

Engine Announcement: X40DF

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Summary

With this Technical Information Note, WinGD is announcing the launch of their new X40DF engine.

1 General Information

WinGD, the marine industry's leading low speed gas engine developer, extends its offering in the low-speed dual-fuel engine series. Based on the X40-B design, the X40DF engine is now included in the portfolio.

This Otto cycle engine uses natural gas as fuel, making it Tier III compliant without the need for an expensive exhaust gas cleaning process, such as a scrubber or SCR systems. The low-emission operation provides clear environmental benefits, such as:

- Close to zero SO_x emissions
- Very Low particle emission
- IMO Tier III compliance of NO_x emissions, without exhaust-gas after treatment

Lean engine operation is possible thanks to the excellent gas fuel mixing provided by the engine's gas admission system. The pre-chamber technology ensures the highest level of combustion stability with minimum pilot fuel consumption. In addition to this, WinGD's unique low-pressure gas concept keeps the price of the fuel gas supply system to a minimum, with low operating costs and robust, maintenance friendly components. The X-DF engine design provides environmental, commercial and operational advantages. Furthermore, gas mode can be used across 95% of the engine's power range, making it possible to continually benefit.

Official engine performance data can be found in WinGD's "General Technical Data" (GTD) programme. However, for any further information or questions about this Technical Information Note, please contact your WinGD representative or WinGD directly.

2 Scheduling

WinGD currently assumes the first available cylinder configuration to be the 6-cylinder version, depending on order confirmation. The associated drawings are expected to be available towards the end of 2019. Drawing availability for other cylinder configurations are separated by an approximate interval of 3 months with the sequence of availability depending on official orders. Expected engine delivery varies but is normally 6-12 months after final drawing delivery.

3 Main Engine Parameters

The X40DF engine has cylinder dimensions of 400 mm bore and 1770 mm piston stroke, with a maximum continuous power of 935 kW/cylinder at 146 rpm (R1 rating). The X40DF engine will be available from five-cylinders to eight-cylinders, covering an overall power range of 2775 kW at 104 rpm to 7480 kW at 146 rpm.

Table 1: Engine data

Engine Type	X40DF
Cylinder bore	400 [mm]
Piston stroke	1770 [mm]
Number of cylinders	5 to 8
Power/cylinder, R1 MCR	935 [kW]
Engine speed, R1	146 [1/min]
Engine speed, R3	104 [1/min]
Mean eff. pressure @ R1/R3	17.3 [bar]
Mean piston speed @ R1	8.6 [m/s]
BSEC – Brake Specific Energy Consumption @ R1	7311 [kJ/kWh]
BSGC – Brake Specific Gas Consumption @ R1	145.0 [g/kWh]
BSPC – Brake Specific Pilot (fuel) Consumption @ R1	1.4 [g/kWh]

Engine data is provided above in Table 1, with further information in Appendix A: Engine Outline. The layout field of the engine is defined by the power / speed ratings R1, R2, R3 and R4 as shown below in Figure 1; the entire power field is seen in Appendix B: Rating Field Comparison.

Power

X40-DF	R1	R2	R3	R4
rpm	146	146	104	104
kW/cyl.	935	780	665	555

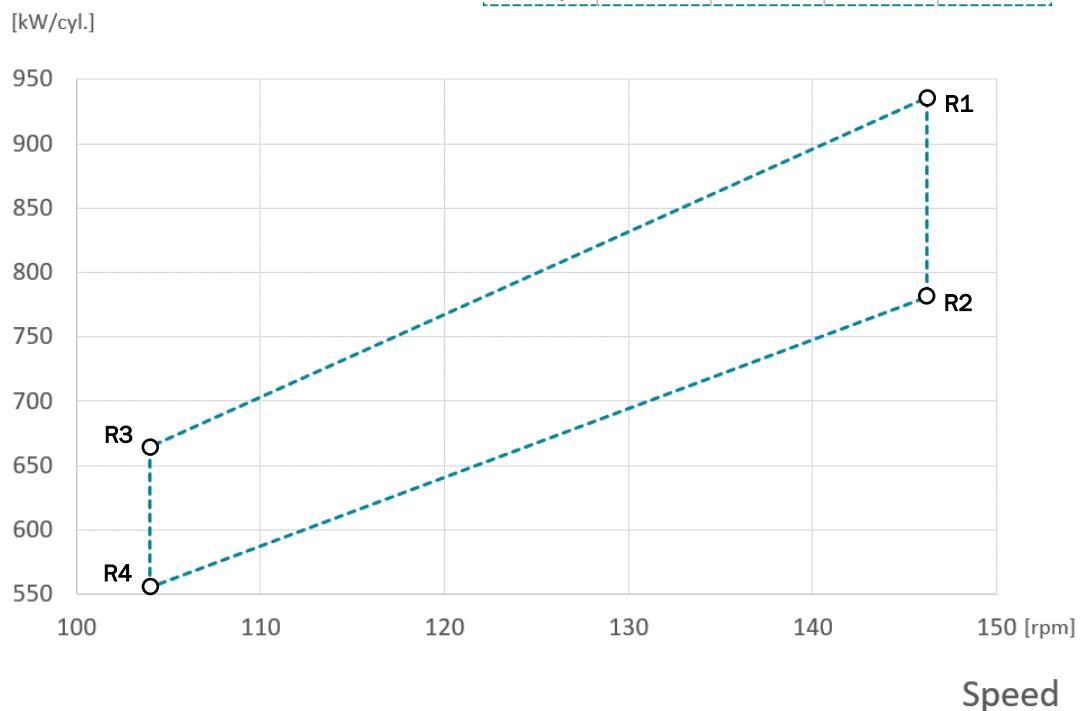


Figure 1: Engine layout field

4 Fuel consumption

This section considers an example of a 6X40DF, tuned with a CMCR of 4700 kW and 125 rpm. The graph below (Figure 2) shows the typical fuel consumption in gas mode, across the power range, showing both gas fuel (Brake Specific Gas Consumption – BSGC) and the pilot fuel (Brake Specific Pilot Consumption – BSPC).

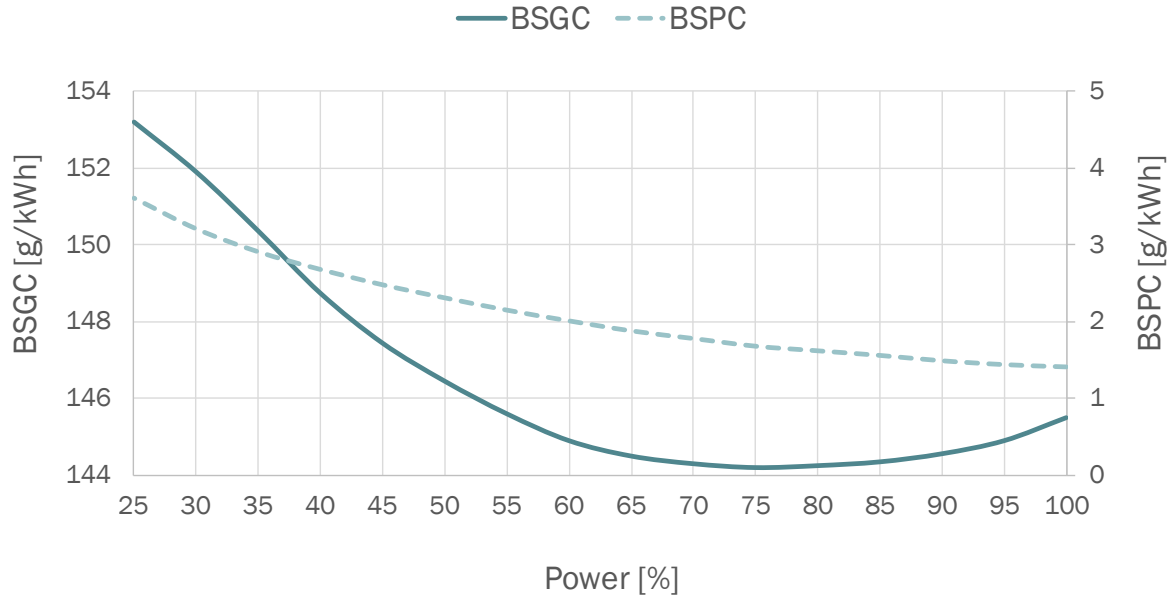


Figure 2: Fuel consumption compared to engine power

Below, (Table 2) shows the specific values and daily fuel consumption at various engine power. This considers the same tuning option as graphically shown above (CMCR at 4700 kW and 125 rpm).

Table 2: Daily fuel consumption

Power [%]	Power [kW]	Speed [rpm]	BSGC [g/kWh]	BSPC [g/kWh]	BSEC [kJ/kWh]	Daily fuel Consumption	
						Gas [tons/day]	Pilot (Fuel) [kg/day]
100	4700	125	145.5	1.4	7335	16.4	158
95	4465	122.9	144.9	1.4	7305	15.5	153
90	4230	120.7	144.6	1.5	7295	14.7	150
85	3995	118.4	144.3	1.6	7286	13.8	149
80	3760	116	144.3	1.6	7284	13.0	145
75	3525	113.6	144.2	1.7	7282	12.2	141
70	3290	111	144.3	1.8	7295	11.4	140
65	3055	108.3	144.5	1.9	7310	10.6	137
60	2820	105.4	144.9	2.0	7334	9.8	135
55	2585	102.4	145.6	2.1	7369	9.0	133
50	2350	99.2	146.5	2.3	7421	8.3	130
45	2115	95.8	147.4	2.5	7477	7.5	125
40	1880	92.1	148.7	2.7	7550	6.7	120
35	1645	88.1	150.4	2.9	7642	5.9	114
30	1410	83.7	151.9	3.2	7730	5.1	108
25	1175	78.7	153.2	3.6	7811	4.3	102

Appendix A: Engine Outline

X40DF

IMO Tier III in gas mode

Cylinder bore	400 mm
Piston stroke	1770 mm
Speed	104-146 rpm
Mean effective pressure at R1	17.3 bar
Stroke / bore	4.43

Cyl.	Length A mm	Weight tonnes				
5	4 512	109				
6	5 212	125				
7	5 912	140				
8	6 612	153				

Dimensions (mm)	B	C	D	
	F1	F2	F3	G
	2 610	950	6 563	
	7 986	8 035	7 590	1 411

Figure 3: Engine definition

Table 3: Extract from drawing DAAD112643 "Standard Engine Data" design group 0800

Rating Field Corners	Speed [rev/min]	Engine Power [kW/cyl]	Mean Piston Speed	Mean Effective Pressure Bar	BSEC Brake Specific Energy Consumption [kJ/kWh]	Gas Mode		Diesel Mode
						BSGC & BSFC Brake Specific Gas & Pilot (Fuel) Consumption [g/kWh]		BSFC Brake Specific Fuel Consumption [g/kWh]
R1	146	935	8.6	17.3	7311	145	1.4	189.8
R2	146	780	8.6	14.4	7072	140	1.7	187.8
R3	104	665	6.1	17.3	7410	147	1.4	189.8
R4	104	555	6.1	14.4	7171	142	1.7	187.8
Consumption (+5% tolerance) at 100% Power								

Appendix B: Rating Field Comparison

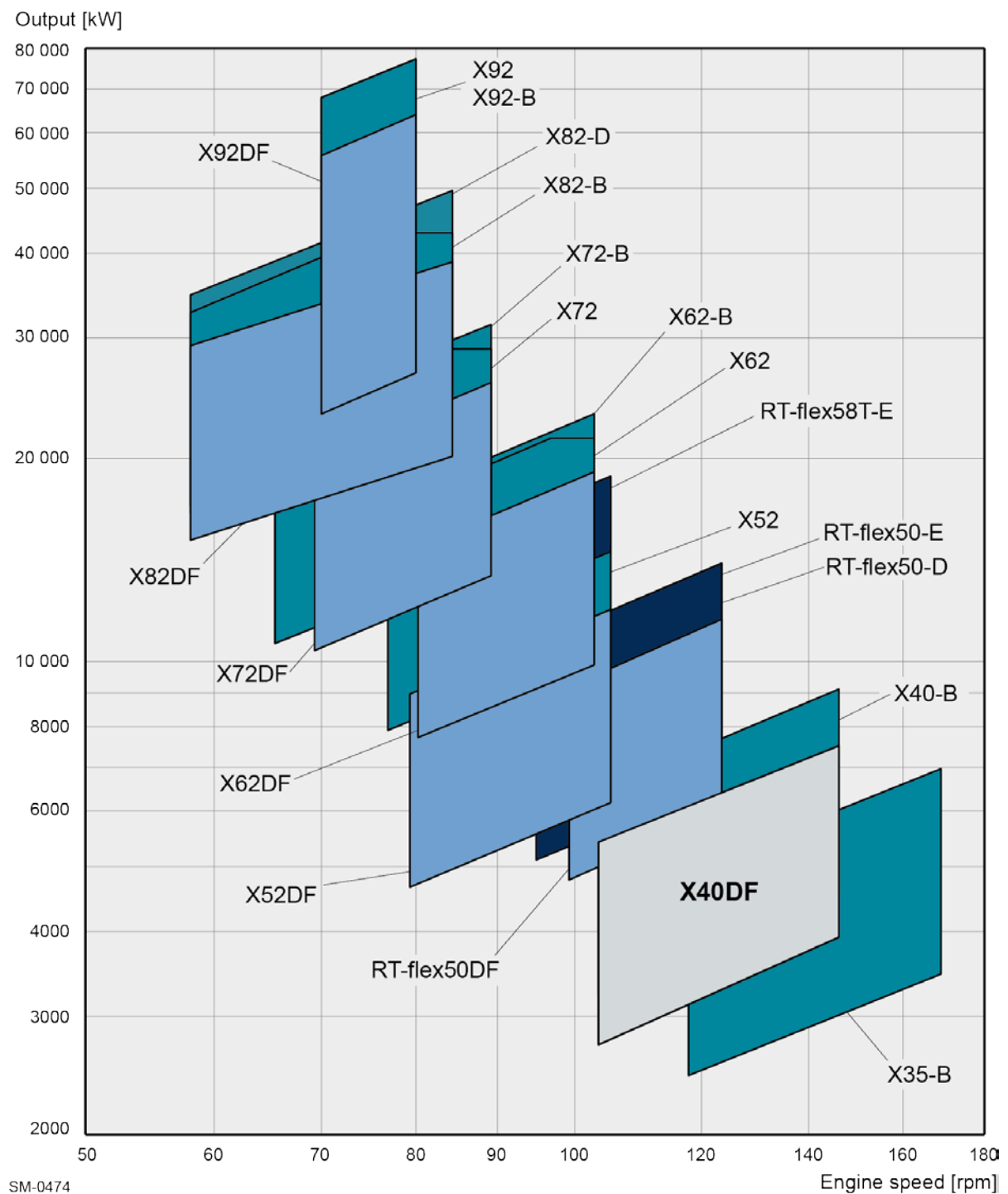


Figure 4: Rating field location of the X40DF