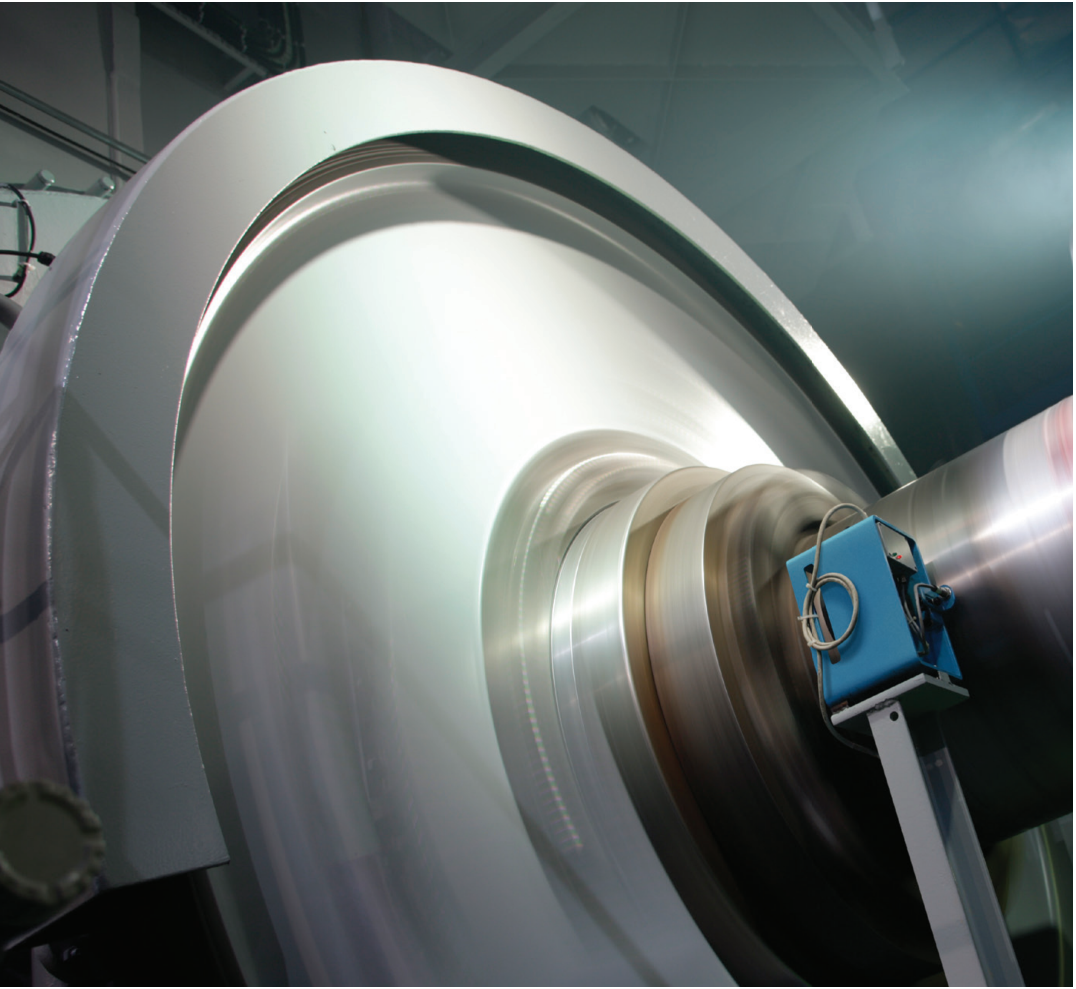
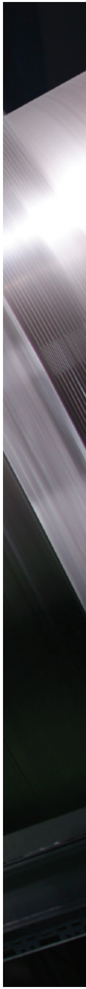
WIN GD
Winterthur Gas & Diesel

Low-speed Engines 2017

Simply a better different



Contents



WinGD at a Glance

Winterthur Gas & Diesel (WinGD) is a leading developer of low-speed Gas and Diesel engines used for propulsion power in merchant shipping.

These engines are utilized for the propulsion of all types of deep-sea ships world-wide, such as oil and product tankers, bulk carriers, car carriers, general cargo ships and container ships. The company continues the long tradition of the Sulzer Diesel Engine business founded in 1898.

WinGD's headquarters is located in Winterthur, Switzerland and has extensive state-of-the-art research and training facilities at its Diesel Technology Centre located in Oberwinterthur, Switzerland.

WinGD originated from the Diesel engine business of Sulzer Brothers in Winterthur, effective in 1898 when the Sulzer Brothers signed an agreement with Rudolf Diesel for his new engine technology.

Sulzer started Diesel engine manufacture in 1903 in Winterthur. In 1986 the last Diesel engine has left the Winterthur works.

Going forward to November 1990, Sulzer established its Diesel Engine & Diesel Power Plant Division as a separate company, New Sulzer Diesel Ltd.

In April 1997, New Sulzer Diesel Ltd merged with Wärtsilä Diesel Oy to create Wärtsilä NSD Corporation which later became Wärtsilä Corporation. The Swiss company, Wärtsilä Switzerland Ltd. was merged with CSSC in early 2015 and renamed Winterthur Gas & Diesel Ltd.

Since 2016 Winterthur Gas & Diesel Ltd. (WinGD) has been 100% owned by China State Shipbuilding Corporation (CSSC). The engine brand was hence changed from 'Wärtsilä' to 'WinGD'.

Powering merchant shipping since 1898

WinGD is strongly committed to Research & Development. The activities are focused on the development of leading technologies for application on a new generation of low-speed engines.

In addressing the future challenges of tightening emission regulations and requirements for alternative fuels, WinGD seeks to achieve the best possible economic and environmental performance for its customers.

WinGD focuses on products and solutions that are fuel-efficient, reliable and safe, self-diagnostic, cost-efficient to operate, and produce minimal environmental impact throughout their lifecycles.

WinGD is also the leader in low-pressure Dual-Fuel Technology. Gas is widely acknowledged as a fuel of the future. Low-pressure X-DF engines are strongly established as main engines for LNG carriers with increasing growth into all merchant sectors.

Our products are cost-efficient, reliable and produce minimal environmental impact

WinGD continuously strengthens the company's technology leadership, thereby improving its competitive edge in the global marine market.

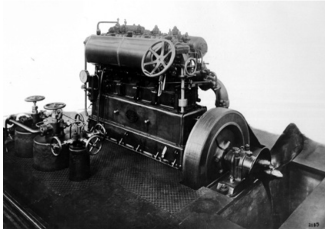
Our Engine Development History

1900's

In 1905 the first reversing 2-stroke marine engine was developed by Sulzer (shown right). It led the way to the first valveless 2-stroke engines at sea, two 559 kW Sulzer 4SNo.6a engines in the Italian cargo ship 'Romagna' in 1910.

In 1912 the first ocean-going ship with valveless crosshead type 2-stroke engines was the German cargo ship 'Monte Penedo', which was equipped with two Sulzer 4SNo.9a engines with a total of 1250 kW (shown below).

Developments rapidly followed thereafter with engines for rail traction, submarines, a 1000 mm-bore research engine, a broader range of engine types and sizes for ship propulsion, marine auxiliary duties and land-based power plants, increased power outputs, lowered fuel consumption, and improved reliability.



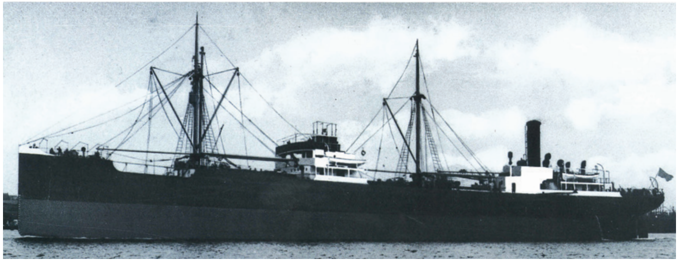
1920's

Sulzer was a famous name for Diesel engines in ships, power plants, and railways around the world.

1930's

Airless fuel injection became standard from 1930 in all engine types, greatly improving their efficiency and reducing their maintenance requirements.

The next step was the development of turbocharging, greatly improving the power concentration of the engines with less weight and less space requirements.



1940's

The first turbocharged 2-stroke Diesel engine in normal operation was a Sulzer 6TAD48 engine in 1946 in the power house of the Winterthur works.

1950's

Turbocharging became standard in marine low-speed engines for ship propulsion, which opened the chapter of the long series of Sulzer R-type low-speed engines – the RSAD, RD, RND, RND-M and RL types.

1970's

The first low-speed marine engine in the world running on gas entered service in 1972. The Sulzer 7RNMD90 engine was running on natural gas in the Norwegian 29,000m^3 LNG carrier Venator.

1980's

A radical change in scavenging from loop to uniflow was made in 1983 with the introduction of the RTA low-speed engines of 380 to 840 mm cylinder bore, increasing to 960 mm in 1994.

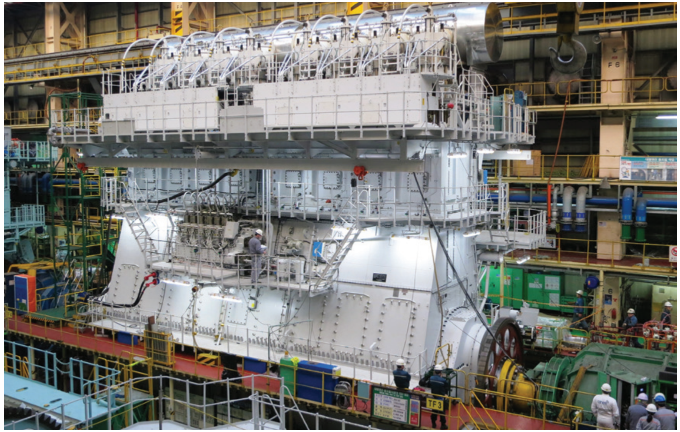
In 1981 tests with electronically-controlled fuel injection began on a four-cylinder research engine.

1990's

This led in 1998 to the world's first large, electronically-controlled low-speed engine with common-rail injection running in the Diesel Technology Centre in Oberwinterthur, Switzerland and the launch of the RT-flex common-rail system with the first RT-flex engine entering service in September 2001.

2000's

The world's largest Diesel engines are now the 14-cylinder RT-flex96C engines of 80,080 kW (108,920 bhp) of which the first entered service in September 2006 (shown below).



In February 2011 a project started to develop dual-fuel gas engine technology for low-speed engines as a solution for complying with the upcoming IMO Tier III NO_X emission limits without additional exhaust after-treatment. Only seven months later, on 19 September, the new technology was successfully demonstrated on a full-scale research engine at Wärtsilä's factory in Trieste, Italy.

In 2011 Generation X-Engines were introduced to the market, which are extremely efficient in terms of fuel consumption and emissions.

In 2012 the large bore engine X92 (shown above) was added to the Generation X engine portfolio. This engine will serve the market for large and ultra-large container vessels.

Aside from the significant fuel cost savings, the X92 engine directly reduces the emission levels of carbon dioxide, making it easier for the shipyard to achieve a better Energy Efficiency Design Index (EEDI).

In January 2015 Winterthur Gas & Diesel Ltd (WinGD) was established

Merchant Ship Applications

The global merchant marine industry is in the midst of a revolutionary transformation with increasing pressure through emission legislation, high operation costs, safety and ongoing volume overcapacity leading to ever-tighter profit margins.

WinGD has responded to the current situation by introducing the electronic-controlled common-rail engines such as RT-flex engines, Generation X engines and low-pressure dual-fuel X-DF engines to provide optimal, efficient and flexible propulsion solutions for the different ship segments.

The tables shown in the following pages provide an indicative engine selection for given ship types.

Final engine choice is dependent on ship specification, investment and operating cost evaluation and preferred engine configuration.

Tanker

Tanker type	WinGD Low-speed Engines					
	X35-B	X40-B	X52 RT-flex48T-D RT-flex50-D	X62-B RT-flex58T-D	X72-B	X82-B
Small Tanker	●	●				
Product Tanker			●			
Panamax Tanker				●		
Aframax Tanker				●	●	
Suezmax Tanker					●	
VLCC						●

Name: Leonidas
Vessel type: VLCC
Ship owner: Leonidas EPE, Greece
Ship yard: Hyundai Heavy Industry, South Korea
Managers: Andriaki Shipping Co., Ltd.
Delivery: 2009
Main engine: 7RT-flex82T

Container Vessel

Container vessel type	WinGD Low-speed Engines						
	X35-B	X40-B	X52 RT-flex48T-D RT-flex50-D	X62-B RT-flex58T-D	X72-B	X82-B	X92
< 700 TEU	●						
700 – 1100 TEU		●					
1100 – 1400 TEU			●				
1400 – 2500 TEU				●			
2500 – 4500 TEU					●		
4500 – 11000 TEU						●	
> 11000 TEU							●

Bulk Carrier

Bulk carrier type	WinGD Low-speed Engines					
	X35-B	X40-B	X52 RT-flex48T-D RT-flex50-D	X62-B RT-flex58T-D	X72-B	X82-B
Handysize Bulkers	●	●				
Handymax Bulkers			●			
Ultramax Bulkers			●			
Kamsarmax Bulkers				●		
Panamax Bulkers				●		
Capesize Bulkers					●	
VLOC						●

© Pacific International Lines (Pte) Ltd, Singapore

Name: KOTA SABAS
Vessel type: 3,800 TEU Container vessel
Ship owner: PSI (4) Pte Ltd, Singapore
Ship yard: Dalian Shipbuilding Industry Co., Ltd, China
Delivery: 2014
Main engine: 6X72

Name: Algoma Equinox
Vessel type: 39,400 dwt bulk carrier
Ship owner: Algoma Central Corp, Canada
Ship yard: Nantong Mingde Heavy Industries, China
Delivery: 2013
Main engine: 5RT-flex50

Multipurpose Vessel

Vessel type	WinGD Low-speed Engines			
	X35-B	X40-B	X52 RT-flex48T-D RT-flex50-D	X62-B RT-flex58T-D
Small	●	●		
< 30,000 dwt			●	
> 30,000 dwt				●

Gas Carriers

LNG Carrier type	WinGD Low-speed Engines		
	X52DF RT-flex50DF	X62DF	X72DF
10,000 – 30,000 m^3	●		
> 30,000 m^3		●	
> 60,000 m^3			●
170,000 – 250,000 m^3		● twin-screw	● twin-screw

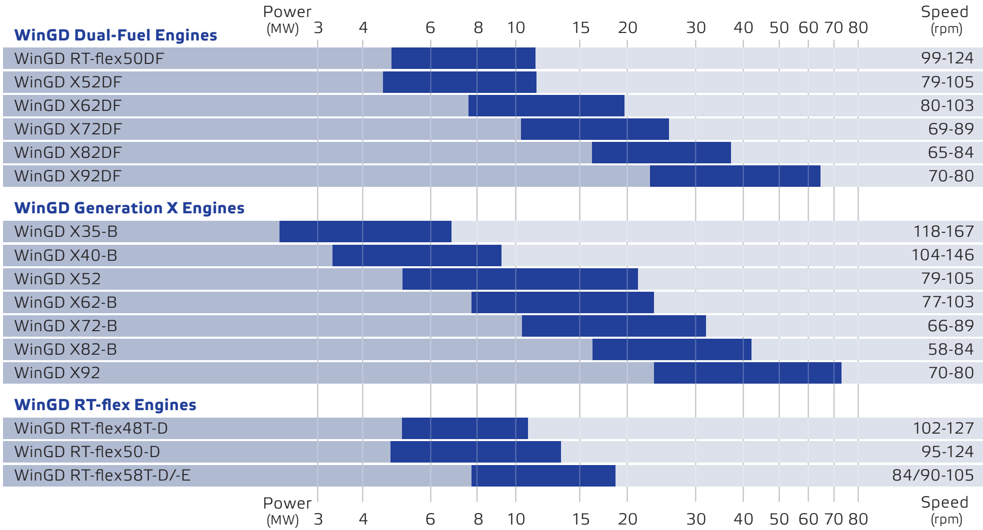
LPG Carrier type	WinGD Low-speed Engines				
	X35-B	X40-B	X52 RT-flex48T-D RT-flex50-D	X62-B	X72-B
10,000 – 30,000 m^3	●	●	●		
> 30,000 m^3				●	
> 60,000 m^3					●

Name: Shansi
Vessel type: 25,486 GT Multipurpose
Ship owner: China Navigation Company Pte Ltd (CNCo), Singapore
Ship yard: Zhejiang Ouhua Shipyard, China
Delivery: 2013
Main engine: 6RT-flex50

Name: Vessel under construction
Vessel type: 180,000 CBM LNG Carrier
Ship owner: SK Shipping Co., Ltd, South Korea
Ship yard: Hyundai Heavy Industries Co., Ltd., South Korea
Delivery: 2019
Main engine: Twin 5X72DF

WinGD Low-speed Engines

Power range for WinGD Low-speed Engines



WinGD low-speed engines are the optimal propulsion solution for merchant vessels with directly driven propellers. WinGD's well proven electronically-controlled common-rail technology plays a key role in enabling shipowners to reduce fuel and lubricants costs. The benefits to shipowners and operators may be summarised as:

- The optimal power and speed for every operational need
- Competitive capital cost
- Lowest possible fuel consumption over the whole operating range, especially in part-load
- Operate on high density fuel ISO F 8217:2012/RMK700
- Special tunings to suit particular sailing profiles
- Low cylinder oil feed rate
- Full compliance with NO_X emission control regulations
- Low steady operational speeds
- Up to five years between overhauls
- Smokeless operation at manoeuvring and sailing conditions
- Reduced maintenance requirements, resulting in low operational costs, higher reliability and durability

The following WinGD engines are available on request:

- RT-flex50-B 4 850–13 280 kW/95–124 rpm
- RT-flex68-D 10 950–25 040 kW/76–95 rpm
- RT-flex82-C 21 720–54 240 kW/87–102 rpm
- X62 7 950-21 280 kW/77-103 rpm
- X72 10 600-28 880 kW/66-89 rpm
- X82 18 600-42 750 kW/65-84 rpm

Generation X Engines

WinGD X35-B

IMO Tier II/Tier III (SCR)

Cylinder bore	350 mm
Piston stroke	1550 mm
Speed	118–167 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.43

Rated power, principal dimensions and weights

Cyl.	Output in kW at 167 rpm		Output in kW at 118 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
5	4 350	3 475	3 075	2 450	4 398	74
6	5 220	4 170	3 690	2 940	5 010	84
7	6 090	4 865	4 305	3 430	5 622	95
8	6 960	5 560	4 920	3 920	6 234	105

Dimensions (mm)				
	B	C	D	E
	2 284	830	5 556	1 605
	F1	F2	F3	G
	6 850	6 900	6 450	1 326

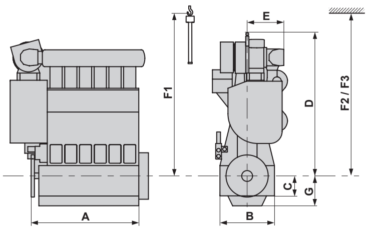
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	16.8	21.0	16.8
BSFC	Standard Tuning	174.8	168.8	174.8	168.8

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	171.2	170.8	170.5	169.3	166.0

For definitions see page 36.



WinGD X40-B

IMO Tier II/Tier III (SCR)

Cylinder bore	400 mm
Piston stroke	1770 mm
Speed	104–146 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.43

Rated power, principal dimensions and weights

Cyl.	Output in kW at 146 rpm		Output in kW at 104 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
5	5 675	4 550	4 050	3 250	4 390	109
6	6 810	5 460	4 860	3 900	5 090	125
7	7 945	6 370	5 670	4 550	5 790	140
8	9 080	7 280	6 480	5 200	6 490	153

Dimensions (mm)				
	B	C	D	E
	2 610	950	6 344	1 647
	F1	F2	F3	G
	7 750	7 860	7 400	1 411

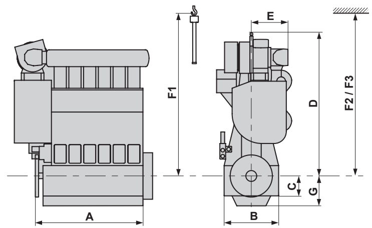
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	16.8	21.0	16.8
BSFC	Standard Tuning	173.8	167.8	173.8	167.8

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	170.2	169.8	169.5	168.3	165.0

For definitions see page 36.



WinGD X52

IMO Tier II/Tier III (SCR)

Cylinder bore	520 mm
Piston stroke	2315 mm
Speed	79-105 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.45

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Length A* mm	Weight tonnes
	105 rpm		79 rpm				
	R1	R2	R3	R4			
5	9 050	6 800	6 800	5 100	5 891	6 990	217
6	10 860	8 160	8 160	6 120	6 831	7 930	251
7	12 670	9 520	9 520	7 140	7 771		288
8	14 480	10 880	10 880	8 160	8 711		323

Dimensions (mm)	B	C	D	E	E*
	3 630	1 205	8 550	3 555	1 500
	F1	F2	F3	G	
	10 350	10 350	9 800	1 910	

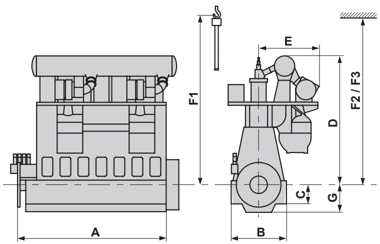
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	15.8	21.0	15.8
BSFC	Standard Tuning	166.8	159.8	166.8	159.8

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	163.2	162.8	162.5	161.3	158.0

For definitions see page 36.



WinGD X62-B

IMO Tier II/Tier III (SCR)

Cylinder bore	620 mm
Piston stroke	2658 mm
Speed	77–103 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.29

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	103 rpm		77 rpm			
	R1	R2	R3	R4		
5	14 500	10 650	10 800	7 950	7 000	325
6	17 400	12 780	12 960	9 540	8 110	377
7	20 300	14 910	15 120	11 130	9 215	435
8	23 200	17 040	17 280	12 720	10 320	482

Dimensions (mm)	B	C	D	E
	4 200	1 360	9 580	3 915
	F1	F2	F3	G
	11 775	11 775	10 950	2 110

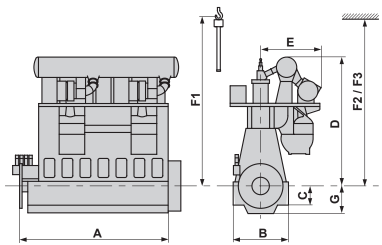
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	15.4	21.0	15.4
BSFC	Standard Tuning	166.8	159.3	166.8	159.3

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	163.2	162.8	162.5	161.3	157.3

For definitions see page 36.



WinGD X72-B

IMO Tier II/Tier III (SCR)

Cylinder bore	720 mm
Piston stroke	3086 mm
Speed	66–89 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.29

Rated power, principal dimensions and weights

Cyl.	Output in kW at 89 rpm		Output in kW at 66 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
5	19 600	14 300	14 550	10 600	8 085	481
6	23 520	17 160	17 460	12 720	9 375	561
7	27 440	20 020	20 370	14 840	10 665	642
8	31 360	22 880	23 280	16 960	11 960	716

Dimensions (mm)	B	C	D	E
	4 780	1 575	10 790	4 710
	F1	F2	F3	G
	13 655	13 655	12 730	2 455

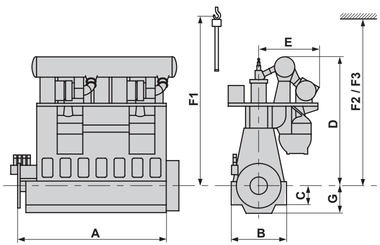
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	15.4	21.0	15.4
BSFC	Standard Tuning	166.8	159.3	166.8	159.3

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	163.2	162.8	162.5	161.3	157.3

For definitions see page 36.



WinGD X82-B

IMO Tier II/Tier III (SCR)

Cylinder bore	820 mm
Piston stroke	3375 mm
Speed	58–84 rpm
Mean effective pressure at R1/R1+	21.0/19.0 bar
Stroke / bore	4.12

Rated power, principal dimensions and weights

Cyl.	Output in kW at 76 / 84 rpm		Output in kW at 58 rpm		Length A mm	Weight tonnes
	R1 / R1+	R2 / R2+	R3	R4		
6	28 500	21 720	21 750	16 590	11 045	805
7	33 250	25 340	25 375	19 355	12 550	910
8	38 000	28 960	29 000	22 120	14 055	1 020
9	42 750	32 580	32 625	24 885	16 500	1 160

Dimensions (mm)	B	C	D	E
	5 320	1 800	12 250	5 400
	F1	F2	F3	G
	14 820	14 800	13 800	2 700

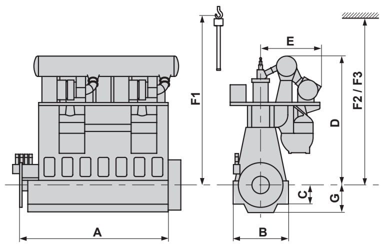
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1/R1+	R2/R2+	R3	R4
BMEP, bar		21.0/19.0	16.0/14.5	21.0	16.0
BSFC	Standard Tuning	164.8/162.8	157.8	164.8	157.8

Part load, % of R1/R1+	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	161.2/159.2	160.8/158.8	160.5/158.5	159.3/157.3	156.0/154.3

For definitions see page 36.



RT-flex Engines

WinGD X92

IMO Tier II/Tier III (SCR)

Cylinder bore	920 mm
Piston stroke	3468 mm
Speed	70–80 rpm
Mean effective pressure at R1	21.0
Stroke / bore	3.77

Rated power, principal dimensions and weights

Cyl.	Output in kW at 80 rpm		Output in kW at 70 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
6	38 700	27 900	33 900	24 420	11 630	1 120
7	45 150	32 550	39 550	28 490	13 210	1 260
8	51 600	37 200	45 200	32 560	14 750	1 380
9	58 050	41 850	50 850	36 630	17 850	1 630
10	64 500	46 500	56 500	40 700	19 520	1 790
11	70 950	51 150	62 150	44 770	21 280	1 960
12	77 400	55 800	67 800	48 840	22 870	2 140

Dimensions (mm)				
	B	C	D	E
	5 550	1 900	12 950	6 050
	F1	F2	F3	G
	15 420	15 450	14 240	2 970

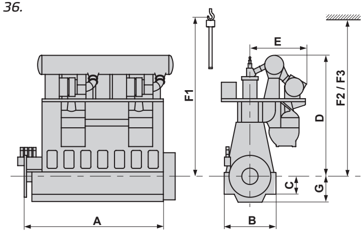
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	15.1	21.0	15.1
BSFC	Standard Tuning	165.8	158.8	165.8	158.8

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	162.2	161.8	161.5	160.3	155.6

For definitions see page 36.



WinGD RT-flex48T-D

IMO Tier II/Tier III (SCR)

Cylinder bore	480 mm
Piston stroke	2000 mm
Speed	102–127 rpm
Mean effective pressure at R1	19.0 bar
Stroke / bore	4.17

Rated power, principal dimensions and weights

Cyl.	Output in kW at 127 rpm		Output in kW at 102 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
5	7 275	5 100	5 825	5 100	5 314	171
6	8 730	6 120	6 990	6 120	6 148	205
7	10 185	7 140	8 155	7 140	6 982	225
8	11 640	8 160	9 320	8 160	7 816	250

Dimensions (mm)				
	B	C	D	E
	3 170	1 085	7 334	3 253
	F1	F2	F3	G
	9 030	9 030	8 790	1 700

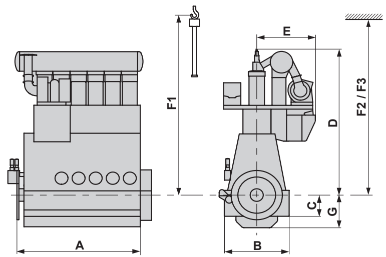
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		19.0	13.3	19.0	16.6
BSFC	Standard Tuning	169.8	163.8	169.8	165.8

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	166.2	164.5	165.5	163.0	159.9

For definitions see page 36.



WinGD RT-flex50-D

IMO Tier II/Tier III (SCR)

Cylinder bore	500 mm
Piston stroke	2050 mm
Speed	95–124 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.10

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Length A* mm	Weight tonnes
	124 rpm		95 rpm				
	R1	R2	R3	R4			
5	8 725	6 650	6 700	5 100	5 576	6 793	200
6	10 470	7 980	8 040	6 120	6 456	7 670	225
7	12 215	9 310	9 380	7 140	7 336		255
8	13 960	10 640	10 720	8 160	8 216		280

Dimensions (mm)					
	B	C	D	E	E*
	3 150	1 088	7 646	3 570	1 900
	F1	F2	F3	G	
	9 270	9 270	8 800	1 636	

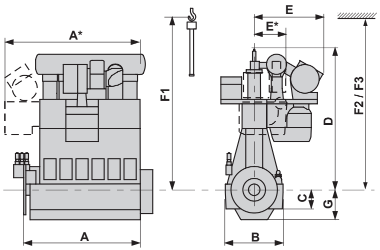
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	16.0	21.0	16.0
BSFC	Standard Tuning	168.8	162.8	168.8	162.8

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	165.2	163.5	164.5	162.0	158.9

For definitions see page 36.



WinGD RT-flex58T-E

IMO Tier II/Tier III (SCR)

Cylinder bore	580 mm
Piston stroke	2416 mm
Speed	90–105 rpm
Mean effective pressure at R1	21 bar
Stroke / bore	4.17

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	105 rpm		90 rpm			
	R1	R2	R3	R4		
5	11 750	7 900	10 075	7 900	6 381	281
6	14 100	9 480	12 090	9 480	7 387	322
7	16 450	11 060	14 105	11 060	8 393	377
8	18 800	12 640	16 120	12 640	9 399	418

Dimensions (mm)				
	B	C	D	E
	3 820	1 300	8 822	3 475
	F1	F2	F3	G
	10 960	11 000	10 400	2 000

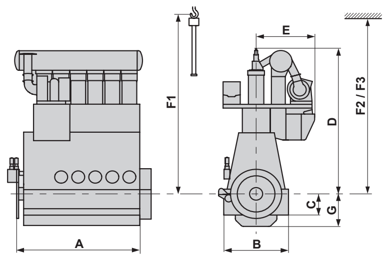
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	14.1	21.0	16.5
BSFC	Standard Tuning	167.8	161.8	167.8	161.8

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	164.2	162.5	163.5	161.0	157.9

For definitions see page 36.



X-DF Engines

WinGD RT-flex58T-D

IMO Tier II/Tier III (SCR)

Cylinder bore	580 mm
Piston stroke	2416 mm
Speed	84–105 rpm
Mean effective pressure at R1	20.2 bar
Stroke / bore	4.17

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	105 rpm		84 rpm			
	R1	R2	R3	R4		
5	11 300	7 900	9 050	7 900	6 381	281
6	13 560	9 480	10 860	9 480	7 387	322
7	15 820	11 060	12 670	11 060	8 393	377
8	18 080	12 640	14 480	12 640	9 399	418

Dimensions (mm)				
	B	C	D	E
	3 820	1 300	8 822	3 475
	F1	F2	F3	G
	10 960	11 000	10 400	2 000

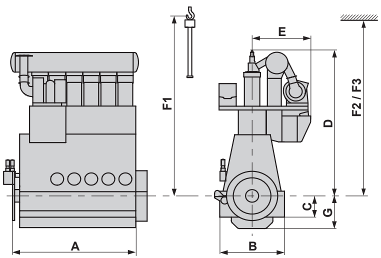
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		20.2	14.1	20.2	17.7
BSFC	Standard Tuning	168.8	162.8	168.8	164.8

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	165.2	163.5	164.5	162.0	158.9

For definitions see page 36.



WinGD RT-flex50DF

IMO Tier III in gas mode

Cylinder bore	500 mm
Piston stroke	2050 mm
Speed	99–124rpm
Mean effective pressure at R1	17.3 bar
Stroke/bore	4.10

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Length A* mm	Weight tonnes
	124 rpm	124 rpm	99 rpm	99 rpm			
	R1	R2	R3	R4			
5	7 200	6 000	5 750	4 775	5 576	6 793	200
6	8 640	7 200	6 900	5 730	6 456	7 670	225
7	10 080	8 400	8 050	6 685	7 336		255
8	11 520	9 600	9 200	7 640	8 216		280

Dimensions (mm)					
	B	C	D	E	E*
	3 150	1 088	7 646	3 570	1 900
	F1	F2	F3	G	
	9 270	9 270	8 800	1 636	

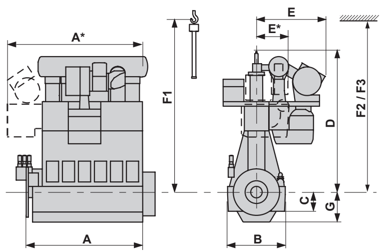
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 200	7 158	7 200	7 158
BSGC (gas)	g/kWh	142.7	141.6	142.7	141.6
BSPC (pilot fuel)	g/kWh	1.5	1.8	1.5	1.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.1	182.1	182.1	182.1

For definitions see page 36.



WinGD X52DF

IMO Tier III in gas mode

Cylinder bore	520 mm
Piston stroke	2315 mm
Speed	79–105 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.45

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Length A* mm	Weight tonnes
	105 rpm		79 rpm				
	R1	R2	R3	R4			
5	7 450	6 200	5 600	4 650	5 891	6 990	217
6	8 940	7 440	6 720	5 580	6 831	7 930	251
7	10 430	8 680	7 840	6 510	7 771		288
8	11 920	9 920	8 960	7 440	8 711		323

Dimensions (mm)	B	C	D	E	E*
	3 630	1 205	8 550	3 555	1 500
	F1	F2	F3	G	
	10 350	10 350	9 800	1 910	

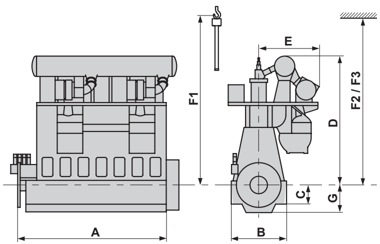
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 200	7 158	7 200	7 158
BSGC (gas)	g/kWh	142.7	141.6	142.7	141.6
BSPC (pilot fuel)	g/kWh	1.5	1.8	1.5	1.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.1	182.1	182.1	182.1

For definitions see page 36.



WinGD X62DF

IMO Tier III in gas mode

Cylinder bore	620 mm
Piston stroke	2658 mm
Speed	80–103 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.29

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	103 rpm		80 rpm			
	R1	R2	R3	R4		
5	11 925	9 925	9 250	7 700	7 000	325
6	14 310	11 910	11 100	9 240	8 110	377
7	16 695	13 895	12 950	10 780	9 215	435
8	19 080	15 880	14 800	12 320	10 320	482

Dimensions (mm)	B	C	D	E
	4 200	1 360	9 580	3 915
	F1	F2	F3	G
	11 775	11 775	10 950	2 110

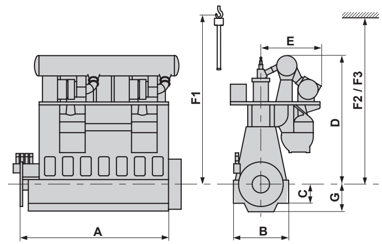
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 166	7 089	7 166	7 089
BSGC (gas)	g/kWh	142.5	140.8	142.5	140.8
BSPC (pilot fuel)	g/kWh	1.0	1.2	1.0	1.2

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	180.0	180.0	180.0	180.0

For definitions see page 36.



WinGD X72DF

IMO Tier III in gas mode

Cylinder bore	720 mm
Piston stroke	3086 mm
Speed	69-89 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.29

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	89 rpm		69 rpm			
	R1	R2	R3	R4		
5	16 125	13 425	12 500	10 400	8 085	481
6	19 350	16 110	15 000	12 480	9 375	561
7	22 575	18 795	17 500	14 560	10 665	642
8	25 800	21 480	20 000	16 640	11 960	716

Dimensions (mm)	B	C	D	E
	4 780	1 575	10 790	4 710
	F1	F2	F3	G
	13 655	13 655	12 730	2 455

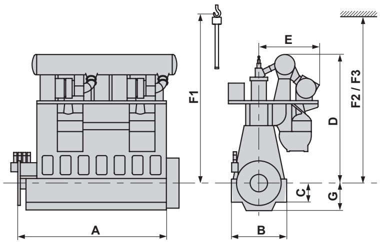
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 149	7 059	7 149	7 059
BSGC (gas)	g/kWh	142.3	140.3	142.3	140.3
BSPC (pilot fuel)	g/kWh	0.8	1.0	0.8	1.0

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	180.0	180.0	180.0	180.0

For definitions see page 36.



WinGD X82DF

IMO Tier III in gas mode

Cylinder bore	820 mm
Piston stroke	3375 mm
Speed	65-84 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.12

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	84 rpm		65 rpm			
	R1	R2	R3	R4		
6	25 920	21 600	20 070	16 710	11 045	805
7	30 240	25 200	23 415	19 495	12 550	910
8	34 560	28 800	26 760	22 280	14 055	1 020
9	38 880	32 400	30 105	25 065	16 500	1 160

Dimensions (mm)	B	C	D	E
	5 320	1 800	12 250	5 400
	F1	F2	F3	G
	15 020	15 000	14 000	2 700

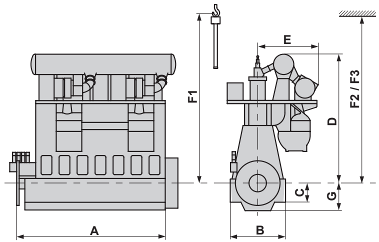
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 115	7 025	7 115	7 025
BSGC (gas)	g/kWh	141.8	139.9	141.8	139.9
BSPC (pilot fuel)	g/kWh	0.6	0.7	0.6	0.7

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	178.9	178.9	178.9	178.9

For definitions see page 36.



WinGD X92DF

IMO Tier III in gas mode

Cylinder bore	920 mm
Piston stroke	3468 mm
Speed	70-80 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	3.77

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	80 rpm		70 rpm			
	R1	R2	R3	R4		
6	31 920	26 580	27 930	23 250	11 630	1 120
7	37 240	31 010	32 585	27 125	13 210	1 260
8	42 560	35 440	37 240	31 000	16 350	1 460
9	47 880	39 870	41 895	34 875	17 850	1 630
10	53 200	44 300	46 550	38 750	19 520	1 790
11	58 520	48 730	51 205	42 625	21 280	1 960
12	63 840	53 160	55 860	46 500	22 870	2 140

Dimensions (mm)	B	C	D	E
	5 550	1 900	12 950	6 050
	F1	F2	F3	G
	15 620	15 650	14 440	2 970

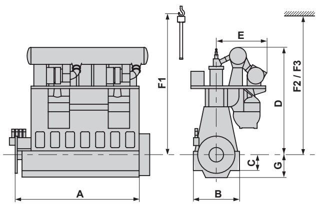
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 089	7 000	7 089	7 000
BSGC (gas)	g/kWh	141.4	139.5	141.4	139.5
BSPC (pilot fuel)	g/kWh	0.5	0.6	0.5	0.6

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	178.9	178.9	178.9	178.9

For definitions see page 36.



Engine Designation

W8X82-B

- Diesel engine version
- Bore size (cm)
- Engine series (i.e. X engines, RT-flex engines)
- Number of cylinders
- Winterthur Gas & Diesel (WinGD)

W8X82DF

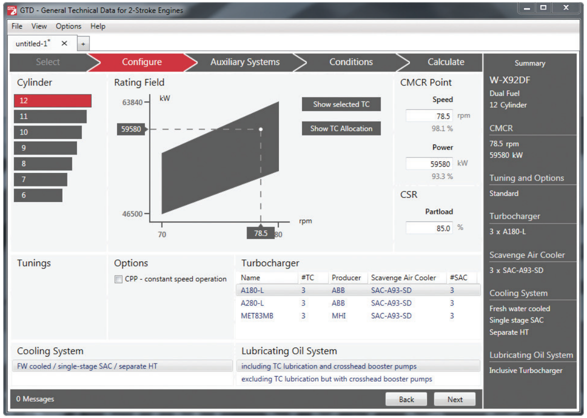
- Low-pressure dual-fuel engine

General Technical Data Application

WinGD's General Technical Data (GTD) application provides information to plan the layout of WinGD marine low-speed engines.

Create new projects in three simple steps:

1. Select an engine from our product portfolio
2. Define a configuration which meets your vessel requirements
3. Analyze the resulting performance data and export them as PDF



Start your next engine project by downloading GTD:
www.wingd.com/en/media/general-technical-data

GTD

Scan this QR-code to send above link by email

The program is a desktop application and supported by all Windows operating systems from version 7.

Engine Documentation

WinGD introduces Shipdex compliant engine documentation, i.e. Operation Manual, Maintenance Manual and Spare Part Catalogue will be made available – in addition to the PDF/paper format – in an electronic format which could be directly loaded by the Ship Management Software on board the vessel.

Shipdex is a marine business related adaptation of the S1000D standard (www.S1000D.org), a collection of international business rules, and is developed to standardise and improve the production, the exchange and the use of technical information between equipment makers, shipyards and ship owners. It allows to exchange the information via XML based data modules.

The electronic data format approach allows automatic updating of the data base by receiving Shipdex compliant Service Bulletins.

The first engine documentation set will be available for the X52 engine by end of April 2017.

WinGD joined the Shipdex Maintenance Group, in order to support and help further developing this industry documentation standard.

Shipdex

More information about Shipdex:
www.shipdex.com

Engine Definitions and Notes

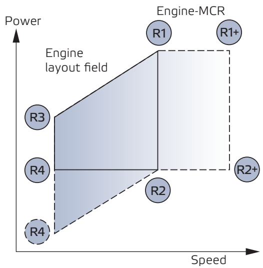
ISO Standard (ISO 3046-1) reference conditions

1.0 bar	Total barometric pressure at R1
25ºC	Suction air temperature
30%	Relative humidity
25ºC	Cooling water temperature before engine

Rating points

The engine layout fields for WinGD low-speed engines are defined by the power/speed rating points R1, R2, R3 and R4 (see diagram below). In certain engines, the layout field is extended to the points R1+ and R2+.

R1, or R1+ instead if applicable, is the nominal maximum continuous rating (MCR).



Any power and speed within the respective engine layout field may be selected as the Contract-MCR (CMCR) point for an engine.

Dimensions and weights

- All dimensions are in millimetres and are not binding

A Engine length up to coupling flange
B Width of engine
C Crankshaft to underside of foot flange
D Height of engine above crankshaft
E Distance from engine centreline to T/C flange
F1 Min. height for vertical removal
F2 Min. height for vertical removal with double-jib crane
F3 Min. height for tilted removal with double-jib crane
G Distance from crankshaft axis to the bottom of the oil pan

- The engine weight is net in metric tonnes (t), without oil and water, and is not binding

Fuel/energy consumption

All brake specific fuel consumptions (BSFC) and brake specific pilot fuel consumptions (BSPC) are quoted for fuel of lower calorific value 42.7 MJ/kg.

Brake specific gas consumptions (BSGC) are quoted for gas of lower calorific value 50.0 MJ/kg.

Brake specific energy consumptions (BSEC) for dual-fuel engines are based on energy delivered to the engine as gas and pilot fuel for one kilowatt hour mechanical power output.

For all WinGD low-speed diesel and dual-fuel engines stepwise tolerances have been introduced for the brake specific fuel and energy consumption (BSFC/BSEC) guarantee, referring to ISO standard reference conditions (ISO 15550 and 3046):

- +5% tolerance for 100% to 85% engine load
- +6% tolerance for 84% to 65% engine load
- +7% tolerance for 64% to 50% engine load

The BSFC/BSEC guarantee is possible at up to three load points between 50–100%.

Available engine tunings

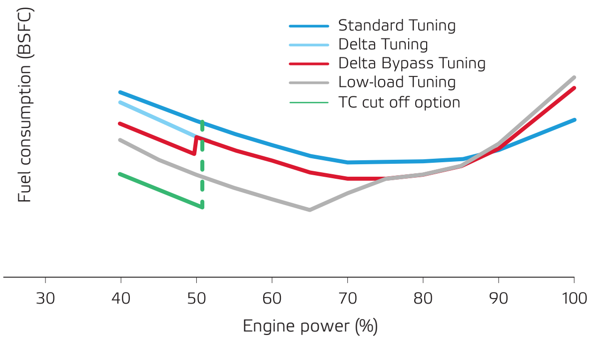
Standard Tuning, Delta Tuning, Delta Bypass Tuning and Low-Load Tuning are available for all WinGD low-speed diesel engines to provide optimum fuel consumption for different engine loads. Delta Tuning and Low-Load tuning focus on reducing fuel consumption in the operating range below 90% or 75% engine load.

Delta Bypass Tuning provides increased steam production between 50 and 100% engine power. By adding the advanced technology of Steam Production Control (SPC) the required steam amount can be produced with optimum fuel consumption.

Dual tuning is available on request and in cooperation with Classification Societies.

WinGD X82-B and X92 engines with multi-turbocharger configuration can be equipped with a Turbocharger (TC) cut off tuning that significantly reduces the engine's fuel consumption at low loads.

The TC cut off tuning is designed for slow steaming operation and the application is customised on demand.



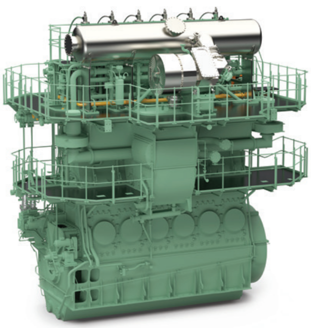
Low-pressure X-DF Technology

The technology

Low-pressure X-DF technology is based on the lean-burn principle (Otto cycle), in which fuel and air are premixed and burned at a relatively high air-to-fuel ratio – a concept already used widely on medium-speed engines.

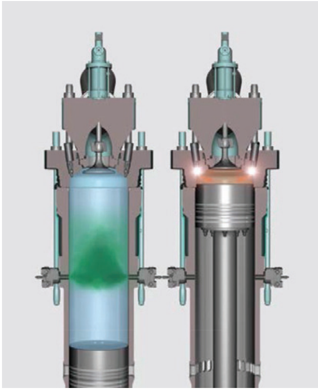
WinGD is following this industry standard and applied depth of gas engine expertise and experience to its low-speed engines – a move that extends the benefits of DF technology across the broader marine industry.

To date, this technology has been received with great enthusiasm and numerous orders have been placed for a variety of vessel types, including large and small LNG carriers, container feeder vessels and tankers.



WinGD 5RT-flex50DF engine

The low-pressure X-DF engines provide the following benefits



- Low-pressure gas supply means low investment costs and low power consumption
- Pilot fuel quantity below 1% of total heat release
- DF engine can be operated on gas from idle
- Low NO_X emissions, IMO Tier III compliant in ECAs without after-treatment
- Particulate matter emissions reduced to almost zero

Applications

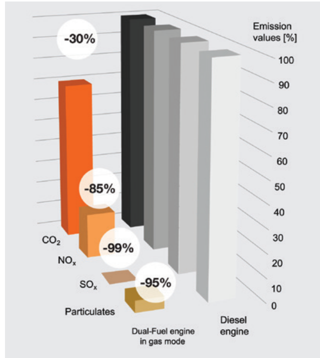
X-DF technology is applicable on a variety of vessel types, i.e. LNG carriers, chemical tankers, container ships and holds excellent potential for vessels operating in Emission Control Areas (Baltic, coasts of North America, Gulf of Mexico). In the marine business, the low-pressure X-DF solution is an increasingly attractive alternative for companies looking for environmentally friendly propulsion solutions.

As the lifespan of a vessel is usually measured in decades, retrofitting an engine to DF operation is often highly cost-effective, since it 'future proofs' your investment. The X-DF ready concept, available on all WinGD X-engines, makes the conversion of low-speed diesel to DF a matter of course, as retrofitting can be combined with planned maintenance, during a standard docking period, for example.

DF-ready option

All Generation X engines can be converted to use LNG as fuel. For simplifying the future conversion WinGD has introduced the DF-ready version as an option. The DF-ready engines can be easily converted to dual-fuel, as no major structural components need to be modified. All parts, which are to be replaced at a later conversion, are either typical wear parts or specific X-DF components and systems. The DF-ready version is the recommended solution for LNG-ready ships.

Fully compliant with IMO Tier III



Example of emission reduction obtained by switching to gas

Due to its lean-burn combustion process, this technology has an inherent potential to reduce the formation of NO_X – by up to 90% compared to diffusion combustion of diesel or high-pressure direct-injected gas-diesel engines (GD).

Thus, with lean-burn X-DF engines, no additional exhaust gas treatment system is needed to meet the IMO Tier III NO_X limits in coastal regions. The low-pressure X-DF solution also reduces the vessel's total CO_2 footprint compared to HFO.

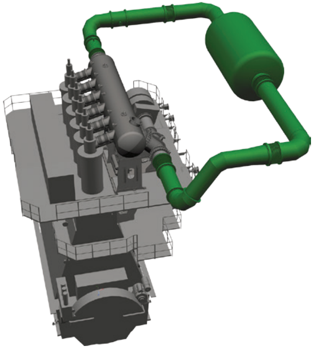
IMO Tier III Solutions

Low-pressure X-DF Solution

In order to achieve compliance with both the IMO Tier III NO_X standards and the requirements for SO_X control, a variety of solutions is theoretically conceivable, starting with the choice of fuel and fuel system, including conventional and more advanced tuning concepts, the addition of particular substances and, ultimately, the after-treatment.

Switching from liquid to gas fuel is a viable solution for dealing with both challenges simultaneously. Please check the X-DF engines section in this booklet for more details.

However, when considering liquid fuels only, various options need to be taken into account, combining the individual solutions to control the two key pollutants SOx and NOx.



Typical high pressure SCR arrangement

SCR Solutions

SCR technology is based on the reduction of nitrogen oxides (NO_X) by means of a reductant (typically ammonia, generated from urea) at the surface of a catalyst in a reactor.

The temperature of the exhaust gas is thereby subject to constraints both on the upper and the lower side. The latter is particularly an issue with fuels containing higher fractions of sulphur, such as those present in typical heavy fuel oil (HFO) qualities available today, which calls for even higher minimum temperatures in the catalyst.

High Pressure SCR

The SCR reactor is put on the high-pressure side, before the turbine. Integrating the SCR reactor before the turbine allows the reactor to be designed in the most compact way due to the higher density of the exhaust gas.

WinGD has developed and is systematically deploying high pressure SCR solutions for the complete low-speed engine portfolio with single and multi-turbocharger applications.

Further, WinGD allows third party brand high pressure SCR suppliers to interface to the engine provided interface specifications are met.

Low Pressure SCR

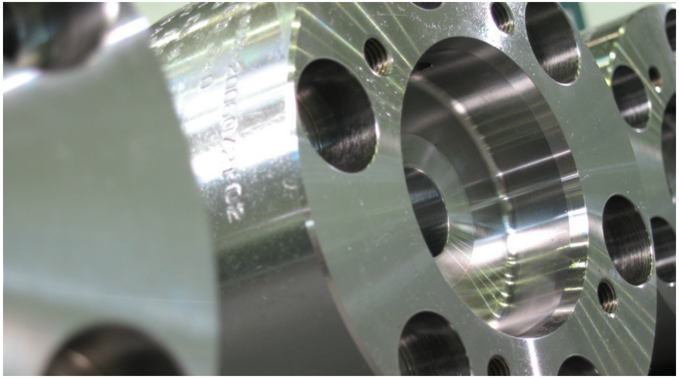
The SCR reactor is put on the low-pressure side, after the turbine. WinGD has developed a low-speed engine interface specifications for low pressure SCR applications that complies with the known low pressure SCR system providers. Low pressure SCR is typically larger in volume and has the advantage of being less complicated to integrate into the exhaust stream.

EGR Solutions

Additional to IMO Tier III dual fuel and SCR solutions, exhaust gas recirculating (EGR) concepts might be commercially viable for certain applications. WinGD is further developing this concept.

Pollutants	Measure 1	Measure 2
SO_X	Low-Sulphur Fuel	Scrubber
NO_X	SCR	Engine internal measures (EGR)

All WinGD low-speed engines included in this booklet are fully compliant with IMO Tier II NO_X limits specified in Annex VI of the MARPOL 73/78.



WinGD Digital Solution

During the last decades, ship design has evolved in many different aspects and the efficiency of ships and on-board machinery have been significantly improved.

Today the digital technology offers an additional new opportunity to use ship and machinery more efficiently, produce regulatory reports digitally and support the global integrated transportation system development.

WinGD provides ship owners and operators with digital solutions that will enhance both operational efficiency and crew decision-making processes related to the main engine and ship operations.

Collect	Analyse	Predict	Support
• Display trend of ship and machinery data • Communicate engine data onshore to the ship owner • Store data in a secured environment	• Intelligently diagnose the engine status via performance information, sub systems and components current behaviour	• Prediction and diagnosis of component malfunction and extensions of maintenance intervals	• Troubleshoot abnormalities by providing customers with more detailed information on which key components are affected and what are the relevant steps to fix the malfunction

WinGD digital solution to create value from engine and ship data

Creating value from engine and ship data

WinGD's suite of digital products is a comprehensive and integrated solution for creating value from engine and ship data. It allows operators to **collect** and **analyse** ship and machinery data and to **predict** components malfunctions and **support** with live troubleshooting and diagnostic advice to the crew.

All these capabilities are implemented into a user-friendly on-board system comprising of the most competitive and state-of-the-art hardware, software and data analytics techniques.

A modular and flexible digital solution

WinGD offers a modular and flexible digital solution that analyses ship and engine data directly on board with the possibility to transfer relevant information onshore and to receive remote support.

WinGD digital solution includes the following applications:

Engine Performance diagnostic	Component monitoring
Dynamic Maintenance plan	Trouble-shooting
Interactive training	Spare parts

Flexible and modular applications for an easy and effective diagnostic

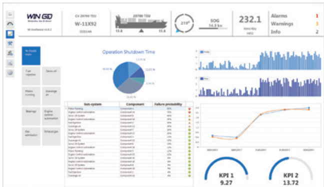
Engine performance diagnostic

It is based on engine thermodynamic process simulation that constantly calculates the ideal engine performance reference. The actual engine operating performance is measured by collecting relevant information on the engine and on the ship. The deviation between actual and optimal reference engine performance is quantified and root-cause analysis with problem solving solutions is provided.

Components monitoring, analytics and predictive diagnostics

The data collected from the main engine components/functions are used for monitoring and trending the measured values of all relevant signals, analyzing signals data, defining correlations between signals, and predicting engine component malfunctions.

Such activities are based on WinGD core competences, statistical and predictive model and machine learning algorithm.



Dynamic Maintenance plan

Engine data analytics allows predictive maintenance. Consequently, the engine maintenance plan becomes dynamic based on the actual condition and prediction, and no longer only relied on achieved running hours.

Troubleshooting

The troubleshooting module provides customers with instructions on how to solve problems in case an alarm or a failure occurs. It reports the problem, the list of alarms, and the identification of the part involved, as well as providing drawings and documents of components affected. Information can be sent to an operating center providing online support for remote troubleshooting.

Virtual and interactive training

Specific training sections, with a training library organized according to engine components/ functions, are designed based on standardized criteria.

It is possible to upload/download training videos and run an engine room simulator.

Spare parts

When a failure is predicted, it might involve ordering spare parts. The module includes an electronic spare part catalogue according to Shipdex standard, which could be directly loaded by the Ship Management Software on board. A part order can be created and handed out to external suppliers.

The benefits of our digital solution

WinGD digital solution helps our customers increase return on assets by analyzing the engine and ship data with the utmost cybersecurity.

We offer:

- **Reduction of engine unplanned stoppage**
- **Saving of fuel cost**
- **Troubleshooting**
- **Extension of Time Between Overhaul**
- **Access to operational support remotely**
- **Access to spare parts and field service**

Cylinder Lubrication

WinGD's 'Pulse Jet' cylinder lubrication system is incorporating the latest findings of engine research dealing with slow-steaming and cold corrosion with decades of experience in regard to reliability.

Very homogeneous lubricant distribution on the cylinder liner surface and the refreshment of the lubricant film by regular injections at minimal lubricant feed rate guarantees to keep operational expenses at the lowest possible level.

Together with WinGD-validated lubricants from a wide variety of suppliers covering a base number (BN) range from 15 to 140 mgKOH/g (according ASTM 2896), Pulse Jet cylinder lubrication is the prerequisite to achieve long time between overhauls of piston rings and cylinder liners with outstanding reliability and engine availability.

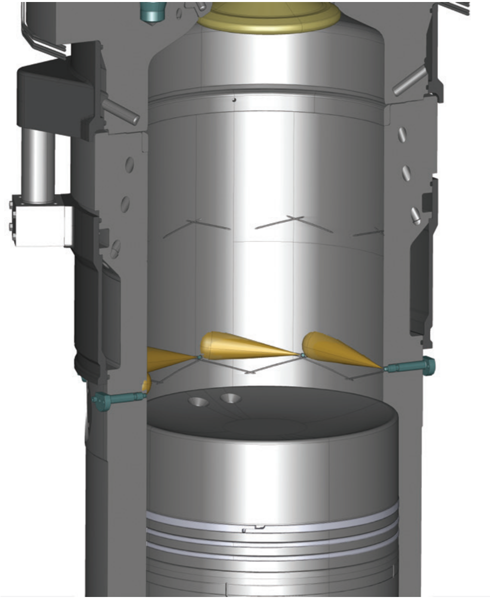
Pulse Jet cylinder lubrication features various technologies to ensure safe lubrication and acid-neutralization for piston rings and the entire cylinder liner running surface:

- The spray angles of Pulse Jet's maintenance-friendly lubricant injection nozzles and the electronically controlled timing of lubricant pump actuation are tailored to achieve highly homogeneous distribution of cylinder lubricant
- The zig-zag-shaped grooves in the cylinder liner running surface provide further vertical and horizontal distribution of the freshly injected lubricant in the upper stroke area, where high pressure and temperature of combustion gas requires special attention
- Each piston ring provides with its specific design a function with regard to the combustion gas sealing and perfect mixing of fresh lubricant with the existing lubricant film at each and every piston stroke. This suppresses cold corrosion by distributing the additives in the lubricant film in intervals adapted to the current need
- The extremely tough Chromium-Ceramic coating of piston ring running surface is highly resistant against both acidic corrosion and mechanical stresses covering engine operating conditions from manoeuvring to full power

By applying regular laboratory and on-board analysis of piston underside drain oil samples, lubricant consumption can be reduced to the minimum possible considering the operating conditions.

Easy-understandable documentation for engine operation provides guidance for the correct choice of cylinder lubricant for gas, distillate and residual fuels as well as for safe and economic maintenance intervals which are either time-dependent or condition-based.

WinGD's low-speed engines with Pulse Jet cylinder lubrication system are the state-of-the-art solution for reliable and cost-effective transportation of cargo



WinGD Piston Running Concept with Pulse Jet Cylinder Lubrication System

Steam Production Control

In order to improve the steam production on board via the exhaust gas economizer, the X-engines can be equipped with a controlled exhaust gas bypass valve. Such a valve can be opened on demand when the exhaust gas temperature is lower than the target temperature, or when the steam pressure is lower than required. As a consequence of the exhaust gas bypass opening, the exhaust gas temperature increases and steam production through the boiler is increased.

As an example, ***Figure 1*** shows the same X-engine with and without the variable bypass. With the variable bypass it is possible to target exactly the minimum steam production needed if the exhaust gas temperature is lower than that required. Where no variable bypass is installed, it is necessary to switch on the thermal boiler to reach the targeted steam production.

Figure 2 indicates clearly that increasing the steam production with an engine variable bypass is more efficient than switching on the thermal boiler, and fuel consumption savings of 2–6 g/kWh are possible.

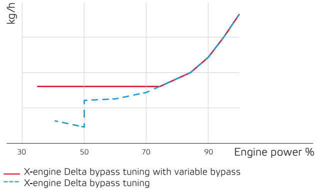


Figure 1

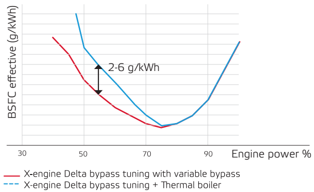


Figure 2

High-Efficiency Waste Heat Recovery (WHR)

Waste heat recovery is an effective technology for simultaneously cutting exhaust gas emissions and reducing fuel consumption.

High-Efficiency Waste Heat Recovery plants can be installed with WinGD engines. This enables up to 10% of the main engine shaft power to be recovered as electrical power for use as additional ship propulsion power and for shipboard services. These WHR plants thus cut exhaust gas emissions and deliver fuel savings of up to 10%.

Steam based WHR has already been successfully fitted in several installations to WinGD low-speed marine engines. In the WHR plant, a turbo-generator combines input from a steam turbine and an exhaust gas power turbine to generate electrical power, while steam from the economiser is available for ship service heating. Steam based WHR is recommended for vessels with high installed power.

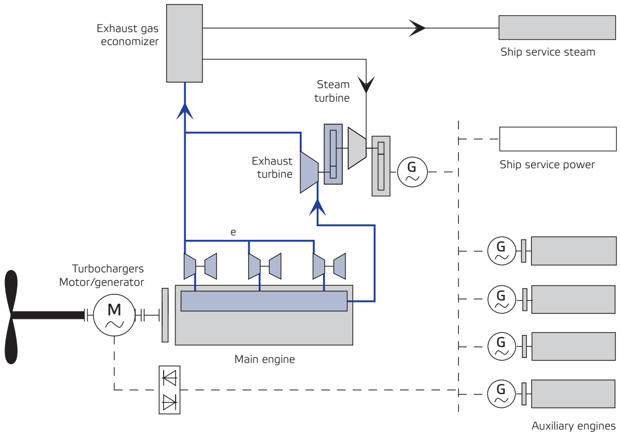


Diagram of a High-Efficiency Waste Heat Recovery plant typical for large container ships

WinGD Engine Training

W-Xpert Full Mission Simulator – example of Engine Control Room action room

For hands-on training we offer almost 'real-life' conditions

Participants have the chance to perform selected maintenance and adjustment procedures by working with actual engine components and sub-assemblies. They can get to know and understand the WinGD low-speed engines, while learning the correct procedures under the guidance and supervision of our experienced instructors.

Additionally, depending on the engine production schedule, participants can have an opportunity to witness engine assembly, and to experience engine operation on the test bed at the HHM facilities in Shanghai.

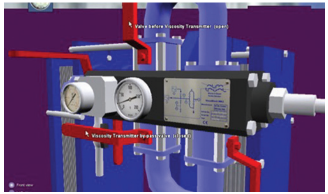
For operational training we provide a range of simulators to aid instruction on actual operating procedures.

Hardware Simulators

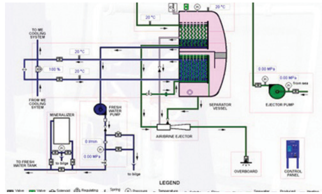
The WinGD Training Centre is equipped with hardware engine simulators based on real electronic control modules where participants can familiarize themselves with our engine control systems, discover their diagnostic and fine adjustment functions, and learn troubleshooting routines.

Winterthur Gas & Diesel Training Centre in Shanghai offers extensive training possibilities.

In 2017 new WinGD training centres in Switzerland, South Korea and Greece will be opened. Please follow our website for more information.



Example screen from an interactive training module – Fuel Conditioning Module sequence of start-up



Example screen from an interactive training module – Fresh water Generator operation principle

Virtual Simulators

Recently W-Xpert, a virtual engine simulator, has been installed at the WinGD Training Centre in Shanghai. This allows operational training on the main engine with regard to engine performance, giving close attention also to all engine room systems.

From early 2017 the W-Xpert Full Mission Engine Room Simulator will be available opening a new chapter in crew trainings provided by WinGD Training Centre.

Our W-Xpert Simulators are:

- Designed and built in compliance with requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers – STCW 2010 Convention (with later Manila Amendments)
- Approved for official marine engineers training and examinations on all levels according to STCW 2010 as above

Our engine trainings are effective and interesting. Both old and new technologies are presented in a comprehensive ways utilizing interactive simulations.

Simulation Tools

In addition to the engine training provided by the WinGD Training Centre in Shanghai, WinGD also offers its customers the possibility to purchase the product specific simulation software for continued engine training in house.

For customers who wish to take advantage of a professional engine room training environment, WinGD offers the Full Mission Simulator hardware to fulfil these needs.

For more information regarding these products, please contact WinGD headquarters in Winterthur, Switzerland.

W-Xpert simulators software

In order to improve the crew training efficiency and to ensure smooth operation of WinGD X-engines in the field, the W-Xpert – an interactive Engine Room Simulator has been developed.

In the virtual and fully interactive environment of the Engine Room our low-speed engine plays the main role, however, as in the reality, the main engine couldn't be operated without supporting systems and auxiliary machineries.

W-Xpert simulator offers detailed simulation of X-engine behaviour in all operational aspects, its functionality and performance. The thermodynamic model offers also visualisation of cylinder pressures, SFOC and emissions depending on virtual operating conditions, simulated wear and failures.

W-Xpert simulators have Classification Societies approvals as training and competence assessment software (SW) for marine engineers in accordance to the STCW 2010 Convention (with Manila Amendments).

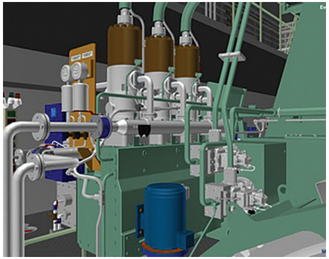
The simulation SW is protected by a USB access key and it can be operated on a standard PC or even a laptop, however for best results it is recommended to use two screens or projectors.

Currently the following engine types are represented in W-Xpert:

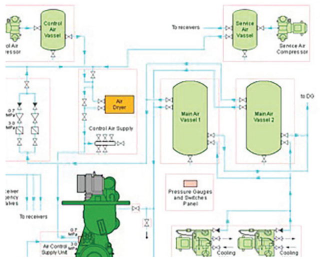
- X35
- X62
- X72
- RT-flex50DF

W-Xpert simulators for big bore engines such as X82 and X92 engines will be ready in 2017.

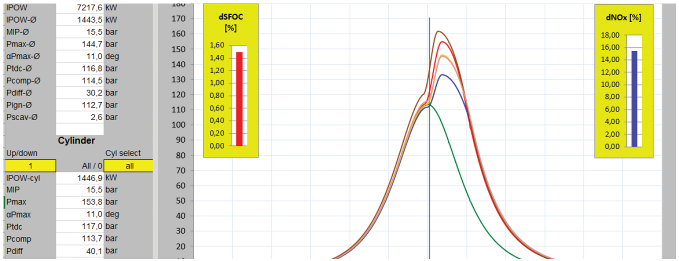
Example of an action screen: Engine Control Room with zoom-in on the interface of the Propulsion Control System



Example of the action screen: the Supply Unit of W-X72 engine



Example of Engine Room Compressed Air system



Example of Intelligent Combustion Monitoring interface: simulated engine failures are reflected in combustion pressures, fuel consumption penalties and increased emissions

W-Xpert Full Mission Simulator hardware

The most efficient training with W-Xpert virtual Engine Room Simulators can be achieved by using the recently developed Full Mission Simulator (FMS), consisting of 5 computers, 16 big size touch screens, loudspeakers, intercom and CCTV system, which is fully compatible with W-Xpert simulation software (SW) located in three 'functional' rooms: Engine Control Room, Engine Room, Emergency Generator and the Instructor Station.

This setup is particularly designed for trainings of entire engine crews, who could exercise their responses to emergencies and develop coordination skills.

Installation in smaller spaces is also possible. WinGD is ready to assist and advise if required.

Example of W-Xpert Full Mission Simulator (FMS) arrangement: the 'Engine Control Room' with Main Switchboard and Engine Console

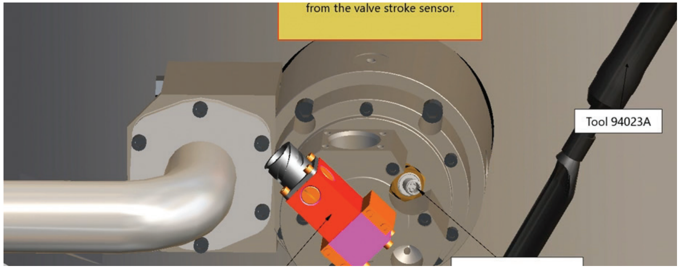
Example of W-Xpert Full Mission Simulator (FMS) arrangement in one room using partitions

Interactive training modules software

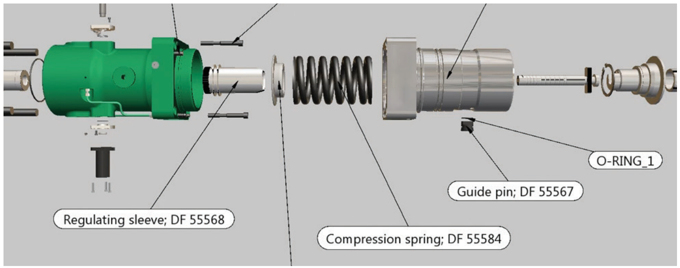
The interactive manuals and training modules are optimised for mobile devices (tablets, smart phones) where best picture quality and interactivity is achieved.

WinGD is planning to cover most of the critical engine components by this kind of instructions. The RT-flex size IV and the Gas Admission Valve are available and more such as: FAST Injector, Injection Control Unit, etc. are to come.

Several key components of X-engines are already covered by the interactive maintenance manuals and training modules. Interactive inspection instructions for bearings and crankshaft deflection are under preparation.



Example of Interactive Maintenance Manual: Gas Admission Valve removal and dismantling



Example of Interactive Parts Code Book: RT-flex size IV Fuel Pump

Engine Warranty Handling & Services

WinGD Warranty Handling Office

Winterthur Gas & Diesel Ltd.
Schützenstrasse 1-3, 8401
Winterthur, Switzerland

Any claim during engine warranty period shall be submitted to the following email address.

E-mail: warranty@wingd.com

WinGD Operations Support

WinGD Operations supports customers through the entire product lifecycle. In case of operational matters, please use following email address to contact us.

E-mail: operations.support@wingd.com

China

Unit 1101, 11F, Lujiazui Century
Financial Plaza No.799
South Yanggao Road, Pudong New
District, Shanghai, 200127 P.R.China

Tel: +86 400 101 1150
(Chinese and English speaking)

South Korea

15-36, Gangbyeon-daero 456beon-gil,
Sasang-gu, Busan, 47033, South Korea

Europe

5th Floor, Grevenweg 72,
20537 Hamburg, Germany

Switzerland

Schützenstrasse 1-3, 8401
Winterthur, Switzerland
Tel: +41 52 262 23 69

WinGD Services Partners

Wärtsilä Services Switzerland Ltd.
24/7 operational support

For questions regarding operational issues please call or contact:

Tel: +41 52 262 80 10
E-mail: technicalsupport.chts@wartsila.com

Wärtsilä Services Switzerland field service

If you require Wärtsilä field service please contact:

Tel: +41 79 255 68 80
E-mail: Ch.Fieldservice@wartsila.com

Wärtsilä spare parts

If you need Wärtsilä spare parts and/or tools, please contact your nearest Wärtsilä representative or your key account manager.

Licensees, Warranty and Service contacts

China

DMD

After-sale service for warranty claims:

Tel: +86 411 84419320
+86 13591789485
(Mr. Wei, 24/7)
Fax: +86 411 84417499
E-mail: weihonglin@dmd.com.cn
dmdservice@163.com
(for out of working time)

Spares & service for out of warranty:

Tel: +86 411 84419320
+86 15841170703 (Mr. Ge, 24/7)
Fax: +86 411 84417499
E-mail: geliang@dmd.com.cn
spare_dmd@163.com
(for out of working time)

YMD

Service

Tel: +86 717 6469141
+86 139 7203 8652 (24x7)
E-mail:
Yichang base: service@ymd.com.cn
Qingdao base: service@qmdltd.com.cn

Spare parts:

Tel: +86 717 6469141
E-mail: sparepart@ymd.com.cn

HHM

Warranty claims/service:

Tel: +86 21 58466043
E-mail: service@hhm.com.cn

Spare parts:

Tel: +86 21 51310006
Fax: +86 21 60756160,
+86 21 60750972
E-mail: spareparts@hhm.com.cn

CMD

Warranty claims/service:

Tel: +86 21 61186666 ext. 7313
+86 21 61186667
E-mail: service@shcmd.com.cn

Spare parts:

Tel: +86 21 51310006
Fax: +86 21 60756160
+86 2160750972
E-mail: spareparts@hhm.com.cn
(HHM sell the spare parts)

CMP

E-mail: spareparts@cssc-cmp.cn
service@cssc-cmp.cn

YCMP

Tel: +86 756 5598086
E-mail: service@ycmp.com.cn

Japan

Diesel United, Ltd. customer support of (Aioi Office)

Technical Support

Tel: +81 791 24 2286
Fax: +81 791 22 6062
E-mail: customer-support@du.ihi.co.jp

Parts Sales

Tel: +81 791 24 2285
Fax: +81 791 22 6064
E-mail: du_sales_aioi@du.ihi.co.jp

Hitachi Zosen Corporation

Sales Group

Tel: +81 6 6569 0502
E-mail: de-hzds@hitachizosen.co.jp

Technical Group

Tel: +81 6 6569 0508
E-mail: de_tech@mml.is.hitachizosen.co.jp

Mitsubishi Heavy Industries Marine Machinery & Engine Co., Ltd.

(for spare parts and service engineers)

Marine Engine Division
Service Business Section

Tel: +81 78 672 4081
Fax: +81 78 672 3794
E-mail: dsales@mhi-mme.com

(for Technical inquiries)

Marine Engine Division
Service Engineering Section

Tel: +81 78 672 4083
Fax: +81 78 672 3814
E-mail: dserv-eng@mhi-mme.com

South Korea

HHI-EMD

Tel: +1 212 845 9803 (24/7)
E-mail: enginecs@hhi.co.kr

Doosan Engine

Tel: +82 10 3559 8836 (24/7)
E-mail: service.engine@doosan.com

Contacts

WinGD Offices

Switzerland Headquarters

Main Office
Winterthur Gas & Diesel Ltd.

P.O. Box 414 Schützenstrasse
1-3 CH-8401 Winterthur

Tel: +41 52 262 4922
Fax: +41 52 212 4917
E-mail: info@wingd.com

Diesel Technology Centre
Winterthur Gas & Diesel Ltd.

DTC Building 650 Sulzer Allee
19 / Sulzer Industriepark
CH-8404 Oberwinterthur

Tel: +41 52 262 4922
E-mail: info@wingd.com

China

Winterthur Gas & Diesel (Shanghai) Co., Ltd.

Unit 1101, 11F, Lujiazui Century Financial Plaza, No. 799 South Yanggao Road Pudong New District, Shanghai, 200127 P.R. China

Tel: +86 21 61681958
Fax: +86 21 61681959
E-mail: china@wingd.com

Dalian Office

Office 1501 Building B,
Dalian International Ocean Building,
No.11 Yu Guang Street, Zhongshan District, Dalian, Liaoning Province,
116001 P.R. China

Tel: +86 411 82396668
Fax: +86 411 82659106
E-mail: china@wingd.com

Winterthur Gas & Diesel Hong Kong Limited

18/F Worldwide House,
19 Des Voeux Road Central,
Hong Kong

Tel: +852 2522 7355
Fax: +852 2810 4114
E-mail: hongkong@wingd.com

Germany

Winterthur Gas & Diesel Ltd. Representation c/o China Shipbuilding Trading Co., Ltd.

5th Floor, Grevenweg 72, 20537
Hamburg, Germany

E-mail: hamburg@wingd.com

Japan

Winterthur Gas & Diesel Japan Ltd.

6-7-2, Minatojima, Chuo-ku,
650-0045 Kobe, Japan

Tel: +81 78 306 2910
Fax: +81 78 306 2912
E-mail: japan@wingd.com

Contacts

WinGD Offices

Singapore

Winterthur Gas & Diesel Singapore Pte. Ltd.

63 Hillview Ave, Lam Soon industrial building floor 10-14669569, Singapore

Tel: +65 82998934
E-mail: singapore@wingd.com

South Korea

Winterthur Gas & Diesel Korea Ltd.

15-36, Gangbyeon-daero 456 beon-gil, Sasang-gu, Busan, 47033, South Korea

Tel: +82 51 320 9800
Fax: +82 51 320 9888
E-mail: korea@wingd.com

United Arab Emirates

Winterthur Gas & Diesel Middle East DMCC

Mazaya Business Avenue
BB1-Office 3604, Dubai

Tel: +971 4 320 9740
Fax: +971 4 320 9741
E-mail: dubai@wingd.com

WinGD Sales Agents

Brazil

Wärtsilä Brasil Ltda.

Rua da Alfândega, 33 – 9o andar Centro
20070-000 Rio de Janeiro, RJ Brasil

Tel: +55 21 2206 2500
E-mail: Lucas.correa@wartsila.com

Canada

Wärtsilä Canada Inc. Services Office

Vancouver British Columbia
1771 Savage Road
Richmond, BC V6V 1R1 Canada

Tel: +1 604 244 8181
Fax: +1 604 244 1181

Cyprus/Israel

Cass Technava Ltd.

4, Riga Fereou Str.
Omega Court, 5th Floor, Flat 51
3095 Limassol, Cyprus

Tel : +357 25 81 99 21
Fax: +357 25 81 99 22
E-mail : info@cass-technava-cy.com

Denmark

Wärtsilä Danmark A/S Marine Solutions & Services Office Copenhagen

H.C. Andersens Boulevard 11, 3. sal,
DK-1553 Copenhagen V, Denmark

Tel: +45 99 56 99 56

Finland

Wärtsilä Finland Oy Marine Solutions & Services Office (Vaasa)

Tarhaajantie 2, P.O. Box 252,
FI-65101 Vaasa, Finland

Tel: +358 10 709 0000
Fax: +358 6 356 7188 (Marine Solutions)

France

Wärtsilä France SAS Services Office (Marseille)

Enceinte portuaire, Porte 4,
Chemin du Cap Janet CS 80263
FR-13344 Marseille cedex 15, France

Tel: +33 491 03 99 20
Fax: +33 491 03 99 21

JEREP sarl

17, rue Jean MERMOZ
F. 75008 Paris, France

Tel : +331 42 25 85 25
+334 66 59 48 02
E-mail: info@jerep.fr

Contact person:
Mr. Jérôme de ROYS

E-mail: Jerome.deroys@jerepmarine.fr
E-mail: Jerome2roys@aol.fr
Mob: + 336 07 05 11 79

WinGD Sales Agents

Germany

**Wärtsilä Deutschland GmbH
Marine Solutions & Services
Office Hamburg**

Schlenzigstrasse 6, D-21107
Hamburg, Germany

Tel: +49 40 75190 0
Fax: +49 40 75190 245 (Marine Solutions)
Fax: +49 40 75190 194 (Services)
E-mail: MarineSolutionsHamburg@wartsila.com
E-mail: hamburg@wartsila.com (Services)

Greece

**Cass Technava
Suppliers & Contractors of
Shipbuilding Equipment**

6 Loudovikou Sq., GR-185 31
Piraeus, Greece

Tel: +30 210 41 13 916
Fax: +30 210 41 22 450

India

**Wärtsilä India Private Limited
Marine Solutions & Services Office**

Kesar Solitaire, 21st Floor, Plot No. 5,
Sector No. 19, Palm Beach Road,
Sanpada,400 705 Navi Mumbai, India

Tel: +91 22 2781 8300/8550
Fax Marine Solutions: +91 22 2781 4732
Fax: +49 40 75190 194 (Services)
E-mail: MarineSolutionsHamburg@wartsila.com
E-mail: hamburg@wartsila.com (Services)

Italy

**Wärtsilä Italia S.p.A.
Marine Solutions & Services
Office Trieste**

Bagnoli della Rosandra, 334,
San Dorligo della Valle, IT-34018
Trieste, Italy

Tel: +39 040 319 5000
Fax: +39 040 827 371

Netherlands

**Wärtsilä Netherlands B.V.
Zwolle**

Wärtsilä Netherlands B.V.
Hanzelaan 95, 8017 JE, Zwolle

Tel: +31 (0) 88 980 3000

Norway

**Wärtsilä Norway AS Marine
Solutions**

Rubbestadneset,N-5420
Rubbestadneset, Norway

Tel: +47 53 42 25 00
Fax: +47 53 42 25 01

Poland

**Wärtsilä Polska Sp. z o.o.
Marine Solutions**

Ul. Twarda 12, 80-871
Gdansk, Poland

Tel: +48 58 347 85 00
Fax: +48 58 347 85 20
E-mail: contact.poland@wartsila.com

Russia

**Wärtsilä Vostok LLC
Marine Solutions & Services Office
St. Petersburg**

Business centre Linkor 36 A
Petrogradskaya naberezhnaya,
197101 St. Petersburg, Russia

Tel: +7 812 448 3248
Fax: +7 812 448 3241

Spain

**Wärtsilä Ibérica S.A. Marine
Solutions & Services Office Bermeo**

Poligono Industrial Landabaso s/n,
ES-48370 Bermeo, Spain

Tel: +34 946 170 100
Fax: +34 946 170 105 (Marine Solutions)
Fax: +34 946 170 104 (Services)

Sweden

**Wärtsilä Sweden AB
Services Office Gothenburg**

Götaverksgatan 10, P.O. Box 8006,
402 77 Gothenburg, Sweden

Tel: +46 31 744 4600
Fax: +46 31 744 4670

Taiwan

Hrong Yan Co.

Contact person:
Mr. Wen-Hrong Lee

Tel: +886 2 26515439
Fax: +886 2 26515439
Mob: +886 917893349
+886 989170180.
E-mail: whzlee@hyc.com.tw
whzlee@gmail.com

Turkey

**Wärtsilä Enpa Dis Ticaret A.S.
Marine Solutions & Services
Office Tuzla**

Aydintepe Mah. D100 Karayolu
Cad. No: 14/E Bahar Is Merkezi,
34947 Tuzla Istanbul, Turkey

Tel: +90 216 494 5050
Fax: +90 216 494 5048

UK

**Wärtsilä UK Ltd.
Marine Solutions & Seals and
Bearings Product Company
UK (PCUK)**

4 Marples Way, Havant Hampshire
PO9 1NX, United Kingdom

Tel: +44 239 240 01 21
Fax: +44 239 249 24 70

USA

**Wärtsilä North America, Inc.
North America Headquarters**

11710 N. Gessner Dr, Suite
A Houston, TX 77064

Tel: +1 281 233 6200
Fax: +1 281 233 6233
E-mail: joe.amyot@wartsila.com

WinGD Engine Licensees

China

CSSC-MES Diesel Co Ltd. (CMD)

No.6, Xinyuan Rd (S), Lingang
Shanghai, 201306

Tel: +86 21 6118 6666
Fax: +86 21 6118 8088

CSSC Marine Power Co., Ltd (CMP)

Changjiang Road No. 402,
Zhenjiang, Jiangsu, 212002

Tel: +86 511 8451 1273
Fax: +86 511 8451 0033

Dalian Marine Diesel Co., Ltd. (DMD)

No.1-2 Hai Fang Street,
116021 Dalian

Tel: +86 411 8441 7273
Fax: +86 411 8441 7499

Hefei Rong'an Power Machinery Co Ltd. (RPM)

No. 9166 Susong Rd,
Hefei Economic and Technological
Development Area, 230601 Hefei

Tel: +86 551 6878 8888
Fax: +86 551 6878 8888
ext. 1001

Hudong Heavy Machinery Co Ltd. (HHM)

2851 Pudong Dadao,
200129 Shanghai

Tel: +86 21 5131 0000
Fax: +86 21 5846 2023

Jingjiang Dakai Heavy Machinery Co., Ltd. (DKD)

No. 9, Liuzhugang Road, Xingang Park
Zone Jingjiang City, Jiangsu Province

Tel: +86 523 8235 5998
Fax: +86 523 8235 5955

Yichang Marine Diesel Engine Co., Ltd. (YMD)

Yichang base

No 93, Xiling Er Road, Yichang, Hubei,
443002 China

Tel: +86 717 6468689
Fax: +86 717 6468152

Qingdao base (formerly QMD)

No 501, Li Jiang East Road, Economic
and Technological Development Zone,
Qingdao, 266520 China

Tel: +86 532 86708080
Fax: +86 532 86708080 (ext. 788)

Yuchai Marine Power Co Ltd (YCMP)

Fushan Industrial Park, Zhuhai,
Guangdong Province, 519175

Tel: +86 756 588 8600
Fax: +86 756 588 8985

Croatia

ULJANIK Strojogradnja Diesel d.d.

Flaciusova 1
52100 Pula

Tel: +385 (0)52 373 309
Fax: +385 (0)52 373 821

Japan

Diesel United, Ltd. (Head Office)

8th Floor, Prime Kanda Building
8, 2-chome, Kanda Suda-cho
Chiyoda-ku, Tokyo 101–0041

Tel: +81 3 3257 8222
Fax: +81 3 3257 8220

Diesel United, Ltd. (Aioi Works)

5292 Aioi, Aioi City, Hyogo Pref.
678–0041

Tel: +81 791 24 2650
Fax: +81 791 24 2648

Hitachi Zosen Corporation (Head Office)

7–89, Nanko-kita, Suminoe-ku
Osaka 559–8559

Tel: +81 6 6569 0001
Fax: +81 6 6569 0002

Hitachi Zosen Corporation (Ariake Works)

Nagasu-machi, Tamana-gun
Kumamoto 869–0113

Tel: +81 968 78 2179
Fax: +81 968 78 7037

Hitachi Zosen Corporation (Tokyo Office)

15th floor, Omori Bellport,
26–3, Minami-Ohi, 6-chome
Shinagawa-ku, Tokyo 140–0013

Tel: +81 3 6404 0800
Fax: +81 3 6404 0809

Mitsubishi Heavy Industries Marine Machinery & Engine Co., Ltd.

(Head office)

1-1 Akunoura-Machi,
Nagasaki, 850-8610

Tel: +81 95 828 6970
Fax: +81 95 828 6633

(Marine Engine Division)

1-1 Wadasaki-cho 1-chome,
Hyogo-ku, Kobe, Hyogo Prefecture

Tel: +81 78 672 3790
Fax: +81 78 672 3705

Poland

H. Cegielski-Poznań SA (HCP SA)

ul. 28 Czerwca 1956 r. nr 223/229
61-485 Poznań

Tel: +48 61 831 1102
Fax: +48 61 831 1443

WinGD Engine Licensees

South Korea

Hyundai Heavy Industries Co. Ltd.

1000, Bangeojinsunhwan-doro,
Dong-gu, Ulsan, 44032,
South Korea

Marine Engine & Machinery
Sales Dept.

Tel: +82 52 202 7281
E-mail: enginesales@hhi.co.kr

Doosan Engines Co. Ltd.

18, Gongdan-ro 21 beon-gil,
Seongsan-gu, Changwon-si,
Gyeongnam, 51561, South Korea

Tel. Domestic: +82 55 260 6626
Tel. Overseas: +82 55 260 6641
Fax Domestic & Overseas:
+82 55 260 6381

Vietnam

Vietnam Shipbuilding Industry Corporation (Vinashin)

172 Ngoc Khanh Str, Badinh Dist, Hanoi

Tel: +84 437711212
Fax: +84 437711535

Notes:

Notes:

Notes:

Notes:


The data contained in this document serves informational purposes only and is provided by Winterthur Gas & Diesel Ltd. without any respective guarantee.

02.2017

Winterthur Gas & Diesel

WinGD is a leading developer of low-speed gas and diesel engines used for propulsion power in merchant shipping.

Sustainable, long-term global provider
Next generation fuel and cost efficient marine engines to let you operate compliantly.

Engineering Excellence built in
Benchmark engineering technology and passionate about innovation for future reliability.

Collaborative integration
Your agile partner and marine engine specialist offering simplicity and trusted delivery.

www.wingd.com