private) Limited
Plot # 16, Sector 24, Korangi Industrial Area
Karachi 74900
PAKISTAN
Tel: +92 21 507 2091-94
Fax: +92 21 507 2095
EMAIL: m.saeed@orient-power.com

Orient Energy Systems FZCO
Liu, G-06, PO Box 54652
Dubai
UAE
Tel: +971 526853089
EMAIL: iftikhar@orient-power.com

ORIENT Energy Systems Ltd.
11th floor, Land View Building
28, Gulshan North C/A, Gulshan 2
Dhaka 1212
BANGLADESH
Tel: +880 2 8861638
Fax: +88 02 8826530
EMAIL: info.bd@orient-power.com

PEGSA Ltda.
Transversal 55 # 98A-66 Oficina 411
Bogota D.C.
COLOMBIA
Tel: +57 313 4222732
EMAIL: pedro.gomez@pegsa.com.co

RNP Enterprise Ltd.
35 BAEKJEGOBUN-RO 50-GIL
Bang - I - Dong, Song Pa-Ku
Seoul 138830
KOREA
Tel: +82 2 412 3700
Fax: +82 2 412 3044
EMAIL: richard@rnp-ent.co.kr

Shenyang WeiLiDa Engineering Equipment Co., Ltd.
No. 200 Shifu Ave.
Shenyang 110003
CHINA
Tel: +86 24-31696477
EMAIL: reader_song@126.com

Smith Power Mexico, S.DE R.L.DE C.V.
Circuito de la Productividad 133
Parque Industrial
El Salto 45690
MEXICO
Tel: +52 33 31641237
EMAIL: mbsmith@smithppi.com

Smith Power Products
3065 West California Ave.
Salt Lake City, Utah 84104
U.S.A.
Tel: +1 801 415 5000
Fax: +1 801 415 5700
EMAIL: mhayes@smithdda.com
WEB: www.smithpowerproducts.com

SOUER CO., LTD.
B.B. House 99/10, Moo 5, Ban Klong
Muang Phitsanulok 65000
THAILAND
Tel: +66 55 282810
EMAIL: danny@souer.co.th

STI d.o.o.
Mikuliceva 27
1000Zagreb
CROATIA
Tel: +385 14628150
EMAIL: lvucinic@sti.hr

TEB Energy Business SA
55th Floreasca st.
50912Bucharest
ROMANIA
Tel: +40 21 569 84 45
Fax: +40 21 456 84 45
EMAIL: daniel.timofei@teb.com.ro

TES d. o. o.
Gregorciceva 3
2000Maribor
SLOVAKIA
Tel: +421 917 114 879
EMAIL: borut.bencic@tes.si

The Power Service Group, S.A.
Calle Primera, #3, Duquesa-Oeste
Santo Domingo Norte
DOMINICAN REPUBLIC
Tel: +1 809 3284030
EMAIL: pjongejan@carpsg.com

Topkapi Endüstri Mallari Ticaret A.S.
180-182-B Topkapi Mahallesi
Topkapi/Istanbul 34093
TURKEY
Tel: +90 212 534 04 10
Fax: +90 212 524 58 46
EMAIL: sedat@topkapigroup.com.tr
WEB: www.topkapigroup.com.tr

Vinh Nam Joint Stock Company (VAM JSC)
NO. 13 STREET TAN BINH INDUSTRIAL PARK
HO CHI MINH
VIETNAM
Tel: +84 8 38161956
EMAIL: hailk@vam.vn

VIPROPAT S.R.L.
Strada Miron Costin 7
2068Chisinau
MOLDOVA
Tel: +73 22 83849495
EMAIL: v.kucherena@cogeneration.md

Waukesha - Pearce Industries, Inc.
12320 South Main Street
Houston, Texas 77035-6206
U.S.A.
Tel: +1 713 7231050
EMAIL: lmpiii@wpi.com

Yumon International Trade (Shanghai) Co. Ltd. (Sub of Solomon)
Rm. 1001 ZhongRong International Building
Shanghai 200120
CHINA
Tel: +86 21 58781256
EMAIL: tracy.tseng@solomon.com.tw

J

JCB POWER SYSTEMS LTD.

JCB Power Systems Ltd.
Dove Valley Park
1000 Park Avenue, Foston Derby
DE65 5BX
U.K.
Tel: +44 1889 590312
Fax: +44 1283 585630
EMAIL: engine.sales@jcb.com
WEB: www.jcbpowersystems.com
Contact: Robert Payne

Anderson Industrial Engines
13423 Lynam Dr
Omaha, Nebraska 68138
U.S.A.
Tel: +1 402 558 8700
EMAIL: info@ai-engines.com
WEB: www.ai-engines.com
Territory: USA

Brinkmann and Niemeijer Motoren B.V.
Engelenburgstraat 45
7391 AMTwello
NETHERLANDS
Tel: +31 0 571 276900
Fax: +31 0 571 276800
EMAIL: info@bnmotoren.nl
WEB: www.bnmotoren.nl
Territory: The Netherlands

Continental Engines
60 Pelham Davis Circle
Greenville, South Carolina 29615
U.S.A.
Tel: +1 864 242 5567
EMAIL: jcooper@continentalengines.com

EIP Diesel Pty Ltd
37 Eddie Rd
Minchinbury, Australia 2770
AUSTRALIA
Tel: +61 2 9675 3444
EMAIL: sales@eipdiesel.com.au
Territory: Australia

Engine Power Inc.
1830 Executive Drive
Oconomowoc, Wisconsin 53066
U.S.A.
Tel: +1 800 242-2289
Fax: +1 800 897-8999
EMAIL: brian.paulin@enginepower.com
WEB: www.enginepower.com
Territory: USA

GB Equipment Solutions LLC
Dubai Brand Plot #15
Street 14a, AlQuoz
Industrial Area I
414147
UAE
Tel: +971 5044 19920
EMAIL: mazenab@galadariequip.com

Global Power Source Co., Ltd.
NO. 3-43, ALLEY 1, Kuu-Ling Lin, Gung Shi
Village, Gung Shi Village, Gueishan Dist., Taoyuan
Taoyuan City
TAIWAN
Tel: +886 3396 0236
EMAIL: gpscbw@gpsc.com.tw
Territory: Taiwan

Gulf Equipment & Technology w.l.I
P.0. Box: 704,
Manama, Kingdom of Bahrain
704
BAHRAIN
Tel: +973 17 700 008
EMAIL: pande@al-alawi.com
Territory: Kingdom Of Bahrain

M & L Engines LLC
2845 Hwy 311
Schriever, Louisiana 70395
U.S.A.

Tel: +1 800 960 0068
Territory: USA

Marr Indistrial
8550 Delmeade Road, Montreal
(Quebec) Canada H4T 1
CANADA
Tel: +1 514 342 2748
EMAIL: enadeau@marind.ca
Territory: Canada

Maruma Technica Co., Ltd
6-2-1 Ohnodai
Minami-ku
Sagamihara Kanagawa 252-0331
JAPAN
Tel: +81 42 7513024
Fax: +81 42 7519065
EMAIL: overseas@maruma.co.jp
WEB: www.maruma.jp
Territory: Japan

Mastry Engine Center
2801 Anvil Street
St. Petersburg, Florida 33710
U.S.A.
Tel: +1 800 545-4574
Fax: +1 727 381-3235
EMAIL: abedillion@mastry.com
WEB: www.mastry.com
Territory: USA

Mitchell Powersystems
Fullwood Road South
Sutton in Ashfield NG17 2JZ
U.K.
Tel: +44 0 1623 550550
Fax: +44 0 1623 443041
EMAIL: sales@mitchells.co.uk
WEB: www.mitchells.co.uk
Territory: United Kingdom

MOTOR MART SA DE CV
Adolfo Lopez Mateos 201 Parque
Industrial San Rafa
Guadalupe, N.L., Mexico. 67119
MEXICO
Tel: +52 811 7691010
EMAIL: rmurbina@motormart.
com.mx
Territory: Mexico

Multimotors
ul. Holenderska 3
05-152Czosnów
POLAND
Tel: +48 22 785 10 10
Fax: +48 22 785 10 45
EMAIL: biuro@multimotors.com.
pl
WEB: www.multimotors.pl
Territory: Poland

Pace Power & Air
95 Katere Road, New Plymouth
NEW ZEALAND
Tel: +64 62811425
EMAIL: info@power-air.co.nz
Territory: New Zealand

Power Torque (Pty) Ltd
47 5th Street
Wynberg
Gauteng
SOUTH AFRICA
Tel: +27 0 11 786 4247/9
Fax: +27 0 11 440 1547
EMAIL: don@powertorque.co.za
WEB: www.powertorque.co.za
Territory: South Africa

Power Torque Engineering Ltd
Herald Way
Binley
Coventry CV3 2RQ
U.K.
Tel: +44 0 2476 635757
Fax: +44 0 2476 635878
EMAIL: sales@powertorque.co.uk
WEB: www.powertorque.co.uk
Territory: United Kingdom

Presicion Power Services Co., Ltd
117/71 M. 4, Tambol Plutaluang
Amphur Sattahip
20180, Chonburi,, Thailand
20180
THAILAND
Tel: +66 80 0170770
Territory: Thailand

RAMS
43, Rue Ampere
69680Chassieu, Lyon
FRANCE
Tel: +33 0 4 72 47 50 80
Fax: +33 0 4 72 90 30 90
WEB: www.rams.fr
Territory: France

ReviPower
Szilády Áron street 5-7. 1/15
office 6400 Kiskunh
HUNGARY
Tel: +36 30 5954622
EMAIL: info@revipower.hu
Territory: Hungary

RK Power
Carr.#1 KM 25, Solar #6
Urb. Quebrada Arenas Industrial
Park San Juan,
00926
PUERTO RICO
Tel: +1 787 286 6454
EMAIL: raguilar@
rkpowergenerator.com
WEB: www.rkpowergenerator.
com
Territory: Puerto Rico

ScanDiesel GmbH
Ermlandstraße 59
28777Bremen
GERMANY
Tel: +49 0 421 67532 10
Fax: +49 0 421 67532 20
EMAIL: info@scandiesel.de
WEB: www.scandiesel.de
Territory: Germany

SIF
Fatih Mahallesi Katip Çelebi Cad.
No: 49 / 1 34956 Orhanli - Tuzla
/ Istanbul
Istanbul 1 34956
TURKEY
Tel: +90 216 3520000
EMAIL: eren.mengutay@sif.com.
tr
Territory: Turkey

Westquip Diesel Sales
285138 Wrangler Ave
Calgary, Alberta T1X-0K3
CANADA
Tel: +1 403 261-0601
Fax: +1 403 263-9828
EMAIL: dnimmo@westquip.ca
WEB: www.westquip.ca
Territory: Canada

K

KS KOLBENSCHMIDT GMBH

KS Kolbenschmidt GmbH
Large Bore Pistons
Karl-Schmidt-Str.
74172Neckarsulm
GERMANY
Tel: +49 7132 332714
Fax: +49 7132 33 2219
EMAIL: info@de.rheinmetall.com
WEB: https://www.rheinmetall-automotive.com/marken/kolbenschmidt/

KSLP (China) Co., Ltd.
Building E
No. 299 Yu Yang Road
Kunshan
Jiangsu 215300
CHINA
Tel: +86 512 8618 4601
EMAIL: serge.estorez@
cn.rheinmetall.com
WEB: https://www.rheinmetall-automotive.com/marken/kolbenschmidt/

M

MAN ENERGY SOLUTIONS SE

MAN Energy Solutions SE
Stadtbachstrasse 1
86153Augsburg, BY
GERMANY
Tel: +49 0 821 322-0
Fax: +49 0 821 322-3382
EMAIL: powerplant@man-es.com
WEB: www.man-es.com

MAN Energy Solutions SE
Stadtbachstraße 1
86153Augsburg, BY
GERMANY
Tel: +49 0 821 322-0
Fax: +49 0 821 322-3382
EMAIL: powerplant@man-es.com
WEB: www.man-es.com/energy-storage
Territory: Augsburg

P

PERKINS ENGINES COMPANY LIMITED

Perkins Engines Company Limited
Frank Perkins Way
Peterborough, Cambs PE1 5FQ
U.K.
Tel: +44 0 1733 583000
EMAIL: webmaster@perkins.com
WEB: www.perkins.com

Adamjee Diesel Engineering [Pak] Ltd
Adamjee House
4th Floor
1.1 Chundrigar Road
Karachi
PAKISTAN
Tel: +92 21 241 0725
Fax: +92 21 241 8951
WEB: www.adamjeediesel.com

AFM, Tanzania
Nyerer Road
P.O. Box 9262
Dar Es Salaam
TANZANIA
Tel: +255 51 860 160 / 162
Fax: +255 51 864 284
WEB: www.mantractanzania.com

Africa Motors & Machinery
Africa Motors Division
Ring Road West
Industrial Area
Accra
GHANA
Tel: +233 21 221 900 / 916 / 980
Fax: +233 21 221 950 / 228 789
WEB: www.mantracghana.com

Africa Motors and Machinery
7th Street Industrial Area
P.O. Box 7126
Kampala
UGANDA
Tel: +256 41 235 421
Fax: +256 41 235 425

Africa Motors and Machinery
P.O. Box 30097 - 0100
Witu Road off Lusaka Road
Nairobi
KENYA
Tel: +254 253 0903
Fax: +254 255 7594
EMAIL: biroga@mantrackenya.com

Aljomaih Equipment Co.Ltd
P.O. Box 132
Al Kharj Road near Exit 15
Riyadh 11411
SAUDI ARABIA
Tel: +966 01 4934713 / 4921921
Fax: +966 01 4919446

Aljomaih Holding Co
P.O. Box 467
Kilo-6 Madina Road
Jeddah 21438
SAUDI ARABIA
Tel: +966 2 275 2200.
Fax: +966 2 681 1539

Allight [Adelaide]
283-287 Sir Donald Bradman Drive
Brooklyn Park, Sa 5032
AUSTRALIA
Tel: +61 08 8238 3433
Fax: +61 08 8238 3413
EMAIL: perkins@allight.com
WEB: www.allight.com

Allight [Brisbane]
35 Alexandra Place
Murarrie, Queensland 4172
AUSTRALIA
Tel: +61 07 3131 8222
Fax: +61 07 3348 8613
EMAIL: perkins@allight.com
WEB: www.allight.com

Allight [Melbourne]
145-157 Fairbank Rd
Clayton, Victoria 3169
AUSTRALIA
Tel: +61 03 9271 3301
Fax: +61 03 9271 3310
EMAIL: perkins@allight.com
WEB: www.allight.com

Allight [Perth]
12 Hoskins Road
Landsdale
Perth, Western Australia 6065
AUSTRALIA
Tel: +61 8 9302 7000
Fax: +61 8 9302 7001
EMAIL: perkins@allight.com
WEB: www.allight.com

Allight [Rockhampton]
20 Johnson Street
Rockhampton, Queensland 4701
AUSTRALIA
Tel: +61 07 4936 3822
Fax: +61 07 4936 3977
EMAIL: perkins@allight.com
WEB: www.allight.com

Allight [Sydney]
51 Heathcote Road
Moorebank
Sydney, New South Wales 2170
AUSTRALIA
Tel: +61 02 9203 6700
Fax: +61 02 9824 1212
EMAIL: perkins@allight.com
WEB: www.allight.com

Allight Pty Ltd (Perth)
12 Hoskins Road
Landsdale
Perth, Western Austrlia 6065
AUSTRALIA
Tel: +61 8 9302 7000
Fax: +61 8 9302 7001
EMAIL: perkins@allight.com
WEB: www.allight.com

Alpha Diesel Dubai
28 & 29 Block 9 New Extension
P.O. Box 8087 (Amarat)
King Abdual Azziz Street
Khartoum
SUDAN
Tel: +249 11 487511/12
Fax: +249 11 487515
EMAIL: khalid@dgsudan.com
WEB: www.dgsudan.com

Alwatary Trading and Agriculture Devt Co
Tahrir Square
P.O. Box 61
Sanaa
YEMEN
Tel: +967 1 271998
Fax: +967 1 271998

Anciens Comptoirs Ries
P.O. Box 2106
Rue Marchand
DJIBOUTI
Tel: +253 352656/9
Fax: +253 353529
EMAIL: acr@intnet.dj

Arfil S.A. Jose A Laprovitera
Jose L Terra 2824-2826
Montevideo CP 11800
URUGUAY
Tel: +598 2 203 4234
Fax: +598 2 204 5640

Barloworld Energy Products (Pty)
P.O. Box 762
136 Main Reef Road
Boksburg North
Johannesburg
SOUTH AFRICA
Tel: +27 11 898 0450
Fax: +27 11 898 0451
WEB: www.barloworld-energy-products.com

Barloworld Equipamentos Angola
Estrada Do Golf S/N Sector
Talatonia
P.O. Box 6103
Luanda Sol
Luanda
ANGOLA
Tel: +244 267 395 1781
Fax: +244 92 442 399 824
EMAIL: pfouche@barloworld-angola.com

Barloworld Equipment Malawi
Ali-Hasson Mwinyi Road
P.O. Box 30643
Chicihri
Blantyre 3
MALAWI
Tel: +265 187 0666
Fax: +265 187 1281
EMAIL: sdejager@barloworld-malawi.com
WEB: www.barloworld-energy-products.com

Barloworld Mozambique
Av Romao
Fernandes Farinha Nrs 156 e 160
Maputo CP4394
MOZAMBIQUE
Tel: +258 21430 184 / 258 21431 622
Fax: +258 21430 225 / 258 21314 717

Barloworld PTY Ltd (Botswana)
Plot 1226
Haille Selassie Road
PO Box 1616
Gabaronne
BOTSWANA
Tel: +267 395 1781
Fax: +267 395 1459
EMAIL: scooper@barloworldpower.com
WEB: www.bwep.com.za

Barloworld Zambia
Konkola Barloworld
Chililabombwe
PO Box 32890
Lusaka
ZAMBIA
Tel: +260 1 288 218
Fax: +260 1 288 986
WEB: www.barloworld-energy-products.com

BEL Spol sro
Beranovych 65
199 02Praha 9, Letnany
CZECH REPUBLIC
Tel: +420 2 74776702
Fax: +420 2 74812023
EMAIL: perkins@bel.cz
WEB: www.bel.cz

Bels sro
Sancova 52, 81005
Bratislava 81105
Bratislava
SLOVAKIA
Tel: +421 74 524 6107
Fax: +421 74 524 6080
WEB: www.bels.sk

BENIN EQUIPEMENT
ZI Akpakpa PK 3
Cotonou
BENIN
Tel: +229 33 30 92
Fax: +229 33 04 36
EMAIL: info@beninequipements.com

BU Power Systems GmbH & Co. KG
Westfalische Strasse 1
49084Osnabrueck
GERMANY
Tel: +49 541 584740
Fax: +49 541 5847474
WEB: www.bu-power-systems.de

BU Power Systems Italia srl
Via Leonardo Da Vinci 1
22020Gironico, CO
ITALY
Tel: +39 031 463 3411
Fax: +39 031 463 3473
WEB: www.bu-perkins.it

BURKINA EQUIPEMENT
3238 Route de Fada, km 6 - Secteur 28
Dassasgho
Ouagadougou 01 BP 1476 - 01
BURKINA FASO
Tel: +226 34 27 80
Fax: +226 34 27 81

Casa Cross (HF Cross)
Long Bien District
NICARAGUA
Tel: +505 268 4693
Fax: +505 268 1262

CEMCOL Commercial
KM 5 Carretera A La Lima
APDO. # 37
San Pedro Sula
HONDURAS
Tel: +504 559 5899
Fax: +504 559 7566
WEB: www.cemcolcomercial.com

Centro Diesel Snc di Giorgio e Marinella Ghelardoni
Viale G D'Annunzio 238
Marina di Pisa
56013Pisa
ITALY

Tel: +39 050 36683
Fax: +39 050 36855
EMAIL: info@centrodiesel.com
WEB: www.centrodiesel.net

Char Pilakoutas Ltd
P.O. Box 21168
7 Larnaca Road
1503Nicosia
CYPRUS
Tel: +357 2 349572
Fax: +357 2 430294
WEB: www.charpilakoutas.com.cy

CIPAC Industrie
5 Rue Eiffel
BP 11416
Noumea 988023
NEW CALEDONIA
Tel: +687 242036
Fax: +687 242568

Clyde Equipment (Pacific) Ltd
31 Viria Road
P.O. Box 1068
Vatuwaga
Suva
FIJI
Tel: +679 338 6000
Fax: +679 337 0431
EMAIL: salessuva@clydepac.com
WEB: www.clydepac.com

Colombo Srl
Via Moronata 22,
23854Olginate [Lecco]
ITALY
Tel: +39 0341 609111
Fax: +39 0341 604058
EMAIL: info@colomboengines.com
WEB: www.colomboengines.com

Comin Khmere (Cambodia)
8b Down Town Road No 7
P.O. Box 28
Phnom Penh
CAMBODIA
Tel: +855 23 885 640 / 212 514 / 217 003
Fax: +855 23 885 651
EMAIL: ckinfo@comin.com.kh
WEB: www.cominkhmere.com

Crosland Tecnica SA
Avda Argentina 3250
Callao
PERU
Tel: +51 14 515272
Fax: +51 14 296001

De La Sobera Hnos SAIC
Ave Eusebio Ayala Nro
1947 Asuncion
PARAGUAY
Tel: +595 2 1202913
Fax: +595 2 1213334

Delta
Km 8 - Alexandria
Desert Road
Amreya
Alexandria
EGYPT
Tel: +20 3 448 1043
Fax: +20 3 448 1042
WEB: www.mantracegypt.com

Diamond Brothers Limited
23/1 Soi Petkasame 36
Pharsricharoen
Bangkok 10160
THAILAND
Tel: +66 2 4570058
Fax: +66 2 4576664

Diesel Distribution
389 Deerhurst Units 3-4
Brampton, Ontario L6T 5K3
CANADA
Tel: +1 905 799 1544
Fax: +1 905 799 1577
WEB: www.dieseldistribution.com

Diesel Santa Cruz
Avenida Santa Cruz 170
Casilla 2439
Santa Cruz
BOLIVIA
Tel: +591 3 346 3740
Fax: +591 3 346 2413
EMAIL: dieselscz@entelnet.bo

Diperk [UK] Ltd
Kingsbridge Centre
Sturrock Way
Bretton
Peterborough PE3 8TZ
U.K.
Tel: +44 1733 334 500
Fax: +44 1733 334 551
EMAIL: sales@diperk.co.uk
WEB: www.diperk.co.uk

Diperk Argentina (Blue Power)
Ruta Panamericana km 26.8
Coletora Este nr. 27509
Don Torcuato
Buenos Aires
ARGENTINA
Tel: +54 11 47274040
Fax: +54 11 47274646

Diperk Power Solutions
1306 Ketch Court
Coquitlam, British Colombia V3K 6W1
CANADA
Tel: +1 604 527 3340
Fax: +1 604 527 3347
WEB: www.diperkcanada.ca

Distribuidora Perkins Chilena
Avenida Colorado 641
Parque Industrial Aeropuerto
Quilicura
CHILE
Tel: +56 2 620 3700
Fax: +56 2 739 1818
EMAIL: diperk@diperk.cl
WEB: www.diperk.cl

Earthmovers Ltd
P.O. Box N-4894
East Bay Street
Nassau
BAHAMAS
Tel: +1 242 393 5285
Fax: +242 393 6236

Edina Manufacturing Limited
Lissue Industrial Estate
West Lisburn
Co. Antrim BT28 2RE
U.K.
Tel: +44 28 9262 2122
Fax: +44 28 9262 1940
EMAIL: eml@edina.ie
WEB: www.edina.ie

Edina Power Plant Limited
Unit 142 A
Dublin Ind Estate
Glasnevin
Dublin 11
IRELAND
Tel: +353 1 8307788
Fax: +353 1 8307422
EMAIL: sales@edina.ie
WEB: www.edina.ie

Elco Power Equipment [Shenzhen] Limited
No. 5 Industrial Rd
Hao Yong Industrial Zone
Song Gang
Shenzhen
CHINA
Tel: +86 755 8176 6188
Fax: +86 755 8176 6088
EMAIL: elcosz@china.com
WEB: www.elco.com.hk

Elco Power Systems Limited
RM 201-2
Lincoln Ctr
20 Yip Fung Street
Fanling, N.T
HONG KONG
Tel: +852 2814 8441
Fax: +852 2873 1719
EMAIL: info@elco.com.hk

Elco Power Systems Ltd
Room 201-2 Lincoln Centre
20 Yip Fung Street
Fanling New Territories
Hong Kong 511768
CHINA
Tel: +86 769 5314701
Fax: +86 769 5314700
EMAIL: info@elco.com.hk
WEB: www.elco.com.hk

Elco Power Systems Ltd
Room 201-2 Lincoln Centre
20 Yip Fung Street
Fanling New Territories
Hong Kong 511768
CHINA
Tel: +86 769 5314701
Fax: +86 769 5314700
EMAIL: info@elco.com.hk
WEB: www.elco.com.hk

Eltrak Bulgaria Ltd
439 Europa Blvd
1331Sofia
BULGARIA
Tel: +359 2 818 3000
Fax: +359 2 958 6829
EMAIL: ekodjabasheva@eltrakbulgaria.com

Emesa Equipos Y Motores Europeos S.A. de C.V
Miguel Hidalgo No. 103
Parque Industrial Toluca
Domicilio
Parque Industrial Toluca
CP80030
MEXICO
Tel: +52 722 1993357
Fax: +52 722 1994551

Energypac
79 Shahid Tazuddin Ahmad Sarani
Tejgaon 1/A
Dhaka 1208
BANGLADESH
Tel: +880 2 989 2035
Fax: +880 2 881 3262
EMAIL: epgl@energypac.com
WEB: www.energypac.com

Engine Company No 1 Ltd
Fosco Building
R105, 1/F
35 Bis Phung Khac Khoan District 1
Ho Chi Minh City
VIETNAM
Tel: +84 4 8526404
Fax: +84 4 8526408

Engineering & Construction Inc
39-40 Friendship
East Bank
Demerara
GUYANA
Tel: +592 266 3173
Fax: +592 266 3176
WEB: www.eciguyana.com

Engineering & Construction Inc
108 Regent Road,
Bourda

Georgetown
GUYANA
Tel: +592 2253135
Fax: +592 2253267
WEB: www.eciguyana.com

Engineering & Construction Inc
39-40 Friendship
East Bank
Demerara
GUYANA
Tel: +592 2663173
Fax: +592 2663176
WEB: www.eciguyana.com

Expert Diesel SA
Zona Procesadora Panexport
Col Ojo de Agua
Panama Zona 15
PANAMA
Tel: +507 273 8860
Fax: +507 273 7807
EMAIL: expert@cwpanama.net
WEB: www.expertdieselpanama.net

Fred Rasmussen-Odense ApS
Ove Gjeddes Vej 23
PO Box 580
5220Odense SO
DENMARK
Tel: +45 65 560 560
Fax: +45 65 560 570
EMAIL: post@fred-rasmussen.dk
WEB: www.fred-rasmussen.dk

Geminiani Snc di Geminiani Domenico & C
Via De Brozzi 92/3
Lugo Di Ravenna
48022Ravenna
ITALY
Tel: +39 0545 23752
Fax: +39 0545 32291
EMAIL: geminiani@geminiani.com
WEB: www.geminiani.com

Ghaddar Machinery Est
P.O. Box 110
Sidon
Sidan
LEBANON
Tel: +961 7 220 000
Fax: +961 7 223 322

Grupo Palmero [GP]
Ruta Panamericana
Ramal Pilar km35
Buenos Aires
ARGENTINA
Tel: +54 11 5077 1400
Fax: +54 11 5077 1431
EMAIL: consultas@palmero.com
WEB: www.palmero.com

Hae-In Corporation
Hae-In Building
392-6 Yangjae-Dong
Seocho-Gu
Seoul 137-130
KOREA
Tel: +82 2 3498 4668
Fax: +82 2 3498 4659

Hekla hf
Klettradar 8-10
P.O. Box 5310
Reykjavik 125
ICELAND
Tel: +354 569 5500
Fax: +354 562 1285
EMAIL: kg@hekla.is
WEB: www.hekla.is

Henri Fraise
90 Lalana Ravoninahitrinizrivo
Antananarivo
101 - bp28
MADAGASCAR
Tel: +261 20 2222721
Fax: +261 20 2228420

Hited
30 Krasnaya Sosna
Sosna St
Moscow 129337
RUSSIAN FEDERATION
Tel: +7 495 789 3800
Fax: +7 495 789 3895
EMAIL: info@hited.ru
WEB: www.hited.ru

Hithed Ukraine Ltd
Office 315,2/6 Novozabarska St
4074
UKRAINE
Tel: +38 044 501 89 48, 501 91 17
Fax: +38 044 501 89 48
EMAIL: info@hited.com.ua
WEB: www.hited.com.ua/

Hunter NV
Smallandlaan 3b
2660 Hoboken
Antwerp
BELGIUM
Tel: +32 3 820 55 60
Fax: +32 3 828 49 23

Ilkerler Automotive Corp
Esenler Caddes No 12
34160 Bayrampasa
Istanbul
TURKEY
Tel: +90 212 6139200
Fax: +90 212 5763570
EMAIL: info@ilkerler.com
WEB: www.ilkerler.com

Industrias IVOR Ltda
Casa Inglesa
Carrere 126a No. 17-50
Apartado Aereo 3451
Bogota D C
COLOMBIA
Tel: +57 1 422 7700
Fax: +57 1 422 7696
WEB: www.indivor.com

Injelec
Quartier Ratoma
BP 1373 Guinea
GUINEA
Tel: +224 11228384
Fax: +224 423343
EMAIL: www.injelec-conakry@biasy.net

Iseki & Co Ltd
3 - 14 Nishi Nippori 5 Chome
Arakawa-Ku
Tokyo
JAPAN
Tel: +81 3 56047618
Fax: +81 3 56047702
WEB: www.iseki.co.jp

J A DELMAS - Saudequip
Km 5, rue Centenaire de la commune de Dakar
Dakar
SENEGAL
Tel: +221 832 06 83
Fax: +221 832 56 60
WEB: www.delmasexport.com

J A DELMAS - Togo Equipement
Zone Portuaire
Derriere Saga Togo
BP 13300
Lome
TOGO
Tel: +228 227 03 12
Fax: +228 227 03 11
EMAIL: info@togoequipements.com

Jumbo.mat BP 360
Cayenne Cedex 97328
French Guiana
97328
FRENCH GUIANA
Tel: +594 305800
Fax: +594 305030

Kemper en Van Twist Diesel BV
Keerweer 62,
3316 KA Dordrecht
PO Box 156, 3300
Ad Dordrecht
NETHERLANDS
Tel: +31 078 63 26 600
Fax: +31 078 61 36 746

Lei Shing Hong
989 Huqingpong Road,
Shanghai City 201105
CHINA
Tel: +86 21 64217688
EMAIL: jessie.song@ks.lsh.com
WEB: www.lsh-perkins.com

Levant Diesel
T/A Homsi Motors Company
Madaba Street
Suleiman Harb Building
Amman, Ras El Ein
JORDAN
Tel: +962 6 4757540
Fax: +962 6 475 7144
EMAIL: edhomsi@scs-net.org

Liberia Equipment Ltd.
Tweh Farm, Bushroad Island
United Nations Dr
Monrovia
LIBERIA
Tel: +231 6514 861

Mabo SNC di Boem Giorgio & C
Via Calnova 140
San Dona Di Piave
30027Venezia
ITALY
Tel: +39 0421 42314
Fax: +39 0421 220303
EMAIL: info@mabosnc.com
WEB: www.mabosnc.com

MACSA [Pvt] Limited
Sales Offices and Service Workshops
17F, Avissawella Road
Wellampitiya
Colombo 00900
SRI LANKA
Tel: +94 11 253 2583
Fax: +94 11 535 7101

Main Services Ltd
Gasan Centre
Mriehel By Pass
Mriehel BKR14
MALTA
Tel: +356 21 470030
Fax: +356 21 443507

Malte Manson AB
Box 133
59623Skanninge
SWEDEN
Tel: +46 142 299100
Fax: +46 142 41350
EMAIL: info@maltemanson.com
WEB: www.maltemanson.com

MANUTENTION AFRICAINE CÔTE D'IVOIRE
Route de Dabou Yopougon
01 BP 1299
Abidjan
COTE D'IVOIRE
Tel: +225 23 53 55 80
Fax: +225 23 46 63 68
WEB: www.manutafci.com

MANUTENTION AFRICAINE MALI
Quartier Niarella
Bamako
MALI
Tel: +223 212549
Fax: +223 214216

Manutention Africaine Niger
8, rue de rivoli
Niamey
NIGER
Tel: +227 73 36 10
Fax: +227 73 33 48
EMAIL: info@manutafniger.com
WEB: www.delmasexport.com

Marine Machine SL
Ricardo Ankorman 8
07006 Palma de Mallorca
Mallorca
Balearics
SPAIN
Tel: +34 971 462660
Fax: +34 971 463693
EMAIL: marinemachine@marine-machine.com
WEB: www.marine-machine.com

Marine Maintenance Ltd
5 The Square
Marina Bay
GIBRALTAR
Tel: +350 78954
Fax: +350 74754

Mauritrac
Llot 12-Las Palmas
Nouakchott
MAURITANIA
Tel: +222 525 95 01
EMAIL: info@mauritrac.com

Mecanique Plaisance
Marina de La Pointe du Bout,
97229 Trois Llets
Martinique
GUADELOUPE
Tel: +596 596 66 0540
Fax: +596 596 66 0408

Mercantil Antillana C por A
Ave Maximo Gomez 174
PO Box 791
Santo Domingo
DOMINICAN REPUBLIC
Tel: +1 809 5663141
Fax: +1 809 5663144

Michele Caroli Srl
SS 96 KM 116
70026Modugno [BA]
ITALY
Tel: +39 080 5367261
Fax: +39 080 5368316
EMAIL: info@michelecaroli.com
WEB: www.michelecaroli.com

Minelli AG
Mattenstrasse 3
8330 Pfaeffikon - ZH
8331Pfaeffikon/ZH
SWITZERLAND
Tel: +41 0 44 950 17 20
Fax: +41 0 44 995 10 44
EMAIL: motoren@minelli.ch
WEB: www.minelli.ch

Modipesa
Parque Industrial Las Monjas
Avenida de Las Estaciones 1
28850 Torrejon de Ardoz
Madrid
SPAIN
Tel: +34 91 676 6599
Fax: +34 91 677 1771
WEB: www.modipesa.com

Motolusa Motores de Portugal Lda
Estrada Da Circunvalacao
10 Portela Da Ajuda
2795-632 Carnaxide
Lisbon
PORTUGAL
Tel: +351 21 4241820
Fax: +351 21 4241829
WEB: www.motolusa.pt

Motomariner d.o.o
Rijeka
Milutina Baraca 19
51000Rijeka
CROATIA
Tel: +385 51 685 444
Fax: +385 51 685 433
EMAIL: motomariner@ri.htnet.hr
WEB: www.motomariner.hr

Motores Diesel Andinos SA
Avenida los Frutales 202
Ate Lima
PERU
Tel: +51 14 379642
Fax: +51 14 379199
WEB: www.modasa.com.pe

Multico Power Drive Pte Ltd
11 Tuas View Crescent
Multico Building
Singapore 637643
SINGAPORE
Tel: +65 6865 6584
Fax: +65 6863 6819
WEB: www.multicorporation.net

NEOOS (Algeria)
Zone Industrielle De Bouismail
Lotissement 168
Tipaza 42000
ALGERIA
Tel: +213 24 46 74 64
Fax: +213 24 46 74 65
EMAIL: sales@neoos.be

NorAm Power Systems
2810 SW 23rd St
Oklahoma City, Oklahoma 73108
U.S.A.
Tel: +1 405 685 4630
Fax: +1 405 685 4660
WEB: www.norampowersystems.com

Obaikan Equipment and Services [WLL]
P.O. Box 4844
Salwa Road
Doha
QATAR
Tel: +974 458 1001
Fax: +974 458 1122
EMAIL: okaikan@qatar.net.qa

Oman Mechanical Services Co Ltd
P.O. Box 1199
Ruwi 112
Muscat
OMAN
Tel: +968 24504648
Fax: +968 24592235

Otofin Power Cambodia Ltd
No 110 St 366
Sangkat
Toul Svay Prey 1
CAMBODIA
Tel: +855 23 219353
Fax: +855 23 219363

Otofin Sdn Bhd
No 11, Jalan Pemaju U1/15
Seksyen U1
Hicom-Glenmarie Ind Pk
Shah Alam Selangor 40150
MALAYSIA
Tel: +60 03 5569 1168
Fax: +60 03 5569 1200
EMAIL: otofin@otofin.com
WEB: www.otofin.com

Oy Ekstrom AB
P.O. Box 1
Veininlaaksontie 1
02621Espoo
FINLAND
Tel: +358 9 5919636
Fax: +358 9 5919570
WEB: www.ekstrom.fi

Palmero San Luis/Div of GP
Ruta 3 - km 2.8 [5700]
Parque Ind Teodoro Fels
San Luis
ARGENTINA
Tel: +54 265 2456569
Fax: +54 265 2456539

Parts and Power Ltd
Wickhams Cay II
P.O. Box 850
Road Town
Tortola
BRITISH VIRGIN ISLANDS
Tel: +1 284 494 2830
Fax: +284 4946972
WEB: www.partsandpower.com

Patricio Palmero/Div of GP
Rodriguez Penia 2332
General Gutierrez
Maipu 5511
Mendoza
ARGENTINA
Tel: +54 261 4932000
Fax: +54 261 4931700

Perkins France
ZI Paris Nord II - Parc des Reflets
165 Avenue du bois de la Pie
BP 43064 Roissy cdg cedex
95913Roissy Cdg Cedex
FRANCE
Tel: +33 149 907171
Fax: +33 149 907190
EMAIL: perkinsfrance@yahoo.fr
WEB: www.perkins-fr.com

Perkins Motoren GmbH & Co. KG
Saalackerstrasse 4
63801Kleinhostheim
GERMANY
Tel: +49 6027 5010
Fax: +49 6027 501 124
EMAIL: schuler_brigitte@perkins.com
WEB: www.perkins-de.com

Perkins Pacific
6100 South 6th Way
Ridgefield, Washington 98642
U.S.A.
Tel: +1 360 887 5900
Fax: +1 360 887 5901
WEB: www.perkinspacific.com

Perkins Power Corp.
55 Industrial Loop N.
Orange Park, Florida 32073
U.S.A.
Tel: +1 904 278 9919
Fax: +1 904 278 8088
EMAIL: sales@perkinspower.com
WEB: www.perkinspower.com

Perkins Power North East
600 S. Egg Harbor Rd
Hammonton, New Jersey 8307
U.S.A.
Tel: +1 800 234 7660
Fax: +1 609 567-1571
WEB: www.perkinspowerne.com

Perkins QM
4000 Trans-Canada Highway
Pointe-Claire, Quebec H9R 1B2
CANADA
Tel: +1 514 426 6747
Fax: +1 514 426 6741
WEB: www.perkinsqm.com

Perkins Quebec Maritimes
4000 Transcanada Highway
Pointe-Claire, Quebec H9R 1B2
CANADA
Tel: +1 514 426 6747
Fax: +1 514 426 6741
WEB: www.perkinsqm.com

Petros Petropoulos SA
96-102 Iera Odos
P.O. Box 41018
122 10Athens
GREECE
Tel: +30 210 349 9200
Fax: +30 210 3473 114
WEB: www.petropoulos.com

PIMA
27 Avenue de la Republique
1001
Tunis
TUNISIA
Tel: +216 71 35 26 44
Fax: +216 71 348 833
EMAIL: pima@arem-group.com
WEB: www.arem-group.com

Poly-Diesel Engines Et Usinages
B.P. 9037-98715
Papeete
Tahiti
FRENCH POLYNESIA

Power Great Lakes Inc
655 Wheat Lane
Wood Dale, Illinois 60191
U.S.A.
Tel: +1 630 350 9400
Fax: +1 630 350 9900
WEB: www.powergreatlakes.com

Power Tec International Pvt Ltd
P.O. Box 544
Kamaldi
Kathmandu
NEPAL
Tel: +977 1 424 5767 / 6989 / 7323
Fax: +977 1 422 3997

Powerdiesel Philippines Inc
104 G/F Pacific Place
Pearl Drive Corner
Amethyst Road Ortigas Center
Metro Manila, Pasig
PHILIPPINES
Tel: +63 2 635 2501-05
Fax: +63 2 634 8866
EMAIL: parts@powerdiesel.com.ph

Powermec
36-38 Birmingham Road
Southerton
PO Box 590
Harare
ZIMBABWE
Tel: +263 4 755 398/9
EMAIL: powermec@farmec.co.zw

Powerparts Private Limited
A - 8, Road No. 2
Street No. 2, N.H. - 8
Mahipalpur
New Delhi 110037
INDIA
Tel: +91 11 2678-4495/7315/4613
Fax: +91 11 26784495, 26786568
EMAIL: powers@bol.net.in

PT Traktor Nusantara
JL Pulogadung No 32
Kawasan Industri
Pulogadung
Jakarta 13930
INDONESIA
Tel: +62 21 4608 836
Fax: +62 21 4608 843
EMAIL: traknus@traknus.co.id
WEB: www.traknus.co.id

Qaswaa Al-Barrary [For parts and service in your area]
Baghdad
IRAQ
Tel: +964 7901920390
EMAIL: info@qaswaa-albararry.com
WEB: www.qaswaa-albararry.com

R & E Homsi [Aleppo]
P.O. Box 582
Aleppo
SYRIA
Tel: +963 21 21 21 638
Fax: +963 21 21 21 637
EMAIL: edhomsi@scs-net.org

R & E Homsi [Damascus]
P.O. Box 295
Damascus
SYRIA
Tel: +963 11 2219234
Fax: +963 11 2218117
EMAIL: royhomsi@scs-net.org
WEB: www.homsimotors.com

RICCA Srl
Zona Industriale IIa Fase
C. da Mugno ZI.
97100Ragusa
ITALY
Tel: +39 0932 667400
Fax: +39 0932 667294
EMAIL: ricambi@ricambionline.com
WEB: www.ricambionline.com

Ries Engineering Share Co
P.O. Box 1116
Debrezeit Road
Addis Ababa
ETHIOPIA
Tel: +251 114 421133
Fax: +251 114 420667
EMAIL: resco.indws@telecom.net.et

Ries Engineering Share Co
P.O. Box 1116
Debrezeit Road
Addis Ababa
ETHIOPIA
Tel: +251 11 421133
Fax: +251 11 420 667
EMAIL: resco.partsmarketing@telecom.net.et

Rimco Inc.
John F. Kennedy Avenue KM 3.7
Road 2
San Juan
Puerto Rico 0921
PUERTO RICO
Tel: +1 787 792 4300
Fax: +1 787 782 1044

S.C. Maviprod S.R.L.
Str. Pandurilor nr. 74
800223Reghin
ROMANIA
Tel: +40 265 513 353
Fax: +40 265 513 353
EMAIL: perkins@maviprod.ro
WEB: www.maviprod.ro

Saudequip
Km 5, rue Centenaire de la commune de Dakar
Dakar
SENEGAL
Tel: +221 832 06 83
Fax: +221 832 56 60

Scime
3 Rue Charles Darwin
BP 245 Zac 2000
97826
Le Port Cedex 800 076
REUNION
Tel: +262 42 44 02
Fax: +262 42 44 19
WEB: www.scime.com

SCOMAT Ltee
Grewals Lane
Pailles
MAURITIUS
Tel: +230 206 0444
Fax: +230 206 0446
EMAIL: scomat@scomat.com
WEB: www.scomat.com

Secodi Atlantique
15 Rue Marcel Sembat
44100Nantes
FRANCE
Tel: +33 2 40951313
Fax: +33 2 40436403
EMAIL: secodi@secodi.fr
WEB: www.secodi.fr

Secodi Atlantique
Rue de la Scierie
17000 La Rochelle
17000La Rochelle
FRANCE
Tel: +33 5 46 45 13 13
Fax: +33 5 46 41 83 26
EMAIL: secodilr@secodi.fr
WEB: www.secodi.fr

Secodi Avignon
Zi De La Courtine III
140, rue Pierre Paraf
84000Avignon
FRANCE
Tel: +33 4 90 14 43 21
Fax: +33 4 90 14 43 29
EMAIL: secodiav@secodi.fr

Secodi Beauvais
9 Rue Henri Becquerel
ZAC de Ther
60000Beauvais
FRANCE
Tel: +33 3 44 14 46 13
Fax: +33 3 44 02 94 94
EMAIL: secodibv@secodi.fr

Secodi Ile de France
13 Rue Gustave Eiffel
Z1 de la Mariniere
Bondoufle
91070Paris
FRANCE
Tel: +33 1 69116913
Fax: +33 1 60868687
EMAIL: secodiif@secodi.fr
WEB: www.secodi.fr

Secodi Rhone Alpes
4 Avenue des Freres Montgolfier
69680Chassieu
FRANCE
Tel: +33 4 72475113
Fax: +33 4 78900090
EMAIL: secodira@secodi.fr
WEB: www.secodi.fr

Secodi Strasbourg
6 rue Jean Monnet
67201Eckbolsheim
FRANCE
Tel: +33 3 8810 1013
Fax: +33 3 9020 2304
EMAIL: secodist@secodi.fr

Secodi Toulouse
5 Rue De Boudeville
31000Toulouse
FRANCE
Tel: +33 05 61 431313
Fax: +33 05 61 400404
EMAIL: secodito@secodi.fr
WEB: www.secodi.fr2

Sentry Intercontinental Mexico SA
Descartes No 51
Col Veronica Anzure
Mexico DF 11590
MEXICO
Tel: +52 5 254 0461
Fax: +52 5 254 08 25

Servipower
Plot 3 - Block D
Amuwo-Odofin
Apapa Oshodi
Lagos, Expressway Lagos
NIGERIA
Tel: +234 17 94 0373
Fax: +234 1 587 0152 - 52 32
EMAIL: spcoltd@multilinks.com

SHO Cameroun
Zone Industrielle De Bassa
BP 4017
Douala
CAMEROON
Tel: +237 337 9083
Fax: +237 337 31 87
WEB: www.sho-cameroun.cm

SHO CHAD
Boulevard de la Corniche
BP 450
N'djmena
Repulique Du Tchad
CHAD
Tel: +235 51 41 71
Fax: +235 51 90 55

SIA "Autex"
Rigas Street 105a
Kekava
Rigas rejons
LV 2123Riga
LATVIA
Tel: +371 770004
Fax: +371 770004
EMAIL: autex.perkins@neonet.lv
WEB: www.perkins.lv

Société Henri Fraise Fils & Cie
90 Lalana Ravoninahitrinizrivo
Antananarivo
101 - bp28
MADAGASCAR
Tel: +261 20 22 227 21
Fax: +261 20 22 29123
EMAIL: paul@fraise-cat.hff.mg

Sotreq (NOW MD POWER SEE DIST LOCATOR)
Rodovia Anhanguera, KM 111,5
13178-447 SUMARE-SP-BRASIL
CNPJ: 61.064.689/0001-02
BRAZIL
WEB: www.sotreq.com.br

Southwest Products Corp
5143 W. Roosevelt St.
Phoenix, Arizona 85043
U.S.A.
Tel: +1 602 269 3581
Fax: +1 602 269 8448
EMAIL: info@southwestproducts.com
WEB: www.southwestproducts.com

Suministros Industriales Delta C A
URB.Industrial Guayabel Av C.
Parcela 50 Guaremas Edo
Miranda
04717-004
VENEZUELA
Tel: +58 2 418324407
Fax: +582 418325791

Sunir Industrial & Agricultural Machinery Promotion Co.
2nd Floor
No33 Wet Nahid Street
Africa Avenue
Tehran 1967756873
IRAN
Tel: +98 21 22 03 7398 9
Fax: +98 21 22014375
EMAIL: sales@sunirco.com

Taiwan Multico Engineering Co. Ltd
No.36-2, Fenliau Road
Linkou Shiang
Taipei 224
TAIWAN
Tel: +886 2 2601 3891
Fax: +886 2 2601 3896
WEB: www.multicorporation.net

Taylor Power Systems
461 Highway 49 South
Richland, Mississippi 39218
U.S.A.
Tel: +1 601 932 5674
Fax: +1 601 932 4028
WEB: www.taylorpower.com

Tecun
3a Calle 3-60 Zona 9
Guatemala City 001009
GUATEMALA
Tel: +502 3346534
Fax: +502 3346502

Tehnoservis doo
Suha 23
4220Skofja Loka
SLOVENIA
Tel: +386 4 502 2100
Fax: +386 4 652 2140
EMAIL: info@tehnoservis.si
WEB: www.tehnoservis.si

The Kanoo Group
P.O. Box 290
Dubai
UAE
Tel: +971 4 347 9794
Fax: +971 4 347 9179
EMAIL: nigel@kanoosa.com
WEB: www.kanoo.com

The Trading & Industrial Equipment Co
P.O. Box 2159
13022 Safat
Kuwait City
KUWAIT
Tel: +965 4819188
Fax: +965 4810387
EMAIL: tieco@bin-nisf.com
WEB: www.bin-nisf.com/tieco

Tractafric Congo SPRL
Bld du 30 Juin - BP 8615
Kinshasa 1
CONGO (DEM. REPUBLIC)
Tel: +243 88 44 615
Fax: +243 12 33 608
WEB: www.sho-cameroun.cm

Tractafric Congo SPRL
Bld du 30 Juin
BP 8615
Kinshasa 1
CONGO (DEM. REPUBLIC)
Tel: +243 854 98 98
Fax: +243 123 36 08
WEB: www.cameroun.cm

Tractafric G.E.
Caracolas
Malabo
EQUATORIAL GUINEA
Tel: +240 09 65 99
Fax: +240 09 66 02
EMAIL: tractafric@intnet.gq

Tractafric S.H.O Cameroun
Zone Industrielle De Bassa
BP 4017
Douala
CAMEROON
Tel: +237 337 9083
Fax: +237 337 31 87
WEB: www.sho-cameroun.cm

Tractafric S.H.O. Gabon
Zone Industrielle Doloumi
BP 2147
Libreville
GABON
Tel: +241 76 01 40
Fax: +241 76 16 35

Tractafric SA (Maroc)
Route Desserte des Usines
Km 11.6
Autoroute Casa-Rabat
Casablanca, B.P. 2632-20250 Ain Sebaa
MOROCCO
Tel: +212 2275 4450 / (212) 2276 3000
Fax: +212 2275 4795 / (212) 754 455
WEB: www.tractafric.com

Tractafric SNC
5 Rue Bellini
92806Puteaux Cedex
FRANCE
Tel: +33 1 49 06 44 00
Fax: +33 1 47 78 49 76

Tractafric SNC [Head Office]
5 Rue Bellini
92806Puteaux Cedex
FRANCE
Tel: +33 1 49 06 44 00
Fax: +33 1 47 78 49 76

Tractomotriz SA
Contigua al Puente del Rio Torres
Casilla 10255-1000
La Uruca
San Jose
COSTA RICA
Tel: +506 232 9966
Fax: +506 232 8876
EMAIL: tracto@racsa.co.cr

Tractor & Equipment
6-8 Blackhall Road
PO Box 127
Freetown
SIERRA LEONE
Tel: +232 22 250 777
Fax: +232 22 250 852
WEB: www.tractorequip.com

Tradewinds Power Corp
5820 NW
84th Avenue
Miami, Florida 33166
U.S.A.
Tel: +1 305 592 9745
Fax: +1 305 592 7461
WEB: www.tradewindspower.com

TransDiesel
Orams Marine Village
Unit 10, 148-158 Beaumont St
Auckland City, Auckland
NEW ZEALAND
Tel: +64 9 379 0260
Fax: +64 9 303 1976
EMAIL: tdasp5@transdiesel.co.nz
WEB: www.transdiesel.com

TransDiesel Ltd (Christchurch)
533 Halswell Junction Road,
P.O. Box 16-35
Christchurch
NEW ZEALAND
Tel: +64 3 3498738
Fax: +64 3 3498384
EMAIL: markf@transdiesel.co.nz
WEB: www.transdiesel.com

Uboldi Luciano & C S.n.c.
Via Campo Sportivo, 15
Fino Mornasco
22073Como
ITALY

Tel: +39 031 927467
Fax: +39 031 920373
EMAIL: info@uboldi.com
WEB: www.uboldi.com

Universal Diesel AS
Industriveien 9
1473
Lorenskog
NORWAY
Tel: +47 67 912800
Fax: +47 67 912801
WEB: www.universal-diesel.no

V-TRAC Infrastructure Development Joint Stock Company
16th Floor, Hoa binh Tower,
No106 Hoang Quoc Viet Street
Cau Giay District
Hanoi
VIETNAM
Tel: +84 4 8526404
Fax: +84 4 8526408

Vallejo Araujo SA
P.O. Box 09-01-717
Avenida Carlos
Julio Arosemena, Kilometro 1.5
ECUADOR
Tel: +593 4 220 0333
Fax: +593 4 200 1651
EMAIL: maquinariasgye@vallejoaraujo.com
WEB: www.vallejoaraujo.com

Vallejo Araujo SA
Avenida 10 de Agosto No.3047
y Acuna P.O. Box 17-01-245
Quito
ECUADOR
Tel: +593 2 290 6450
Fax: +593 2 256 6450
EMAIL: maquinariasuio@vallejoaraujo.com
WEB: www.vallejoaraujo.com

Vegsund Slip AS [4000 Series Only]
Postboks 9072
Vegsund
6022Alesund
NORWAY
Tel: +47 70 190700
Fax: +47 70 190463

Velasalan EHF [Marine Only]
Ananust 1
101 Reykjavik
ICELAND
Tel: +354 5 805300
Fax: +354 5 805301
WEB: www.velasalan.is

WesTrac
No 868
West of North Interchange of
Shibalidian
Chao Yang District
Beijing 100023
CHINA
Tel: +86 010 6748 6061
Fax: +86 010 6748 8667
EMAIL: william.xing@westrac.com.cn

Yusuf Bin Ahmed Kanoo [Machinery Division]
P.O. Box 37
Al Khalidia
Damman 31411
SAUDI ARABIA
Tel: +966 3 857 1265
Fax: +966 3 857 4407

Yusuf Bin Ahmed Kanoo, Bahrain
P.O. Box 45
Manama
BAHRAIN
Tel: +973 735454
Fax: +973 738200

Zeppelin Oesterreich GmbH
Zeppelinstrasse 2
Postfach 127
A-2401Fischamend/Wien
AUSTRIA
Tel: +43 223276026-0
Fax: +43 223276026-399
EMAIL: marketing@zeppelin-perkins.at
WEB: www.zeppelin-perkins.at

T

TRANSFLUID S.P.A.

TRANSFLUID S.p.A.
Via Guido Rossa, 4
2101321013 GALLARATE (VA),
VARESE
ITALY
Tel: +39 0331 28421
Fax: +39 0331 2842911
EMAIL: info@transfluid.eu
WEB: www.transfluid.eu/en/

ACOTEC S.A.
Cesapedes 2869 (B1607CRM)
Villa Adelina
Buenos Aires
ARGENTINA
Tel: +54 11 47661500
Fax: +54 11 47668100
EMAIL: acotec@tecnogroup.com
WEB: www.tecnogroup.com
Territory: Argentina

AGP REPRESENACIONES S.A.S.
NIT 800.204.652-0
Cale 21 A # 70-40
Bogota 110931
COLOMBIA
Tel: +57 1 5706353
Fax: +57 1 5707335
EMAIL: agp@agp.com.co
WEB: www.agp.com.co
Territory: Colombia

ASC Antriebe Distribution & Service Gmbh
Westbahnstrasse 21
4470Enns
AUSTRIA
Tel: +43 7223 82660
Fax: +43 7223 826604
EMAIL: office@asc-antriebe.at
Territory: Austria

ATRAN TRANSMISSION (M) SDN BHD
No 24, Jalan Pju 1A/10
Taman Perindustria Jaya, Ara
Damansara
Petaling Jaya
Selangorg Darul Ehsan 47301
MALAYSIA
Tel: +60 3 78450668
Fax: +60 3 78461436
EMAIL: atranmalaysia@gmail.com
Territory: Malaysia

ATRAN TRANSMISSION PTE LTD
194 Pandan Loop
°01-15 Pantech Business Hub
Singapore 128383
SINGAPORE
Tel: +65 677 37175
Fax: +65 677 37372
EMAIL: jimmylai@atran.com.sg
Territory: Singapore

BEARING MAN GROUP PTY (Ltd)
Bearing Man Park
Droste Crescent
Droste Park, Ext. 7
Johannesburg
SOUTH AFRICA
Tel: +27 11 6201540
Fax: +27 11 6201680
EMAIL: brandonb@bmgworld.net
WEB: www.bmgworld.net
Territory: South Africa, Sub Saharan Countries

EVANPALA Inc.
Unit 6, #7, Corner of 7th St.
Asadabadi (Yousefabad) St.
Tehran 1433643115
IRAN
Tel: +98 21 88109157
Fax: +98 21 88109156
EMAIL: info@evanpala.com
WEB: www.evanpala.com
Territory: Iran

FAIR POWER TECHNOLOGIES CO. LTD.
5F-2, No. 19, Sec. 4
Nan-Jing E. Road
Taipei 10550
TAIWAN
Tel: +886 2 25140068
Fax: +886 2 27184174
EMAIL: thefair@ms31.hinet.net
Territory: Taiwan

ITACO
70 Mostafa El Nahas Street
Nasr City, Cairo
EGYPT
Tel: +20 22 2878089
Fax: +20 22 2737245
EMAIL: itacou@link.net
Territory: Egypt

JENS S. TRANSMISSIONER A/S
Brogrenen 5
DK - 2635Ishoj
DENMARK
Tel: +45 70 138333
Fax: +45 43 731911
EMAIL: info@jens-s.dk
WEB: www.jens-s.dk
Territory: Denmark, Sweden

KGK Norge AS
Strømsveien 177
0664Oslo
NORWAY
Tel: +47 22884680
Fax: +47 22720902
EMAIL: firmapost@kgk.no
WEB: www.kgk.no
Territory: Norway, Finland

KIWON
47, Gwahaksandan 1-ro
103 Beon-gil, Gangseo-Gu
Busan 46742
KOREA
Tel: +82 70 70002114
Fax: +82 51 9722663
EMAIL: moon@kiwon.kr
WEB: www.kiwon.kr
Territory: Korea

LEBON CO.
#83 No. 9, Brand Center Bldg.
Shahid Lavasani (Farmanien) Str.
Tehran 1954664598
IRAN
Tel: +98 21 26140496
Fax: +98 21 26130981
EMAIL: lebon@lebonco.com
WEB: www.lebonco.com
Territory: Iran

MARINE & INDUSTRIAL TRANS. LTD
Queenborough Shipyard
Queenborough Kent ME11 5EE
U.K.
Tel: +44 1795 580808

Fax: +44 1795 580900
EMAIL: info@mitgroup.co.uk
WEB: www.mitgroup.co.uk
Territory: England, Ireland

MOTION ASIA PACIFIC Pty Ltd
18 Worth street
Chullora NSW 2190
AUSTRALIA
Tel: +61 2 9947 9200
Fax: +61 2 9502 4013
EMAIL: customersupport@motionasiapac.com
WEB: www.motionasiapac.com
Territory: AUSTRALIA

NICO INTERNATIONAL U.A.E.
P.O. Box 12068
Dubai
UAE
Tel: +971 4 3382135
Fax: +971 4 3381832
EMAIL: aamir.inam@topaz-engineering.com
WEB: www.nicouae.com
Territory: United Arab Emirates, Saudi Arabia, Kuwait, Oman

OY JENS S. AB
PL 95
02271Espoo
FINLAND
Tel: +358 9 8676730
Fax: +358 9 8676731
EMAIL: par.nylund@jens-s.fi
WEB: www.jens-s.fi
Territory: Finland

PT. HIMALAYA EVEREST JAYA
Ji. Daan Mogot km. 10 No. 151
Pesing Podlar Kedaung Kah Angke
Barat Jakarta 11710
INDONESIA
Tel: +62 21 5448965
Fax: +62 21 6191925
EMAIL: import@hej.co.id
WEB: www.hej.co.id
Contact: Jl. Daan Mogot Km. 10 No. 151

REDVARIO LDA
Rua da Alegria 5
Loja
2735 469Cacem
PORTUGAL
Tel: +351 21 9132959
Fax: +351 21 9180757
EMAIL: redvario@clix.pt
WEB: redvario.comsapo.pt
Territory: Portugal

REMAS REDUKTOR VE MAKINA A..S.
Tepeoren Koyu
Tuzla, Istanbul 81700
TURKEY
Tel: +90 216 3041360
Fax: +90 216 3041369
EMAIL: remas@remas.com.tr
WEB: www.remas.com.tr
Territory: Turkey

SCEM Ltda.
Equipos Y Maquinarias Industriales
Santa Adela No. 9620
MAIPU
SANTIAGO
CHILE
Tel: +56 2 3691800
Fax: +56 2 3691806
EMAIL: importaciones@scem-chile.cl
WEB: www.scem-chile.cl
Territory: Chile

SENOMA LTD
Aleja Korfatego 191
PL40 153Katowice
POLAND
Tel: +48 32 7303030
Fax: +48 32 7303033
EMAIL: senoma@senoma.pl
WEB: www.senoma.pl
Territory: Poland

SYSTEM CORP. LTD.
10 Rajburana Soi 4
Rajburana
Bangkok 10140
THAILAND
Tel: +66 2 4682999
Fax: +66 2 4683338
EMAIL: admin@systemcorp.co.th
WEB: www.systemcorp.co.th
Territory: Thailand

TECNOTRANS BONFIGLIOLI S.A.
Pol. Ind - Zona Franca
Sector C - Calle F - No.6
08040Barcelona
SPAIN
Tel: +34 93 4478400
Fax: +34 93 3360402
EMAIL: tecnotrans.info@bonfiglioli.com
WEB: www.tecnotrans.bonfiglioli.com
Territory: Spain

TESPO ENGINEERING s.r.o.
Roubalova 7a
60200Brno
CZECH REPUBLIC
Tel: +420 543 3312967
Fax: +420 543 330287
EMAIL: info@tespo-eng.cz
WEB: www.tespo-eng.cz
Territory: Czech Republic

TRANSFLUID (BEIJING) TRADE CO.LTD
101 room. 1st floor. 9th Building
Maohua Industri
Caida 3rd Street, Nancai Town
Shunyi District
Beijing 101399
CHINA
Tel: +86 10 60442301
Fax: +86 10 60442305
EMAIL: info@transfluid.cn
WEB: www.transfluid.eu
Territory: China

TRANSFLUID FRANCE
202, Route de la Garrene
38110Rochetoirin
FRANCE
Tel: +33 975635310
Fax: +33 426007959
EMAIL: tffrance@transfluid.it
WEB: www.transfluid.eu
Territory: France, Belgium, Algeria, Marocco, Tunisia

TRANSFLUID LLC
150 Auburn Park Drive
Auburn, Georgia 30011
U.S.A.
Tel: +1 770 8221777
EMAIL: tfusa@transfluid.us
WEB: www.transfluid.us
Territory: USA, Canada, Messico

TRANSFLUID OOO
Krasny Proezd, 15
Ruza Disctrict
Ruza, Moscow Region 143100
RUSSIAN FEDERATION
Tel: +7 495 7782042
EMAIL: tfrussia@transfluid.eu
WEB: www.transfluid.eu
Territory: Russia, Bielorussia, Kazakistan, Ucraina

TRANSFLUID S.p.A.
Via Guido Rossa 4
21013Gallarate, VA
ITALY
Tel: +39 0331 28421
Fax: +39 0331 2842911
EMAIL: info@transfluid.eu
WEB: www.transfluid.eu
Territory: Italy

V

VIA INTERNATIONAL D.O.O.

VIA INTERNATIONAL d.o.o.
Perovo 30
1241Kamnik
SLOVENIA
Tel: +386 1 8395090
Fax: +386 1 8395091
EMAIL: info@viaint.si
WEB: www.viaint.si
Territory: Slovenia, Bosnia And Herzegovina, Croatia, Serbia

W

WOODWARD L'ORANGE GMBH

Woodward L'Orange GmbH
Porschestrasse 8
70435 Stuttgart
GERMANY
Tel: +49 711 82609-0
Fax: +49 711 82609-61
EMAIL: sales@lorange.com
WEB: www.lorange.com

L'Orange Fuel Injection Trading (Suzhou) Co., Ltd.
No. 116 Qingqiu Street, Suzhou Industrial Park
Jiangsu 215024
CHINA
Tel: +86 512 6285 0935
Fax: +86 512 6285 0931
EMAIL: marc-tran.heller@lorange.com
WEB: www.lorange.com
Contact: Marc-Tran Heller

Woodward L'Orange GmbH - Servicecenter Rellingen
Siemensstrasse 55b
25462Rellingen
GERMANY
Tel: +49 4101 302933
Fax: +49 4101 302959
EMAIL: service@lorange.com
WEB: www.lorange.com
Contact: Laris Borsum

DIRECTORY OF ADVERTISERS

Design Begins Here


Making it possible for
OEM's around the world.