12VP185 Industrial Users Guide

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1 Introduction

This guide is intended to assist set builders, by providing information on the 12VP185 range of industrial engines in the early stages of a design project, to permit initial engine selection and arrangements for power generation purposes.

The information provided is supplied on bona fide basis, the details are not guaranteed. For exact details you will need to consult MAN Diesel & Turbo UK Ltd.

The company reserves the right to amend the information contained herein, without prior notice. From time to time this document is updated. For the latest issue please contact MAN Diesel & Turbo UK Ltd.

Drawings referenced throughout this guide can be found in section 18 MAN Drawings.

1.1 VP185 Engine Design

The VP185 range of high speed diesel engines combine high power output with a light weight and compact design to meet the needs of marine, industrial, rail and off-road applications world-wide.

The simple VP185 engine design allows for ease of maintenance routine service and inspection. Low fuel and lubricating oil consumption, long maintenance intervals, low exhaust emissions and high reliability make the VP185 a favourable option for power generation and industrial prime mover applications.

1.1.1 Crankcase

This is cast in high strength spheroidal graphite iron, and is a robust and light weight design. In the lower portion of the crankcase the underslung crankshaft is supported by main bearing caps which are double cross bolted to the deep side faces of the casting. In addition the vertical main bearing studs are hydraulically tensioned and the entire arrangement provides a strong and stiff core for the engine. Generously sized crankcase doors are provided to give access to the connecting rods and crankshaft for in-situ servicing. The crankcase supports the remainder of the engine’s components to provide a self-contained power unit.

1.2 Piston & Liner

The piston is a mono-block design manufactured from spheroidal graphite iron. Piston cooling is achieved using a lubricating oil cooled gallery under the crown, behind the compression ring groove and much of the second ring groove. The oil feed is via accurately aligned standing jets mounted in the crankcase. The pistons run in wet liners made of centrifugally cast high grade cast iron. Each liner has a top flange which sits on the flat top deck of the crankcase. The liner is held between the crankcase and the cylinder head at the liner flange. The lower support for the liner is arranged to be high in the crankcase and incorporates two ‘o’ ring seals and a large ‘wedge’ ring.

1.2.1 Connecting Rods

Side by side connecting rods are made from high-strength forged steel. The rods are fully machined to give strength and weight consistency between individual rods. After machining they are ferritic nitro-carburised. The large end is obliquely split to allow the rod to pass through the liner for assembly and overhaul. This permits rod and piston removal from the top of the engine without the need to remove the engine from its mounts.

1.2.2 Crankshaft

The crankshaft is a fully machined steel forging, gas nitrided for maximum strength and long wear life. Counterbalance weights are bolted to the crankshaft on every throw to reduce the out of balance caused by the reciprocating mass of piston and connecting rods. The generous overlap between crankpin and main bearing journal provides a high degree of stiffness. Torsional damping is by means of a tuned damper fitted to the free end and totally enclosed within the free end casing.

1.2.3 Cylinder Heads

The cylinder heads are manufactured from high strength compacted graphite iron and have an internal configuration that ensures maximum flame face stiffness and high cooling efficiency. They are mounted individually and can be removed for maintenance without disturbing adjacent heads. The air and exhaust ports have been optimised aerodynamically to maximise the efficiency of cylinder charging and scavenging. Each cylinder head carries two inlet and two exhaust valves, and a centrally located unit pump injector.

1.2.4 Camshaft & Valve Train

A single camshaft located in the centre of the engine vee provides the actuation for all valves and unit pump injectors. The 90° vee engine configuration allows the camshaft gear to mesh directly with the crankshaft gear, so eliminating the need for an idler gear and providing a very stiff drive to the fuel injection equipment. Large base circle cams coupled to high rates of lift give the essential characteristics for good combustion and low emission levels. The cam-follower, push rod and rocker lever feature maximised stiffness consistent with minimised associated mass.

1.2.5 Exhaust System and Turbocharging

The VP185 has a two-stage turbocharging system with intercooling and after-cooling. No valves or electronic controls are needed thereby maintaining the engine’s central theme of simplicity and reliability.

All of the exhaust manifolds are contained in water cooled gas tight casings. The turbochargers are mounted directly into the side wall of water cooled turbocharger housings. The turbine side of the turbochargers and all exhaust ductwork are contained within the water cooled housing. The total arrangement of manifolds, turbochargers and housings gives the engine a gas tight system with cool exposed surfaces, an important safety feature.

The turbochargers are of cartridge type and may be readily replaced when required. The oil feed and drain lie within the turbocharger housing, avoiding the need for external pipework.

The turbochargers are arranged in groups of three comprising one high pressure and two low pressure units. The 12VP185 engine is fitted with 3 groups of turbochargers.

Exhaust gas from the engine is relayed to the high pressure turbines. The exhaust from each high pressure turbine splits and drives two low pressure turbines before passing to the engine exhaust outlet.

Incoming charge air passes through the low pressure compressors and is relayed to the air intercoolers. The air is then taken to the high pressure compressors, through the air after-cooler and on to the engine. The air after-cooler is of a passive split circuit construction providing both cooling of incoming charge under normal operating conditions and also heating of incoming charge to help maintain air manifold temperature during part load and engine starting conditions, in both cases preventing ignition delay.

Air filter panels can be supplied for fitting on-engine. Alternatively, a ducted air intake may be arranged if required.

1.2.6 Lubricating Oil System

The engine is of the wet sump design with a gear driven externally accessible oil pump.

The 12VP185 engine is fitted with an on engine duplex filter arrangement.

The oil is cooled by the oil cooler, the temperature being controlled by a bypass thermostat. The oil cooler is mounted on engine providing a complete engine power unit and avoiding the use of connections to off engine equipment. Some flexibility in system design is however available to suit any special requirements.

1.2.7 Gear Train

The gear train comprises carburise hardened and ground gears located in a lightweight cast aluminium casing at the free end of the engine.

The crankshaft gear meshes directly with the camshaft gear. Additional drives are arranged for the gear driven oil and coolant pumps, and for the on engine actuator.

The fuel lift pump is mounted on, and driven through the oil pump.

1.2.8 Fuel Injection System

A combined fuel pump and injector, known as a unit pump injector offers a minimum trapped volume with an associated high rate of pressure rise. The maximum injection pressure of 1400 bar, coupled with a high injection rate gives good combustion characteristics with low emissions and low fuel consumption. The unit injector avoids the use of any exposed high pressure pipes and joints; this is a distinct safety feature inherent in the VP185 design. The unit injectors are rack controlled via a linkage operated by the engine mounted actuator.

The VP185 is also available with electronic fuel injection. Flexibility on injection timing allows for optimisation for fuel consumption or reduced NOx emissions.

1.2.9 Fuel Filters

The industrial engine is fitted with a single type fuel filter as standard. Low pressure fuel oil is delivered via the fuel filters to the unit injectors from a gear driven fuel lift pump.

1.2.10 Cooling Circuits

The cooling system is divided into two circuits designated primary and secondary.

The primary circuit runs at relatively high temperatures with coolant flowing through the engine housing and on engine mounted assemblies. The high operating temperatures keep the engine warm and help maintain steady combustion.

The secondary circuit runs at a lower temperature and is the key to achieving a sufficiently low lubricating oil and inlet air temperatures in hot environments.

The primary coolant and secondary coolant are circulated around the engine by on engine mounted gear driven centrifugal pumps.

Some flexibility in system design is available to suit any special requirements.

1.2.11 Governing System

For Industrial applications the Woodward UG on engine actuator & 2301 governor speed controller is fitted as standard. This system provides basic functions of engine speed control, adjustable load characteristics and protection logic suitable for most industrial applications.

There are many alternative options which can be used for the VP185 to suit a user's specific requirements.

The standard on engine actuator is located in the centre of the vee at the free end of the engine, and is gear driven via the engine camshaft. The on engine actuator is controlled by the off engine mounted engine control panel.

1.2.12 Engine Protection

The engine is fitted with multiple sensors, switches and monitoring devices as standard, which will operate in response to critical operating parameters such as low oil pressure, high oil temperature, high primary coolant temperature and engine over-speed.

For the example of engine over-speed engine shutdown is initiated not only by closing of fuel racks but also by on engine air shutdown valves which cut off the supply of incoming air to help provide a quick shutdown.

The level of engine protection can be increased to suit the user's specific requirements.

1.2.13 Benefits

- Simple, uncomplicated and user-friendly design results in a low component count
- Lightweight, compact and robust
- All major ancillaries engine-mounted
- Low radiant heat
- High power to weight ratio
- 2-stage turbocharging
- No high pressure fuel lines minimises fire risk
- Water-cooled exhaust manifolds minimises the exposure of hot surfaces

1.2.14 Environmental

- Low NOx emissions
- Low lub oil consumption
- Unit pump injectors minimise particulates

1.2.15 In Service

- In excess of three million operating hours *
- Long maintenance intervals
- Short service down times:
  - Individually mounted cylinder heads
  - Pistons removable through liners
- Comprehensive worldwide service and spares support

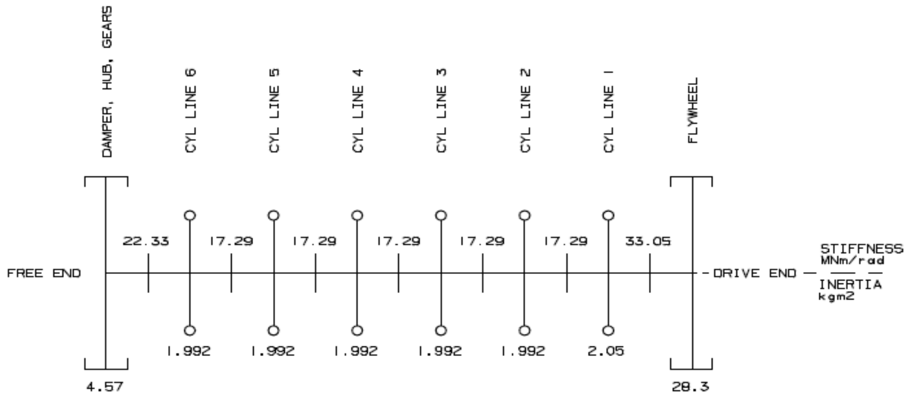
*At October 2015

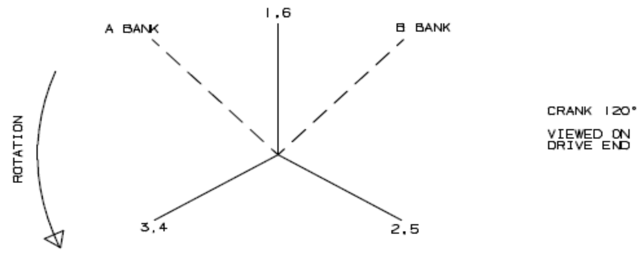
2 General Data

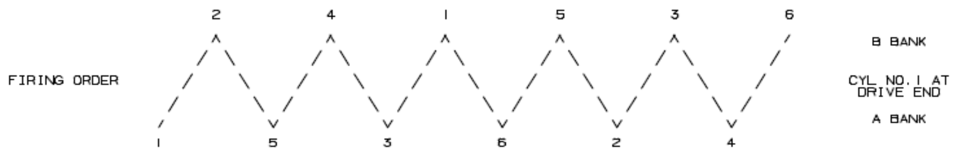
2.1 12VP185 Engine Technical Data

Engine Type	12VP185
Configuration	90° vee
Operating cycle	4-stroke
Number of cylinders	12
Bore x stroke	185mm x 196mm
Swept volume per cylinder (litres)	5.269
Swept volume per engine (litres)	63.23
Compression ratio	13.1:1
Combustion system	Direct injection
Charge air system	2 stage, intercooled and after cooled
Operating speed range capability (revs/min)	600 to Synchronised Speed
Idling speed (revs/min)	600 or agreed high speed idle
Over-speed setting (revs/min)	Synchronised Speed + 8% (Typical)
Direction of rotation	Anti-clockwise looking on flywheel
Inertia with standard damper and flywheel (kg m^2)	44.88
Mean piston speed (m/s) 1200 rpm	7.84
Mean piston speed (m/s) 1500 rpm	9.8
Mean piston speed (m/s) 1800 rpm	11.76
Thread system	SI metric and BSP

2.2 Mass Elastic System







FIRING INTERVALS	30°, 90°, 30°	VEE ANGLE 90°	
DAMPER HOLSET		GENERAL DATA	
INERTIA	3.30 kgm2	WRECIP	23.62 kg/cyl
		CON-ROD CENTRES	406 mm
		BORE	185 mm
		STROKE	196 mm

2.3 12VP185 Engine Build Weights

Component Description	Weight (kg)
For a typical engine build including… Crankcase, Sump, Engine Feet, Crankshaft, Piston & Connecting Rod Assemblies, Camshaft, Auxiliary Gearing, Valve-Train Assembly, Flywheel Housing, Flywheel & Starter Ring, Free End Cover, Damper, Cylinder Heads, Intake & Exhaust Manifold's, Turbocharger Assemblies & Housings, Air Shutdown Valves, Air Filter Housings. Primary & Secondary Coolant Pumps, Primary Coolant Thermostat, Heat Exchanger, Intercoolers, After-Cooler. Oil Strainer, Oil Pump, Oil Thermostat, Duplex Main Oil Filter Assembly, Centrifugal Oil Filter Assemblies, Crankcase Breather Coalescer Assembly. Fuel Solenoid, Fuel Lift Pump, Unit Pump Injectors, Fuel Reservoir, Duplex Fuel Filter Assembly, Return Fuel Cooler. Engine Actuator, Electric Starter Motors, All On Engine Mounted Wiring & Junction Boxes.	
Engine Base Weight (Dry) kg	**7,699**
Additional Components Required for Installation	
AV Mounts & Sole Plates	120
Lub Oil Priming Pump	46
Priming Pump Starter Panel	20
Primary & Secondary Header Tanks	60
Total Installation Components	246
Engine Installation Weight (Dry) kg	**7,945**
Fluids	
Primary Coolant Capacity 200 litres	200
Secondary Coolant Capacity 120 litres	120
Oil Capacity 287 litres	255
Fuel in system approx. 16.5 litres	14
5% Fluid Contingency	29.5
Total Fluid Weight	618.5
Engine Installation Weight (Wet) kg	**8,564**
Optional Components	
Noise Reduction Panels (2 Required Per Engine)	66
Noise Attenuation Panels (6 Required Per Engine)	54

Table 1: 12VP185 Engine Build Weights

2.4 Overall Engine Dimensions

See MAN drawing 2011D070

3 Engine Power Outputs

The following engine power ratings have been given in accordance with ISO 8528-1:2005. Available engine powers are listed for continuous, prime and limited time power applications however please note MAN Diesel & Turbo UK Ltd does not offer an emergency standby power rating. Therefore ratings given for limited time power represent the maximum available engine power.

Please also note the below engine powers are engine powers only and therefore generator efficiency will need to be applied when assessing the required load capability.

1500 revs/min and 1200/1800 revs/min engines are for 50Hz and 60Hz applications respectively.

An engines rating and the number of operating hours are directly related the recommended maintenance intervals, see section 17 for more details.

3.1 Continuous Power (COP)

Brake Power (kWb)	Engine Speed (revs/min)	BMEP (bar)	Maintenance Interval
2165	1200	34.25	1
2165	1500	27.40	1
2200	1800	23.21	1

Table 2: Continuous Power Ratings

Continuous power is defined by ISO 8528-1:2005 as being the maximum power which the generating set is capable of delivering continuously whilst supplying a constant electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as prescribed by the manufacturer.

For the continuous ratings available above MAN Diesel & Turbo UK Ltd also allows for a 10% overload on the above ratings for 1 hour in every 12 hour period. For example an engine rated at 2165 kWb is allowed to run at 2382 kWb (10% overload) up to a maximum of 1 hour in every 12 operating hours.

A continuous rating may have benefit over a prime rating as its continuous output capability provides a higher average power output over time and therefore can satisfy loads which would otherwise exceed the limitations of a prime rated unit.

3.2 Prime Power (PRP)

Brake Power (kWb)	Engine Speed (revs/min)	BMEP (bar)	Maintenance Interval
2165	1200	34.25	2
2300	1500	29.11	2
2350	1800	24.78	2

Table 3: Prime Power Ratings

Prime power is defined by ISO 8528-1: 2005 as being the maximum power which a generating set is capable of delivering continuously whilst supplying a variable electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as prescribed by the manufacturer. It also states that the permissible average power output over 24 hours of operation shall not exceed 70% of the rating unless otherwise agreed with the engine manufacturer.

For the prime ratings available above MAN Diesel & Turbo UK Ltd also allows for a 5% overload on the above ratings for 1 hour in every 12 hour period. For example an engine rated at 2165 kWb allows for a peak power of 2273 kWb (5% overload) in support of a varying load for up to a maximum of 1 hour in every 12 operating hours. Use of this 5% overload must still respect the limitation for an average power output of 70% of the standard rating over a 24 hour period.

A prime rating may have benefit over a continuous rating as it can support greater peak loads in support of varying load.

3.3 Limited Time Running Power (LTP)

Brake Power (kWb)	Engine Speed (revs/min)	BMEP (bar)	Maintenance Interval
2165	1200	34.25	3
2520	1500	31.89	3
2600	1800	27.42	3

Table 4: Limited Time Running Power Ratings

Limited time running power is defined by ISO 8528-1:2005 as the maximum power available, under the agreed operating conditions, for which the generating set is capable of delivering for up to 500 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers.

Limited time running power ratings are beneficial in support of high loads which would otherwise exceed the limitations of continuous or prime rated engines.

3.4 Other Speeds

MAN Diesel & Turbo UK Ltd may be able to support other fixed engine speeds or variable speed applications. Please contact MAN Diesel & Turbo UK Ltd to discuss your requirements.

3.5 Engine De-Rate Data

De-rating means reducing the power output of an engine from its maximum defined rating at normal temperature and pressure conditions to allow for adverse effects of site conditions due to altitude or ambient temperatures.

The percentage de-rate figures shown in the following section are based on a maximum secondary coolant return temperature of 60°C.

These are suitable for ambient conditions up to 50°C. For de-rate values outside this limitation please contact MAN Diesel & Turbo UK Ltd.

Other key factors that will reduce the engine power output include intake air depression and exhaust gas backpressure.

All specified power outputs are based on the two following standard parameters:

Exhaust Gas Backpressure: 255 mm wg (25 mbar)

Air Intake Depression: 152 mm wg (15 mbar

See section 12 Exhaust System & section 13 Aspiration Air for more details.

3.6 De-Rate Table for 1200 rpm Engines

		Air Intake Temperature (°C)							
		15	20	25	30	35	40	45	50
Altitude (M.A.S.L)	3000	0.0	0.0	0.0	0.0	0.0	1.7	3.6	5.6
	2500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
	2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		35	40	45	50	55	60	60	60
		Secondary Water Temperature (°C)							

Table 5: De-Rate Values for 1200 rpm Engines

3.7 De-Rate Table for 1500 rpm Engines

		Air Intake Temperature (°C)							
		15	20	25	30	35	40	45	50
Altitude (M.A.S.L)	3000	9.3	11.6	14.0	16.3	18.6	21.0	21.8	22.9
	2500	4.5	6.9	9.3	11.7	14.1	16.5	17.4	18.6
	2000	0.0	2.2	4.7	7.1	9.6	12.1	13.1	14.3
	1500	0.0	0.0	0.0	2.6	5.1	7.7	8.7	10.0
	1000	0.0	0.0	0.0	0.0	0.6	3.3	4.4	5.7
	500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		35	40	45	50	55	60	60	60
		Secondary Water Temperature (°C)							

Table 6: De-Rate Values for 1500 rpm Engines

3.8 De-Rate Table for 1800 rpm Engines

		Air Intake Temperature (°C)							
		15	20	25	30	35	40	45	50
Altitude (M.A.S.L)	3000	11.6	13.8	15.9	18.1	20.3	22.4	23.5	24.5
	2500	6.7	8.9	11.1	13.4	15.6	17.9	18.8	19.8
	2000	1.7	4.0	6.3	8.6	11.0	13.3	14.1	15.1
	1500	0.0	0.0	1.5	3.9	6.3	8.7	9.4	10.4
	1000	0.0	0.0	0.0	0.0	1.6	4.1	4.7	5.7
	500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		35	40	45	50	55	60	60	60
		Secondary Water Temperature (°C)							

Table 7: De-Rate Values for 1800 rpm Engines

3.9 Typical Engine Performance Data – Continuous Ratings

The following data shows the typical performance of 12VP185 engines operating with standard ratings as described in section 3.1 to 3.3. The following data has been recorded under the ISO conditions of 25°C ambient air, barometric pressure of 1 bar and a relative humidity of 30% unless otherwise stated. Please see notes column and the following section 'notes applicable to typical performance data'.

Notes	Description	Units	Engine Speed (revs/min)		
			1200	1500	1800
Power Outputs					
	Engine output	kWb	2165	2165	2200
	BMEP	bar	34.25	27.40	23.21
	Piston speed	m/s	7.84	9.80	11.76
	Compression ratio		13.1:1	13.1:1	13.1:1
Fuel Consumption					
1	Fuel consumption max power	g/kWh	202.4	202.2	207.5
1	Fuel consumption 75% max power	g/kWh	204.0	204.2	210.7
1	Fuel consumption 50% max power	g/kWh	208.1	212.8	223.3
	Lift Pump Flows	m^3/hr	1.3	1.3	1.6
	Max Suction Lift	m	2	2	2
Lub Oil					
	Sump capacity (min/max)	litres	277 / 308	277 / 308	277 / 308
2	Consumption rate	kg/hr	1.5	1.5	1.5
Aspiration Air					
	Air consumption	kg/s	4.7	4.7	5.0
	Air consumption	m^3/s	4.0	4.0	4.2
3	Intake depression	mbar	15	15	15
Exhaust Gas Data					
	Exhaust gas flow	kg/s	4.9	4.9	5.1
	Exhaust gas flow	m^3/s	9.5	8.7	9.0
4	Exhaust temp	°C	420	360	350
3	Back pressure	mbar	25	25	25
Radiated Heat					
5	Radiated heat from engine	kW	45	45	45
Primary Cooling Circuit					
	Capacity (pump suction to engine outlet)	litres	175	175	175
6	Flow rate	m^3/hr	112	112	140
6	External head	bar	1.0	1.0	1.0
7	Alarm/shutdown settings	°C/°C	90/95	90/95	90/95
8	Primary Heat Dissipation	kW	922	1007	1049
	Primary ΔT at Radiator	-	7.1	7.7	6.4
Secondary Cooling					
	Capacity (pump suction to engine outlet)	litres	120	120	120
9	Flow rate	m^3/hr	155	155	206
9	External head	bar	1.5	1.5	1.5
7	Alarm/shutdown settings	°C/°C	55/60	55/60	55/60
8	Secondary Heat Dissipation	kW	982	962	1064
	Secondary ΔT at Radiator	-	5.5	5.3	4.4

Table 8: Typical Performance Data – Continuous Ratings

3.10 Typical Engine Performance Data – Prime Ratings

The following data shows the typical performance of 12VP185 engines operating with standard ratings as described in section 3.1 to 3.3. The following data has been recorded under the ISO conditions of 25°C ambient air, barometric pressure of 1 bar and a relative humidity of 30% unless otherwise stated. Please see notes column and the following section 'notes applicable to typical performance data'.

Notes	Description	Units	Engine Speed (revs/min)		
			1200	1500	1800
Power Outputs					
	Engine output	kWb	2165	2300	2350
	BMEP	bar	34.25	29.11	24.78
	Piston speed	m/s	7.84	9.80	11.76
	Compression ratio		13.1:1	13.1:1	13.1:1
Fuel Consumption					
1	Fuel consumption max power	g/kWh	202.4	203.3	206.5
1	Fuel consumption 75% max power	g/kWh	204.0	206.9	209.3
1	Fuel consumption 50% max power	g/kWh	208.1	212.9	221.4
	Lift Pump Flows	m^3/hr	1.3	1.3	1.6
	Max Suction Lift	m	2	2	2
Lub Oil					
	Sump capacity (min/max)	litres	277 / 308	277 / 308	277 / 308
2	Consumption rate	kg/hr	1.5	1.5	1.5
Aspiration Air					
	Air consumption	kg/s	4.7	5.0	5.1
	Air consumption	m^3/s	4.0	4.2	4.3
3	Intake depression	mbar	15	15	15
Exhaust Gas Data					
	Exhaust gas flow	kg/s	4.9	5.1	5.2
	Exhaust gas flow	m^3/s	9.5	9.2	9.3
4	Exhaust temp	°C	420	370	360
3	Back pressure	mbar	25	25	25
Radiated Heat					
5	Radiated heat from engine	kW	45	45	45
Primary Cooling Circuit					
	Capacity (pump suction to engine outlet)	litres	175	175	175
6	Flow rate	m^3/hr	112	112	140
6	External head	bar	1.0	1.0	1.0
7	Alarm/shutdown settings	°C/°C	90/95	90/95	90/95
8	Primary Heat Dissipation	kW	922	1072	1092
	Primary ΔT at Radiator	-	7.1	8.2	6.7
Secondary Cooling					
	Capacity (pump suction to engine outlet)	litres	155	155	155
9	Flow rate	m^3/hr	155	155	206
9	External head	bar	1.5	1.5	1.5
7	Alarm/shutdown settings	°C/°C	55/60	55/60	55/60
8	Secondary Heat Dissipation	kW	982	1024	1103
	Secondary ΔT at Radiators	-	5.5	5.7	4.6

Table 9: Typical Performance Data – Prime Ratings

3.11 Typical Engine Performance Data – Limited Time Ratings

The following data shows the typical performance of 12VP185 engines operating with standard ratings as described in section 3.1 to 3.3. The following data has been recorded under the ISO conditions of 25°C ambient air, barometric pressure of 1 bar and a relative humidity of 30% unless otherwise stated. Please see notes column and the following section ‘notes applicable to typical performance data’.

Notes	Description	Units	Engine Speed (revs/min)		
			1200	1500	1800
Power Outputs					
	Engine output	kWb	2165	2520	2600
	BMEP	bar	34.25	31.89	27.42
	Piston speed	m/s	7.84	9.80	11.76
	Compression ratio		13.1:1	13.1:1	13.1:1
Fuel Consumption					
1	Fuel consumption max power	g/kWh	202.4	204.4	208.6
1	Fuel consumption 75% max power	g/kWh	204.0	203.3	209.7
1	Fuel consumption 50% max power	g/kWh	208.1	212.5	219.7
	Lift Pump Flows	m^3/hr	1.3	1.3	1.6
	Max Suction Lift	m	2	2	2
Lub Oil					
	Sump capacity (min/max)	litres	277 / 308	277 / 308	277 / 308
2	Consumption rate	kg/hr	1.5	1.5	1.5
Aspiration Air					
	Air consumption	kg/s	4.7	5.1	5.3
	Air consumption	m^3/s	4.0	4.3	4.5
3	Intake depression	mbar	15	15	15
Exhaust Gas Data					
	Exhaust gas flow	kg/s	4.9	5.2	5.5
	Exhaust gas flow	m^3/s	9.5	9.3	10.3
4	Exhaust temp	°C	420	380	390
3	Back pressure	mbar	25	25	25
Radiated Heat					
5	Radiated heat from engine	kW	45	45	45
Primary Cooling Circuit					
	Capacity	litres	175	175	175
6	Flow rate	m^3/hr	112	112	140
6	External head	bar	1.0	1.0	1.0
7	Alarm/shutdown settings	°C/°C	90/95	90/95	90/95
8	Primary Heat Dissipation	kW	922	1166	1213
	Primary ΔT at Radiator	-	7.1	9.0	7.5
Secondary Cooling					
	Capacity (pump suction to engine outlet)	litres	155	155	155
9	Flow rate	m^3/hr	155	155	206
9	External head	bar	1.5	1.5	1.5
7	Alarm/shutdown settings	°C/°C	55/60	55/60	55/60
8	Secondary Heat Dissipation	kW	982	1113	1225
	Secondary ΔT at Radiator	-	5.5	6.2	5.1

Table 10: Typical Performance Data – Limited Time Ratings

3.12 Notes Applicable to Typical Performance Data

1. The stated fuel consumptions apply to engines driving all essential pumps including primary, secondary, lubricating oil and fuel lift.

   Fuel consumption tolerance from stated figures -0 / +5%

2. Tolerance -0, +5%.
3. Values at full load – values above the reference value may require engine de-rate, depending on other parameters.
4. After low pressure turbocharger turbine (exhaust outlet).
5. Typical depending on ventilation air movement.
6. Figures based on example external system with a requirement for 1.0 bar of available head at synchronised speed.
7. Standard temperature switches
8. Heat dissipation based on a maximum ambient temperature / radiator air on temperature of 45°C. For heat dissipations beyond 45°C please contact MAN Diesel & Turbo UK Ltd.
9. Figures based on example external system with a requirement for 1.5 bar of available head at synchronised speed.

4 Governing Systems

4.1.1 Engine Actuator & Governor Speed Controller – Mechanical Injection

The minimum engine control system that MAN typically provides for industrial applications consists of an engine mounted actuator and an off engine mounted governor speed controller.

The engine mounted actuator provides mechanical actuation for the fuel injection racks in response to a control signal from the governor speed controller. For synchronised speed applications the governor speed controller will typically have 2 speed demand settings, one for the required synchronised speed and one for a lower speed idle. The governor speed controller will monitor key engine operating parameters in order to determine the actuator control signal.

The above system is designed to be used in conjunction with the generator control system.

4.1.2 Engine Control Panel – Electronic Injection

MAN is also able to offer electronic fuel injection. Electronic injection does not require mechanical fuelling control. The unit pump injectors are controlled by a current pulse from an electronic injection control unit. The electronic control unit is the equivalent of the mechanical speed controller but with the additional ability to map fuel injection timing across the operating envelope.

For synchronised speed applications the electronic injection control unit will typically have 2 speed demand settings, one for the required synchronised speed and one for a lower speed idle. The electronic injection control unit will monitor key engine operating parameters in order to determine the actuator control signal.

For more details of electronic injection see section 11.4.

There are many options available for engine governing, however the following are typical examples commonly fitted to the VP185.

4.1.3 Governing System – Woodward

The Woodward governing system consists of a UG engine mounted actuator and an off engine mounted 2301 governor speed controller.

The 2301 governor speed controller incorporates adjustable engine speed characteristics for all aspects of typical industrial operation. This includes start fuel limiting, idle and rated speed demand setting, acceleration ramp time adjustment, load response characteristics and engine protection behaviour.

The UG actuator is an electro-hydraulic actuator converting a current control signal into a proportional hydraulically driven output.

Key Features

- Engine actuator mechanical drive provides required hydraulic oil pressure for fuel rack operation.
- Self-contained oil supply.
- Isochronous and Droop setting available.
- In the absence of a signal from the magnetic pick-up the actuator will return to the minimum fuel setting.
- Multi-functional speed controller unit designed to handle typical operations of most industrial generator set applications.
- Expandable system with other Woodward industrial control products available.
- Low voltage or high voltage models available.

4.1.4 Governing System - Heinzmann

The Heinzmann governing system consists of a StG engine mounted actuator and an off engine mounted KG governor speed controller.

The KG governor speed controller incorporates a high level of functionality for all aspects of typical industrial operation. This includes start fuel limiting, idle and rated speed demand setting, acceleration ramp time adjustment, load response characteristics and engine protection behaviour.

The StG actuator is an electronic actuator converting a current control signal into a proportional torque motor output.

The Heinzmann system may be a more favourable option where a higher level of functionality and also a higher level of governing quality are required.

Key Features

- Fully electronic and therefore does not require mechanical drive.
- Maintenance free and long working life.
- Isochronous or Droop setting available.
- High level of functionality designed to handle typical operations of most industrial generator set applications.
- High precision electronic monitoring of actuator output shaft helps to provide short response times, little overshoot and high speed accuracy.
- Current limitation protection to prevent overheating in the event of the actuator being blocked mechanically.
- Expandable system with other Heinzmann industrial control products available.

4.1.5 Engine Wiring Loom

A standard engine wiring loom is fitted, which terminates in an engine mounted terminal box. The exhaust thermocouples (if specified) are connected to a separate wiring loom also terminating in an engine mounted terminal box.

4.1.6 Notes on Control System Wiring

All connecting wiring to the actuator and speed controller/generator control system must be screened and the screening earthed (joins in the screen cable should be kept at a minimum). Control and monitoring equipment wiring must be routed away from power cables (minimum distance 300mm), where wiring crosses power cables it must do so at 90°.

5 Load Acceptance

5.1 Typical Engine Start-Up Times

This section gives details of typical engine start-up times and minimum allowable times from engine start-up to the first application of load.

Important

The engine start-up times provided are based upon an engine which has not been running but has been maintained in the following conditioned state.

- Primary coolant temperature of 40°C – maintained by a coolant pre-heater
- Minimum oil prime level achieved – maintained by the oil priming system
- Start fuel limitation set to hold actuator output to an indicated rack position of 11mm

The above conditions help to guarantee a first time clean engine start without ignition delay and to safeguard the engine from potential damage. This also ensures minimum delay to load acceptance with reliable engine starting and load step performance.

Actuator Boost Unit (For Air Start Applications Only)

To further ensure a quick engine start-up and to reduce the initial engine cranking time an actuator boost unit is available for applications utilizing an air starter motor.

Under normal conditions (without a boost unit) it is typical to expect a delay between cranking and the initiation of fuel control due to lack of sufficient oil pressure. A boost unit uses compressed air to provide pressurised oil to the governor from the start of cranking. This ensures that fuel control is available at the same instance and can improve starting performance and reduce cranking time.

12VP185 Typical Engine Start-Up Times

Start-up times provided are for a mechanical injection engine without an actuator boost unit.

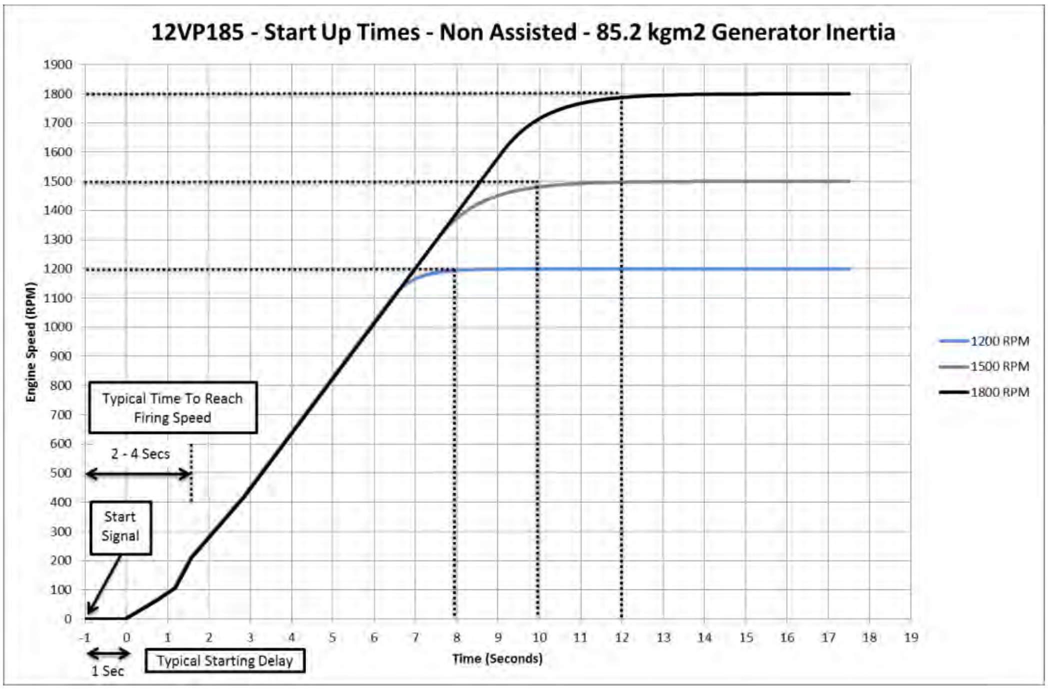


Figure 1: 12VP185 Typical Engine Start-Up Times

Engine Speed (rpm)	Start Delay + Cranking Time (secs)	Total Time to Rated Speed (secs)	Total Time Before Load Application (secs)
1200	2-4	8-10	8-10 + Synchronisation Delay
1500	2-4	10-12	10-12 + Synchronisation Delay
1800	2-4	12-14	12-14 + Synchronisation Delay

Table 11: 12VP185 Engine Start-Up – Time Before Load Application

5.2 ISO 8528 – Performance Class Operating Limits

In order to categorize generator set performance and to identify the correct compatibility for the intended supply, operating limits are specified for 4 performance classes within ISO 8528.

Parameter		Unit	Performance Class			
			G1	G2	G3	G4
Transient Frequency Deviation From Rated Frequency	100% Sudden Power Decrease	%	≤ + 18	≤ + 12	≤ +10	Customer Agreed
	Sudden Power Increase	%	≤ - 15	≤ - 10	≤ - 7	Customer Agreed
Frequency Recovery Time		S	≤ 10	≤ 5	≤ 3	Customer Agreed

Parameter		Unit	Performance Class			
			G1	G2	G3	G4
Transient Voltage Deviation From Rated Frequency	100% Sudden Power Decrease	%	≤ + 35	≤ + 25	≤ + 20	Customer Agreed
	Sudden Power Increase	%	≤ - 25	≤ - 20	≤ - 15	Customer Agreed
Voltage Recovery Time (Load Increase/Decrease)		S	≤ + 10	≤ + 6	≤ + 4	Customer Agreed

Table 12: ISO 8528 Key Performance Class Operating Limits

5.3 ISO 8528 – Guideline Values for Maximum Possible Power Increases

With respect the above performance class operating limits ISO 8528 also gives guideline values for maximum possible power increases (load steps) as a function of engine BMEP. As a general rule engines with a high BMEP also have high rates of acceleration / de-acceleration which can limit their load acceptance capability.

For the 12VP185 the guideline relationship illustrates a maximum 1^{st} load step of approx. 25% based on a typical 12VP185 BMEP of 3000 kPa.

Load capability of the 12VP185 is dependent upon the chosen power rating, engine speed and generator set inertia. In applications where the generator inertia is assumed to be 85.2 kgm^2, load capability exceeds this guideline limitation and can support 1^{st} load steps of up to 70% whilst adhering to G2 performance class operating limits.

5.4 12VP185 1st Load Step Performance – 1200 rpm Applications

Please note whilst figures are representative, they are for guidance only. Please also observe notes applicable to load step performance data in section 5.7

Continuous / Prime / Limited Time Ratings

Engine Rating (kW)	Load Step %	Frequency Deviation %	Max Voltage Deviation %	Recovery Time (secs)	Performance Classes		
					G1	G2	G3
2165	30	1.0	-14	2			
2165	45	5.2	-14	2.5			
2165	50	7.5	-14	2.6			

Table 13: 1200 rpm Applications – Load Step Performance – Cont / Prime / Limited Ratings

5.5 12VP185 1st Load Step Performance – 1500 rpm Applications

Please note whilst figures are representative, they are for guidance only. Please also observe notes applicable to load step performance data in section 5.7

Continuous Ratings

Engine Rating (kW)	Load Step %	Frequency Deviation %	Max Voltage Deviation %	Recovery Time (secs)	Performance Classes		
					G1	G2	G3
2165	30	0.5	-14	2			
2165	55	6.7	-14	3			
2165	60	8.7	-14	3.2			

Table 14: 1500 rpm Applications – Load Step Performance – Continuous Ratings

Prime Ratings

Engine Rating (kW)	Load Step %	Frequency Deviation %	Max Voltage Deviation %	Recovery Time (secs)	Performance Classes		
					G1	G2	G3
2300	30	0.8	-14	2.2			
2300	50	6.0	-14	3			
2300	60	10.1	-14	3.2			

Table 15: 1500 rpm Applications – Load Step Performance – Prime Ratings

Limited Time Ratings

Engine Rating (kW)	Load Step %	Frequency Deviation %	Max Voltage Deviation %	Recovery Time (secs)	Performance Classes		
					G1	G2	G3
2520	30	1.2	-14	2.2			
2520	45	5.7	-14	3			
2520	50	7.7	-14	3.2			

Table 16: 1500 rpm Applications – Load Step Performance – Limited Time Ratings

5.6 12VP185 1st Load Step Performance – 1800 rpm Applications

Please note whilst figures are representative, they are for guidance only. Please also observe notes applicable to load step performance data in section 5.7

Continuous Ratings

Engine Rating (kW)	Load Step %	Frequency Deviation %	Max Voltage Deviation %	Recovery Time (secs)	Performance Classes		
					G1	G2	G3
2200	30	0.4	-14	2.2			
2200	50	3.5	-14	3			
2200	70	9.7	-14	3.5			

Table 17: 1800 rpm Applications – Load Step Performance – Continuous Ratings

Prime Ratings

Engine Rating (kW)	Load Step %	Frequency Deviation %	Max Voltage Deviation %	Recovery Time (secs)	Performance Classes		
					G1	G2	G3
2350	30	0.7	-14	2.2			
2350	50	4.5	-14	3			
2350	65	9.5	-14	3.5			

Table 18: 1800 rpm Applications – Load Step Performance – Prime Ratings

Limited Time Ratings

Engine Rating (kW)	Load Step %	Frequency Deviation %	Max Voltage Deviation %	Recovery Time (secs)	Performance Classes		
					G1	G2	G3
2600	30	0.95	-14	2.5			
2600	45	4.2	-14	3			
2600	60	10.0	-14	3.6			

Table 19: 1800 rpm Applications – Load Step Performance – Limited Time Ratings

5.7 Notes Applicable to Load Step Performance Data

1. Figures have been based upon a mixture of real data and simulation data using known generator set inertias and available engine power. These figures whilst representative are therefore for guidance only. For exact predictions in response to a known or proposed load please contact MAN Diesel & Turbo UK Ltd.

2. Load performance data has been based upon a generator with optimised AVR settings, including the use of a LAM (Load Assistance Module) to utilize the maximum allowable voltage deviation to reduce load during the transient period.

3. Further optimisation of AVR and LAM settings may allow load steps in excess of that stated. To discuss your exact requirements, please contact MAN Diesel & Turbo UK Ltd.

4. Performance data has been based upon a generator inertia of 85.2 kgm^2.

5. Performance data has been based upon an engine with standard mechanical injection.

5.8 Sudden Power Decrease Performance

Sudden power decrease performance is dominated by the engine actuator characteristics and also inertia. It will therefore vary depending upon the actuator unit / governing system fitted and the total inertia of the generator set.

The use of electronic fuel injection can further improve the governing system performance and help to achieve more stringent requirements.

For the example governing systems as described in section 4 using standard mechanical injection, with the correct optimisation can achieve G3 operating limits.

5.9 Base Loading / Second Load Step Performance

Engine load step performance is generally improved when there is an existing load on the generator set. With some base load the engine is generating more boost than it would be unloaded and therefore helps to provide an improved response and load capability.

For the support of loads greater than the stated allowable 1st load steps in sections 5.4 to 5.6 and for instances where some base load already exists (as in a varying load), reaching higher loads or maximum power can be achieved with a subsequently increased load rate.

Allowable second load step / increased load rate will be dependent upon the optimisation of the governing system, generator set inertia and available engine boost. To discuss your requirements please contact MAN Diesel & Turbo UK Ltd.

5.10 Adjustment for Generator Inertia

Engine start-up times and load step performance data has been based on an example generator inertia of 85.2 kgm^2.

Increasing inertia is expected to extend engine starting times but increase the load step capability. Decreasing inertia is expected to reduce engine starting times but decrease the load step capability.

Using the following adjustment factors, engine starting times and the allowable 1st load steps can be adjusted accordingly.

Engine Starting – Generator Inertia Adjustment

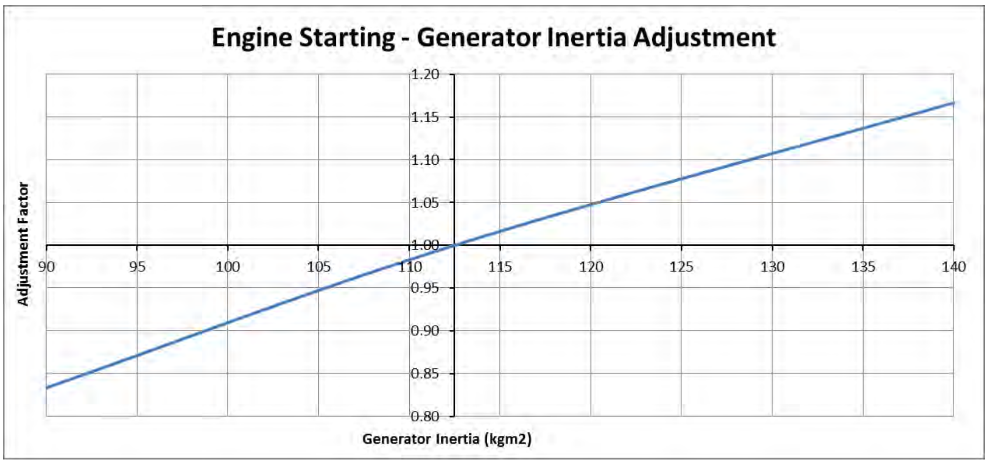


Figure 2: Engine Starting - Generator Inertia Adjustment

Load Step – Generator Inertia Adjustment

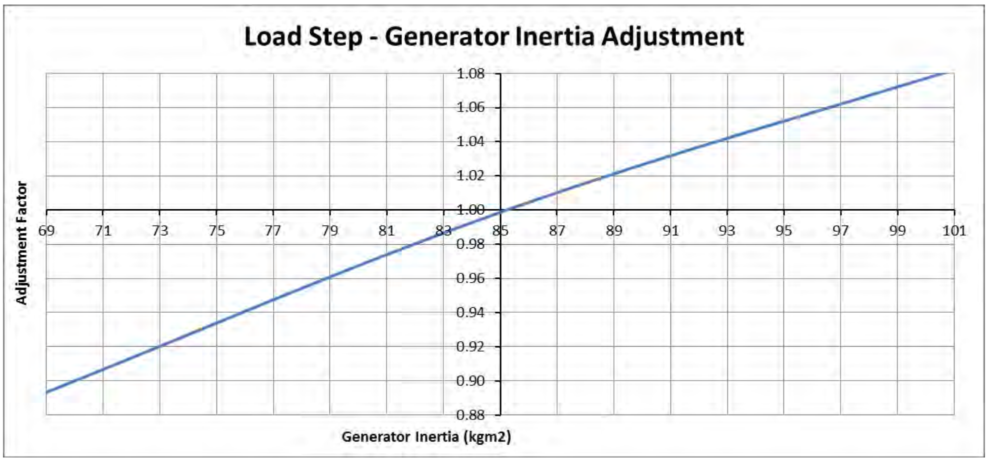


Figure 3: Load Step – Generator Inertia Adjustment

6 Noise Data

6.1 Microphone Arrangement

The following diagram shows the microphone arrangement used to collect noise levels from around the engine. Microphones are situated at approximately 1 metre from the engine / dynamometer at each position.

Each position has a designated number which is referenced throughout the following data so the source of each noise level can be identified.

Data is provided in standard octave bands however is available in 1/3 octave bands upon request. Please contact MAN Diesel & Turbo UK Ltd.

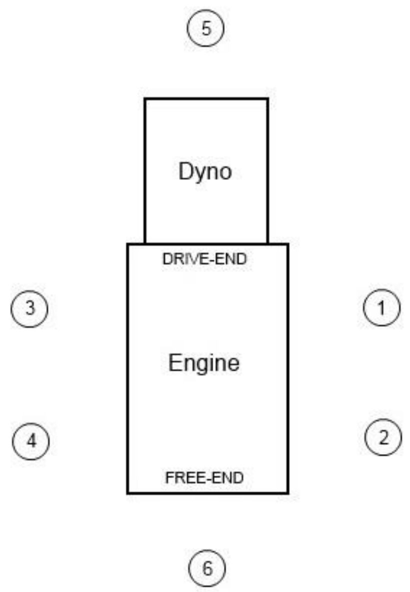


Figure 4: Noise Data Microphone Arrangement

6.2 Standard & Silenced Air Intake / Acoustic Panels

The standard 12VP185 air intake housings have no noise attenuation. This is the most basic option and provides a benchmark for standard VP185 sound levels.

Multiple noise reduction options are available in order to help meet the user’s requirements. MAN Diesel & Turbo UK is able to offer intake housings with louvres and additionally acoustic panels & air filter noise shields.

6.3 12VP185 Airborne Noise – 2165 kW at 1200 rpm – Standard Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	80	69	81	90	97	95	104	97	105	118	108	121.3
2	78	68	81	86	91	96	102	99	105	115	109	119.8
3	78	73	82	85	100	98	102	99	103	123	113	126.1
4	79	72	82	90	100	101	105	99	101	119	113	121.9
5	88	61	79	83	89	89	101	92	94	107	95	111.8
6	88	51	66	83	80	90	95	91	87	97	79	101.7

Table 20: Noise Data - 12VP185 – 2165 kW at 1200 rpm – Standard Air Intake

6.4 12VP185 Airborne Noise – 2165 kW at 1200 rpm – Silenced Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	79	69	79	95	95	94	102	97	95	100	100	109.9
2	79	68	82	95	92	97	102	99	94	106	106	112.6
3	78	72	78	88	100	95	102	98	95	106	102	112.4
4	81	73	78	90	98	99	103	96	93	104	102	111.6
5	85	66	74	84	89	90	98	93	88	93	89	105.3
6	91	57	69	91	87	93	98	96	89	94	88	106.8

Table 21: Noise Data – 12VP185 – 2165 kW at 1200 rpm – Silenced Air Intake

6.5 12VP185 Airborne Noise – 2165 kW at 1200 rpm – Maximum Attentuation

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	78	56	75	93	89	87	95	91	86	88	72	99
2	70	65	80	93	85	93	97	93	87	95	85	103
3	69	71	77	83	94	90	96	92	88	96	84	104
4	70	71	75	88	93	95	95	91	87	95	79	103
5	71	68	75	81	89	91	97	92	88	94	85	105
6	81	49	68	91	86	91	94	91	83	92	81	102

Table 22: Noise Data – 12VP185 – 2165 kW at 1200 rpm – Maximum Attentuation

6.6 12VP185 Airborne Noise – 2165 kW at 1500 rpm – Standard Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	78	81	83	94	99	98	104	100	106	116	108	121.5
2	79	80	83	91	96	99	104	101	106	114	109	120.4
3	78	83	84	91	102	101	104	101	104	120	112	125.8
4	80	82	84	93	102	102	106	101	103	116	112	121.7
5	87	72	81	91	93	92	101	95	96	105	94	112.2
6	87	72	76	91	92	97	101	97	97	107	95	113.6

Table 23: Noise Data - 12VP185 – 2165 kW at 1500 rpm – Standard Air Intake

6.7 12VP185 Airborne Noise – 2165 kW at 1500 rpm – Silenced Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	78	79	81	96	97	98	104	99	99	104	104	113.9
2	80	78	82	95	96	99	104	100	98	105	104	114
3	78	80	81	94	101	99	104	100	98	104	102	114
4	80	80	81	95	100	99	104	99	98	105	102	114.4
5	86	71	79	91	92	94	100	95	92	93	88	107.7
6	89	70	77	92	91	96	100	97	93	93	87	108.5

Table 24: Noise Data – 12VP185 – 2165 kW at 1500 rpm – Silenced Air Intake

6.8 12VP185 Airborne Noise – 2165 kW at 1500 rpm – Maximum Attentuation

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	77	64	77	94	91	91	97	93	90	91	75	102
2	71	75	80	93	89	95	99	94	91	94	84	105
3	69	79	80	89	95	94	97	93	90	94	84	105
4	69	78	78	93	95	95	96	94	92	96	79	106
5	72	73	80	88	92	95	99	94	92	94	84	108
6	80	60	76	92	90	94	96	92	87	91	80	103

Table 25: Noise Data – 12VP185 – 2165 kW at 1500 rpm – Maximum Attentuation

6.9 12VP185 Airborne Noise – 2300 kW at 1500 rpm – Standard Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	77	82	83	94	98	99	105	100	105	118	112	120.4
2	81	81	84	91	96	99	104	101	105	120	112	121.7
3	78	82	83	91	101	102	104	101	103	122	117	123.7
4	80	83	84	92	101	102	106	100	103	123	120	124
5	88	74	80	90	93	92	100	95	96	112	99	113
6	88	73	78	91	92	98	101	98	96	113	100	114.6

Table 26: Noise Data - 12VP185 –2300 kW at 1500 rpm – Standard Air Intake

6.10 12VP185 Airborne Noise – 2300 kW at 1500 rpm – Silenced Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	77	78	80	94	96	98	103	99	99	112	106	115.1
2	80	78	81	93	97	99	104	99	98	109	102	113.4
3	78	80	82	92	99	98	103	99	98	107	105	112.6
4	82	79	81	91	98	98	102	99	98	105	99	112.1
5	86	71	79	90	94	93	99	94	93	99	87	107
6	87	70	77	92	91	96	100	97	93	98	90	107.8

Table 27: Noise Data – 12VP185 – 2300 kW at 1500 rpm – Silenced Air Intake

6.11 12VP185 Airborne Noise – 2300 kW at 1500 rpm – Maximum Attentuation

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	76	63	76	92	90	91	96	93	90	98	76	103
2	71	75	79	91	90	95	99	93	91	98	82	104
3	69	79	81	87	93	93	96	93	90	97	86	104
4	70	77	78	89	93	94	94	94	92	96	77	104
5	72	73	80	87	94	94	98	93	93	100	83	107
6	78	60	76	92	90	94	96	92	87	96	83	103

Table 28: Noise Data – 12VP185 – 2300 kW at 1500 rpm – Maximum Attentuation

6.12 12VP185 Airborne Noise – 2200 kW at 1800 rpm – Standard Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	76	93	85	98	101	101	104	103	107	114	108	121.7
2	80	92	85	96	101	102	106	103	107	113	109	121
3	78	93	86	97	104	104	106	103	105	117	111	125.5
4	81	92	86	96	104	103	107	103	105	113	111	121.5
5	86	83	83	99	97	95	101	98	98	103	93	112.6
6	86	93	86	99	104	104	107	103	107	117	111	125.5

Table 29: Noise Data - 12VP185 – 2200 kW at 1800 rpm – Standard Air Intake

6.13 12VP185 Airborne Noise – 2200 kW at 1800 rpm – Silenced Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	77	89	83	97	99	102	106	101	103	108	108	117.9
2	81	88	82	95	100	101	106	101	102	104	102	115.4
3	78	88	84	100	102	103	106	102	101	102	102	115.6
4	79	87	84	100	102	99	105	102	103	106	102	117.2
5	87	76	84	98	95	98	102	97	96	93	87	110.1
6	87	83	85	93	95	99	102	98	97	92	86	110.2

Table 30: Noise Data – 12VP185 – 2200 kW at 1800 rpm – Silenced Air Intake

6.14 12VP185 Airborne Noise – 2200 kW at 1800 rpm – Maximum Attentuation

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	76	72	79	95	93	94	98	95	93	95	78	106
2	71	85	80	93	93	96	101	95	94	93	82	106
3	69	87	83	95	96	98	99	95	93	92	84	107
4	68	85	81	98	97	95	97	97	96	97	79	108
5	73	78	85	95	95	99	101	96	96	94	83	110
6	78	72	84	93	94	96	98	93	91	90	79	105

Table 31: Noise Data – 12VP185 – 2200 kW at 1800 rpm – Maximum Attentuation

6.15 12VP185 Airborne Noise – 2600 kW at 1800 rpm – Standard Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	87	97	89	94	96	103	107	102	105	120	114	121.3
2	89	96	90	95	100	102	106	103	106	120	115	121.6
3	103	103	102	100	102	104	107	103	105	129	121	129
4	97	94	92	94	101	103	107	104	104	128	120	128.2
5	92	88	85	96	97	97	103	98	98	115	102	116
6	93	89	78	94	94	97	105	100	99	116	104	117

Table 32: Noise Data - 12VP185 – 2600 kW at 1800 rpm – Standard Air Intake

6.16 12VP185 Airborne Noise – 2600 kW at 1800 rpm – Silenced Air Intake

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	88	98	87	96	94	103	107	101	103	115	116	118.1
2	89	97	88	95	100	102	106	102	102	116	111	117.9
3	90	92	85	94	100	102	107	103	102	116	109	118.3
4	93	91	85	93	99	100	109	104	103	115	116	118.5
5	92	89	84	94	95	97	102	98	97	105	97	110.6
6	93	89	77	92	95	96	103	99	98	104	95	111.4

Table 33: Noise Data – 12VP185 – 2600 kW at 1800 rpm – Silenced Air Intake

6.17 12VP185 Airborne Noise – 2600 kW at 1800 rpm – Maximum Attentuation

Micro-phone Position	Z Weighting (dB)											"A" Weighting (dB)
	16 Hz	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	16K Hz	LAeq
1	87	80	82	94	89	95	99	95	93	101	84	106
2	79	93	86	93	93	97	101	96	94	104	89	108
3	79	90	84	89	94	97	100	96	94	105	90	109
4	80	88	82	91	94	96	101	99	96	105	90	110
5	77	91	85	91	95	98	101	97	97	106	92	110
6	83	77	76	92	94	94	99	94	92	102	88	106

Table 34: Noise Data – 12VP185 – 2600 kW at 1800 rpm – Maximum Attentuation

7 Exhaust Emissions

Exhaust emission figures will be dependent upon the engine rating, ambient conditions and the expected area of operation (typical load). Additionally legislation for exhaust emissions varies for land based power generation due to individual countries preferences on allowable quantities, preferences of emission types and the format of how these emissions are assessed.

Furthermore depending whether the user selects mechanical or electrical fuel injection will further have an effect on achievable emission levels. In the case of electronic fuel injection, general trends show that emissions such as NOx output are a compromise of fuel consumption, and therefore will also depend upon the user's preference.

Further improvement of emissions is possible with the addition of an SCR (Selective Catalytic Reduction) system. With an SCR system it is possible to meet very stringent limits with reference to NOx output levels with reductions of up to 95% and therefore will also influence final figures. For more details of an SCR system see section 12.8.

For estimated emission figures and to discuss your exact requirements please contact MAN Diesel & Turbo UK Ltd.

8 Starting Systems

The engine is started by either electric start motors or a compressed air starter motor. Standard engines are able to locate duty and standby start systems should the application demand.

8.1 Engine Starting Torque

The required starter motor torque to start the engine is primarily based upon friction and resistance to rotation through cylinder pumping losses.

The influence of increasing inertia is limited and therefore it should not be necessary for the user to increase starter motor torque.

Both electric and air start options given below are designed to work in applications where combined engine and driven machinery inertia is high, therefore for most industrial applications the following starters will provide sufficient torque for all requirements.

Other makes of starter can be supplied if required.

8.2 Electric Start – Delco Remy Model 50MT

The electric start option consists of 2 x 24 volt starter motors each with a 9kW output, designed to work in parallel to provide a combined power output of 18kW.

Each starter motor is a positive engagement type heavy duty motor using a 13 teeth pinion designed to work with the VP185's standard 222 teeth starter ring.

The starter assembly is completed with a pre-wired terminal box ready to be connected to the engine control system.

The above description outlines the standard scope of supply for the electric start option. Batteries, interconnecting cabling, and a battery charging system are additional options.

8.2.1 Battery Requirements

It is recommended that only batteries designated as "starting batteries" or batteries with a stated engine start capability are used. Furthermore suitably sized batteries or a bank of batteries should be dedicated just for engine starting.

Suitable engine starting batteries must have the correct combination of Ah (amp hours) and high discharge rate ability. High discharge ability is typically indicated by CCA (cold cranking amps) rating or a stated high discharge amps rating. This will vary between manufacturers and therefore using the following information suitable batteries should be selected with help and advice of a battery supplier.

For the VP185 the typical starter motor engagement time is 3 seconds. During this time the average current draw for 2 starter motors is approx. 1350 amps with a maximum inrush current of 3050 amps. This example represents optimum engine starting therefore an allowance should be added to account for the potential of extended cranking periods.

Additionally as per electric starter motor manufacturers instructions batteries must have a maximum CCA rating of 1800 amps per starter motor (3600 amps for 2 starter motors). Alternatively if maximum CCA rating is to be exceeded a starter motor with over crank protection needs to be specified.

<u>Example Battery Specification</u>

Battery Type: Lead Acid
Minimum CCA rating: 3000 amps (for 2 starter motors)

Min rating of 450 Ah for a 10 hour total discharge time

The above Ah rating has been based on the requirement for a minimum of 6 engine starts each with a maximum cranking time of 6 seconds. Additional capacitance has been added to account for significantly reduced capacitance during high discharge, aging of battery, and to provide a useful charge between charges.

For an additional number of required engine starts battery capacitance should be increased proportionally to the number of starts e.g. capacitance for 8 starts =450/6 = 75, 75*8 = 600 Ah

Other battery types will behave differently to lead acid types therefore the above is only suitable for lead acid batteries.

8.2.2 Battery Charging

Batteries should be maintained at full capacity using a 24-volt charger, matched to the battery capacity.

An engine mounted battery charging alternator can be supplied. For details of a battery charging alternator please contact MAN Diesel & Turbo UK Ltd.

8.3 Air Start – TDI Model 45M

The air start option consists of a single, turbine driven, pre-engaged type starter motor with an output of approx.40 kW at a cranking speed of 150 rpm when operating with a system pressure of 145 psig.

The air starter motor uses a 14 teeth pinion gear designed to work with the VP185's standard 222 teeth starter ring. The starter has a rotatable drive housing and also rotatable inlet nozzle for convenient positioning of the starter solenoid and air supply piping.

The starter motor has an internal control module which reads output shaft speed and shuts off air to the motor in an unloaded or over-speed condition.

8.3.1 Minimum System Requirements

In order to safely install and operate the air starter motor the minimum system requirements are:

- Air reservoir (storage tank) – to provide compressed air to drive the starter motor.
- Additionally a means of maintaining levels of compressed air is required via an existing system or a dedicated system.
- Air pressure regulator & Indication valves – To maintain and check max system pressures.

8.3.2 Air Reservoir

For an 12VP185 it is expected that the engine will start within 6 seconds at a consumption rate of approximately 568 litres per second (free air). (3408 litres total per start)

On this basis of 3408 litres (free air) per engine start, the required size of a suitable air receiver can be calculated as follows.

<u>Example calculation</u>

If air is stored at 40 bar then requirement for air is 1/40th of that of free air (approximately 1 bar)

Therefore: 3408/40 = 85.2 litres per start

For 6 engine starts air receiver would need to have capacity of 511.2 litres

From the above example it can be seen that the size of the air receiver is a compromise of cost and weight. The greater pressure the air is stored at the smaller the air receiver can be, however a higher tank pressure must be maintained.

8.3.3 System Pressures

Care should be taken to ensure that the maximum starter motor operating inlet pressure does not exceed 150 psig (10.3 bar). A 1/8" NPT inlet pressure check port is provided to check this. Note pressure measured here reflects all supply air piping and valve losses.

If inlet operating pressure exceeds maximum allowable pressure then a pressure reducing valve or device must be installed.

For industrial applications MAN Diesel & Turbo UK Ltd recommends an operating pressure of 145 psig (gauge pressure) (10 bar), with the expectancy of system pressure losses to give approx. 116 to 130.5 psig (8 to 9 bar) operating pressure at the 1/8" NPT inlet pressure check port.

To satisfy these requirements care should be taken when specifying the compressed air starting system, in particular pipe size.

9 Water Cooling System

The engine has two independent cooling water systems, primary and secondary.

9.1 Primary System

Coolant Capacity: 175 Litres (pump suction to engine outlet)

On the 12VP185 industrial engine inhibited glycol coolant is pumped around the engine by an on engine mounted centrifugal type pump. Coolant initially flows from the coolant pump into the free end cover and crankcase. Coolant then flows through the crankcase passages and around the cylinder liners. From the crankcase the majority of the coolant flows up into the cylinder heads but some coolant is diverted to the after-cooler.

Coolant from the cylinder heads flows into the exhaust manifold jackets and then into the turbocharger housings where coolant from the after-cooler re-joins the main flow. Coolant then flows to a thermostat where temperature dependent the coolant will either bypass back to the pump or onto an off engine mounted cooler / radiator before repeating the cycle.

For a typical primary water schematic see MAN drawing 2015D049.

9.1.1 Primary Coolant Pump Characteristic

The following graph shows the pump characteristic for all standard synchronised engine speeds. Please note that the engine pressure loss curve and the stated pump flows and head figures whilst representative are for guidance only.

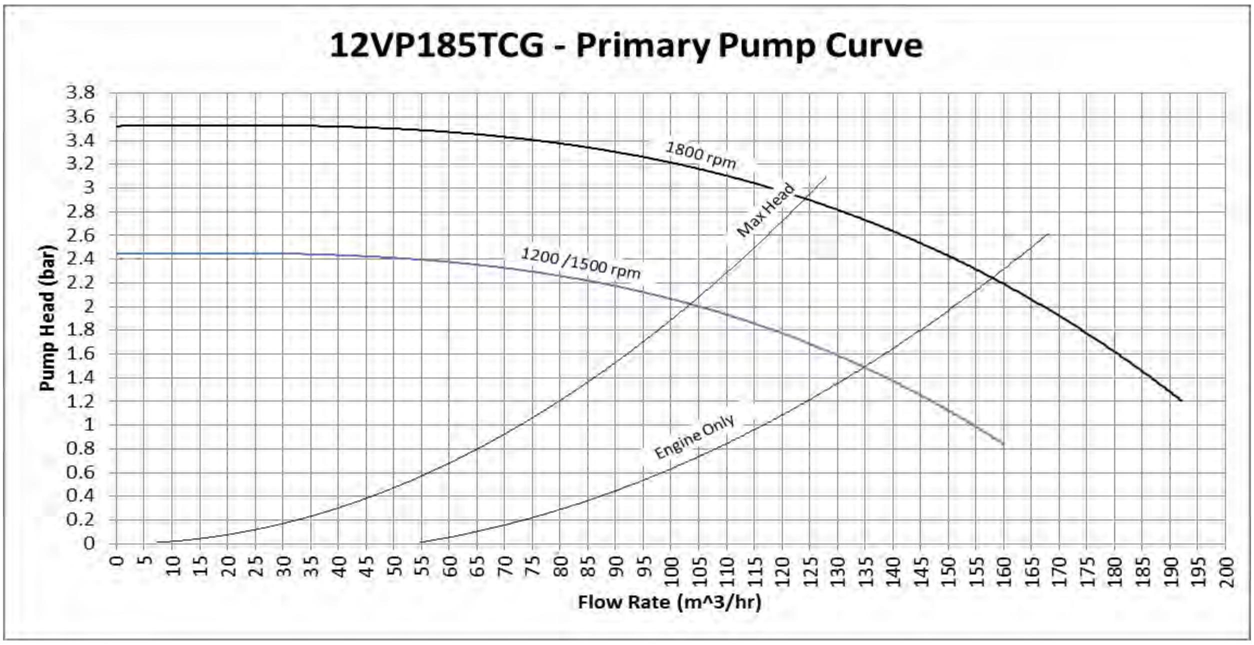


Figure 5: Primary Coolant Pump Characteristic

The following data shows pump flows for an example external system head requirement of 1.0 bar for each standard synchronised speed. Maximum head available for the external system across the pump operating range is shown in 9.1.2.

DESCRIPTION	UNITS	1200 rpm	1500 rpm	1800 rpm
Flow Rate	**m^3/ hr**	112	112	140
Available Pump Head	**bar**	1.0	1.0	1.0
Normal Temp Range	**°C**	77 to 90	77 to 90	77 to 90
High Temp Alarm / Shutdown	**°C / °C**	91 / 96	91 / 96	91 / 96

Table 35: Primary Coolant System Data – Example Operating Points

9.1.2 Maximum Available Head

The following graph shows the relationship between available pump head and pump flow rate, and also the maximum available head for each engine speed.

This graph can help the user to estimate the operating point for the pump for any given head requirement, respecting that no further head is available beyond the max head curve.

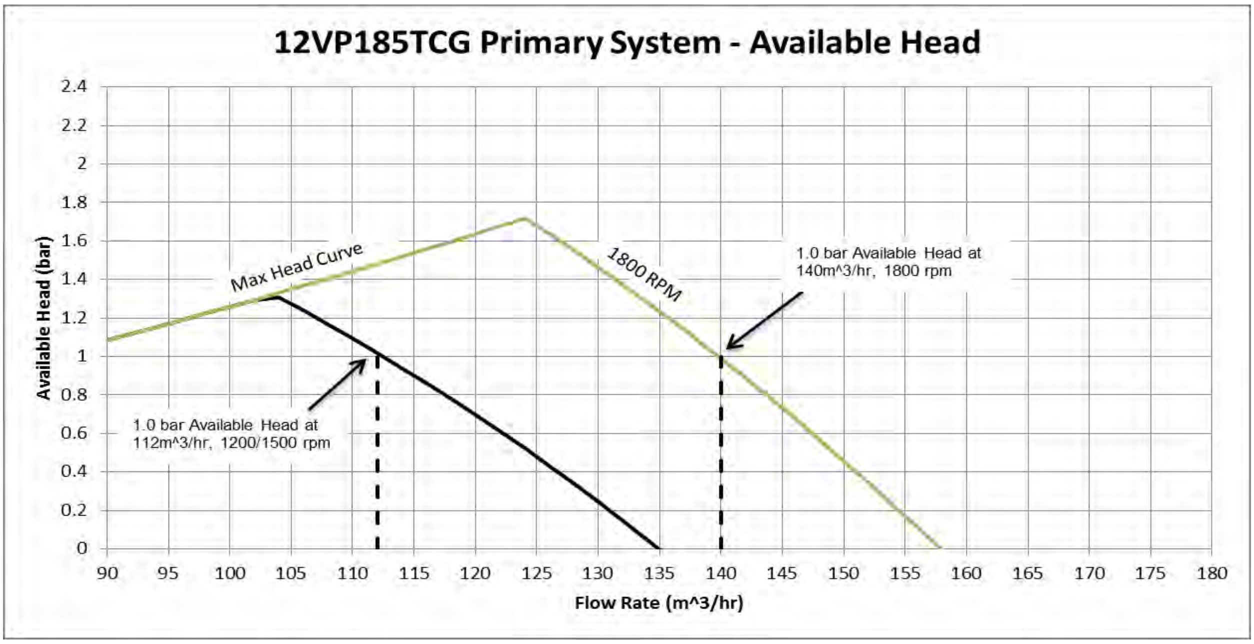


Figure 6: Primary Coolant System – Maximum Available Head

9.1.3 Primary Pre-Heater System

Cold Starting

To ensure that a clean 1st time start is achieved a primary coolant heater should be installed. The heater keeps the engine at a recommended minimum starting temperature of 40°C and will also help to prevent white smoke on start up.

For most applications a pre-heater is an essential requirement; however the level of pre-heating required will depend on the expected ambient conditions.

In areas of high humidity a pre-heater will be required to prevent the onset of condensation during standby periods.

Pre-Heater Selection

The following table shows how the pre-heater power output should be adjusted in accordance with the expected ambient conditions.

Applications operating in tropical conditions will only require minimum output whilst more severe conditions will require a higher output in order to maintain the minimum 40°C starting temperature.

Ambient Temperature	Primary Coolant Pre-Heater Output
Above 30°C	6 kW
10 to 30°C	9kW
-10 to 10°C	12 kW

Table 36: Engine Coolant Pre-Heater Selection

A representative example of the primary coolant pre-heating system is shown in MAN drawing 2014D065. The heating element and pump assembly is supplied loose and is required to be mounted in an off engine location.

For further details please contact MAN Diesel & Turbo UK Ltd

9.1.4 Primary Coolant Water Treatment

In order to protect the engine against bi-metallic and surface corrosion engine coolant must be treated with a corrosion inhibitor. Additionally any application that is potentially subjected to low ambient temperatures below 5°C must also use an anti-freeze additive.

Applications operating in tropical climates are not required to use anti-freeze and therefore only a single additive of approved corrosion protection is required. However it should be noted a single corrosion inhibitor needs to be regularly maintained. If there is any doubt the MAN Diesel & Turbo UK Ltd PAXCOOL inhibitor and anti-freeze additive is a fit and forget product.

Coolant Water Quality

IMPORTANT

It should be noted that the use of poor quality or contaminated water as a base for engine coolant will reduce the effect of any additives used.

It is therefore very important to use only clean drinking quality water that meets that the following specification.

Maximum level of chlorides below 50 ppm
PH value between 7 and 7.8 (indication of pure water)

If the above specification is not achievable or available, distilled demineralized water will need to be used.

Note it will be the responsibility of the user to check and ensure that the above specification of water is met.

Recommended Additives

The following coolant additives are recommended examples for use in all VP185 engines.

PAXCOOL – This is a specifically formulated mixture of both corrosion inhibitor and anti-freeze developed exclusively for the VP185 range of engines.

PAXCOOL mixed in the ratio of 33.3% to 66.6% drinking quality water will protect the engine to -18°C

Stronger concentrations will protect to a greater extent e.g. 50% PAXCOOL to 50% drinking quality water will protect the engine to -25°C.

PAXCOOL is a fit and forget product that requires no maintenance during its useful lifetime between standard maintenance tasks.

NALFLEET 9-111 – This is a corrosion inhibitor only, noted particularly for its favourable protection for aluminium. This product will need to be monitored more closely.

For NALFLEET 9-111 a concentration ratio of 1 litre NALFLEET to 125 litres of drinking quality water should be used.

9.2 Secondary System

Coolant Capacity: 120 Litres (pump suction to seawater outlet)

On the 12VP185 industrial engine inhibited glycol in the secondary system is pumped around the engine by an on engine mounted centrifugal type pump. Coolant flows from the pump and splits into 2 paths to serve engine mounted coolers.

Coolant then flows to a thermostat where temperature dependent the coolant will either bypass back to the pump or on to an off engine mounted cooler / radiator before repeating the cycle.

For a typical secondary water schematic see MAN drawing 2015D044.

9.2.1 Secondary Pump Characteristics

The following graph shows the pump characteristic for all standard synchronised engine speeds. Please note that the engine pressure loss curve and the stated pump flows and head figures whilst representative are for guidance only.

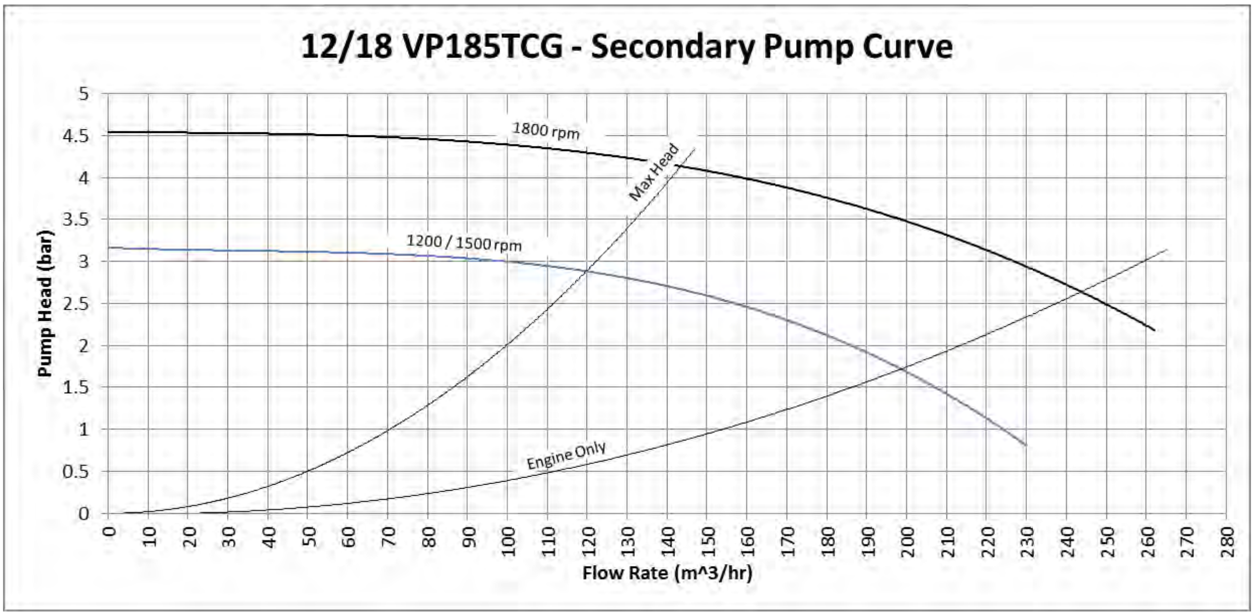


Figure 7: Secondary Pump Characteristic

The following data shows pump flows for an example external system head requirement of 1.0 bar for each standard synchronised speed. Maximum head available for the external system across the pump operating range is shown in 9.2.2.

DESCRIPTION	UNITS	1200 rpm	1500 rpm	1800 rpm
Flow Rate	**m^3/ hr**	155	155	206
Available Pump Head	**bar**	1.5	1.5	1.5
Normal Temp Range	**°C**	45 to 55	45 to 55	45 to 55
High Temp Alarm / Shutdown	**°C / °C**	68 / 73	68 / 73	68 / 73

Table 37: Secondary System Data – Engine Only

9.2.2 Maximum Available Head

The following graph shows the relationship between available pump head and pump flow rate, and also the maximum available head for each engine speed.

This graph can help the user to estimate the operating point for the pump for any given head requirement, respecting that no further head is available beyond the max head curve.

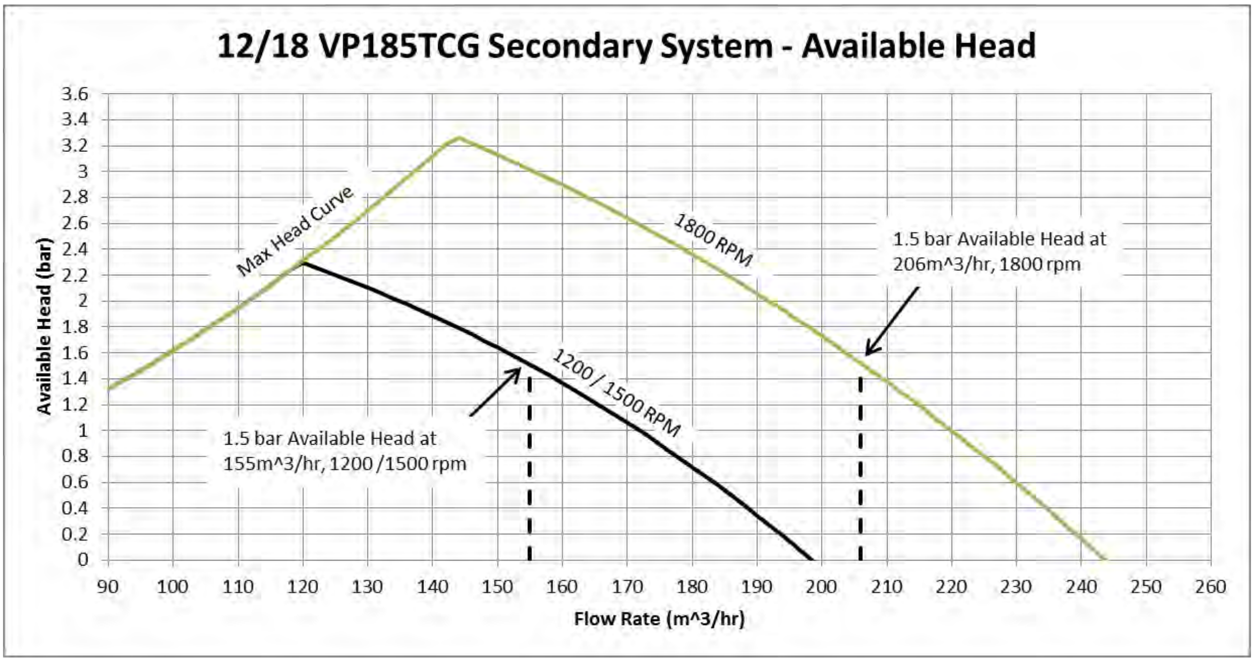


Figure 8: Secondary Coolant System – Maximum Available Head

10 Lubricating Oil System

Sump Capacity: 287 / 308 (min/max static)

Oil is pumped around the engine by the on engine gear driven oil pump. An oil relief valve maintains system pressure.

The 12VP185 uses a duplex filter arrangement for its main filtration. This arrangement allows the operation to isolate individual elements for replacement during engine operation.

The 12VP185 also has a centrifugal oil filter. A small quantity of oil is diverted prior to the oil cooler and sent to the centrifugal filter where the oil is effectively cleaned, removing and absorbing any contaminants in the oil. The cleaned oil is then returned to the sump.

For a typical oil schematic see MAN drawing 2015D046.

10.1 Oil Consumption

Oil consumption will vary according to application but typical consumption is expected to be < 1.5 kg/hr.

10.2 Oil Priming

The oil priming sequence is controlled by the generator control system in auto mode but can be set to manual and started via the local priming pump panel.

A representative example of the priming pump included with the engine is shown in MAN drawing 2014D064. A representative example of a priming pump starter panel is shown in MAN drawing 2016D056 The priming pump and starter panel are both supplied loose and are required to be mounted in an off engine location.

The priming pump should be installed as close to the engine as possible to minimise suction piping and must be installed below the minimum run oil level to ensure the suction of the pump is always flooded.

By using a three way lockable valve & associated pipe fittings the priming pump can also be used to empty the sump during maintenance.

Please contact MAN Diesel & Turbo UK Ltd for more details.

10.3 Crankcase Breather Coalescer System

It is an optional extra for an industrial engine to have a crankcase coalescer system. The system maintains a safe crankcase pressure and traps crankcase contaminants in a filter media. Oil is separated and returned to the sump and cleaned gases are then fed back into the air intake.

The system is on engine mounted and consists of 4 filter canisters installed at the free end of the engine. Supporting pipework, brackets and drains to the sump complete a tidy, well integrated arrangement with minimal impact on overall size.

MAN Schematic 2015D046 shows how the crankcase coalescer is integrated as part of the lubricating oil system.

10.4 Typical Lubricating Oil System Data

	UNITS	1200 rpm	1500 rpm	1800 rpm
Oil Pressure – Engine Idle Speed 600 rpm	bar	2.6	2.6	2.6
Oil Pressure – Example Industrial Idle Speed Demand 1000 rpm	bar	4.3	4.3	4.3
Oil Pressure – Normal Operating Range at synchronised speed **N.B. Regulated by Relief Valve**	bar	5.0 to 5.5	5.0 to 5.5	5.0 to 5.5
Low Oil Pressure Warning (bar) / Shutdown	bar	3.0 / 2.4	3.5 / 2.9	4.1 / 3.5
Oil Temperature – Normal Operating Range	°C	65 to 77	65 to 77	65 to 77
Oil Temperature Alarm Warning / Shutdown	°C	87 / 90	87 / 90	87 / 90

Table 38: Lubricating Oil System Data - Typical

10.5 Approved Lubricating Oils – Mono Grade Oils

Due to the varying standards of branded oils worldwide, oil specifications of these oils cannot be guaranteed. However MAN Diesel & Turbo UK Ltd does generally approve of the following oils.

- Castrol HLX 40
- BP Vanellus C3 40
- Total Disola MT 40

Alternatively MAN Diesel & Turbo UK Ltd generally approves oils of the following monograde specifications.

Minimum Mono Grade Oil Specification

- Mono grade SAE 40
- Designated as a heavy duty diesel oil
- Min TBN (Total Base Number): 8 for fuels with up to 0.2% sulphur content
- Min TBN (Total Base Number): 12 for fuels between 0.2 and 1.0% sulphur content
- An active ACEA claim for designation 'E' heavy duty diesel engine oils

Engine oil which meets the above criteria but doesn't have an active ACEA claim may still be considered if it has previously been tested and certified against a now obsolete ACEA rating.

In such cases the minimum historical ACEA rating which would be considered is preferably E3, however some E2 rated oils may also be considered.

IMPORTANT

In all instances data sheets of the oil intended for use must be submitted to MAN Diesel & Turbo UK Ltd for official approval before use.

10.6 Approved Lubricating Oils – Multi-Grade Oils

MAN Diesel & Turbo UK Ltd is currently developing its list of approved multi-grade oils. Oils that meet the following minimum specification are generally recognized to be suitable for the VP185.

- Multi grade oil with a summer time rating equivalent to a min of SAE 40 e.g. SAE 5W40
- Designation: Heavy duty diesel oil
- Min TBN (Total Base Number) 8 for fuels with up to 0.2% sulphur content
- Min TBN (Total Base Number) 12 for fuels between 0.2% and 1.0% sulphur content
- An active ACEA claim for designation 'E' heavy duty diesel engine oils

Engine oil which meets the above criteria but doesn't have an active ACEA claim may still be considered if it has previously been tested and certified against a now obsolete ACEA rating.

In such cases the minimum historical ACEA rating which would be considered is preferably E3, however some E2 rated oils may also be considered.

IMPORTANT

In all instances data sheets of the oil intended for use must be submitted to MAN Diesel & Turbo UK Ltd for official approval before use.

To discuss your requirements please contact MAN Diesel & Turbo UK Ltd

11 Fuel Oil System

A gear type fuel lift pump fitted at the free end of the engine supplies fuel to the unit pump injectors. Fuel is supplied and piped at low pressure meaning that there are no high pressure pipes on the engine. All the high pressure fuel is contained inside the unit pump injector, which is located inside the cylinder head. In order to control the low fuel pressure in the piping system there is a pressure relief valve in the on engine fuel reservoir.

As fuel passes through the engine cylinder heads it is heated and therefore depending upon ambient conditions it may necessary to have a fuel cooler to ensure a safe return temperature to the tank. The VP185 is available with an on engine mounted fuel cooler as an additional option..

If more than one fuel tank is used to supply the engine it is recommended that a linked valve system be used to ensure that fuel returns to the correct tank.

It should be noted that the excess fuel returned to the tanks may contain traces of lubricating oil. Therefore for installations where the fuel tank serves gas turbines it may be necessary to separate the returned excess fuel from the fuel supply to the gas turbine.

For a typical fuel oil schematic see MAN drawing 2015D047.

11.1 Fuel Oil System Data

	1200 rpm	1500 rpm	1800 rpm
Fuel Pump Flow (m^3/hr)	1.30	1.30	1.57
Fuel pressure (bar) Regulated by Relief Valve	1.50	1.50	1.50
Max suction lift (m wg) *	2.00	2.00	2.00
Max supply press (m wg) **	3.50	3.50	3.50

Table 39: Fuel Oil System Data – Typical

* The suction lift is measured from the crankshaft centreline.
**The maximum supply pressure is the fuel pressure applied to the pump inlet by a fuel system/tank supplying pressurised fuel.

11.2 Fuel Filter

The 12VP185 is fitted with a single type filter as standard on industrial engines.

11.3 Fuel Coalescer System

The fuel coalescer provides a first defence against the ingress of large contaminants but most critically separates moisture and condensate from the fuel. Water free fuel is then passed through the system into the main engine mounted filters which then remove any remaining fine contaminants.

A representative example of the fuel coalescer system that can be offered is shown in MAN drawing 2016D055. The fuel coalescer assembly is supplied loose and is required to be mounted in an off engine location.

Example schematic 2015D042 illustrates how a fuel coalescer is integrated as part of the fuel oil system.

11.4 Fuel Injection Options

The VP185 is available with either mechanical or electronic fuel injection.

Mechanical Injection

All new industrial engines are built with mechanical fuel injection as standard.

Electronic Injection

It is an additional option to have electronic fuel injection. Electronic injection does not require mechanical fuelling control, the unit pump injectors are controlled by a current pulse from an electronic injection control unit.

Electronic injection allows for flexibility on injection timing. This flexibility means the engine can be further optimised for fuel consumption or reduced NOx emissions. It should be noted that generally any reductions in NOx emissions will compromise fuel consumption, and vice versa.

For industrial applications electronic injection alleviates the limitations of mechanical fuel racks and as a result can further improve governing quality and response time.

Actual consumption figures will vary depending on the user's requirements, therefore for estimated figures please contact MAN Diesel & Turbo UK Ltd.

Electronic injection still retains the VP185's key safety feature with low pressure fuel lines.

11.5 Notes on Fuel Oil Quality

The quality of fuel used has a strong influence on many critical operating factors such as lubrication, engine performance, engine emissions, ignition delay and the life of the engine fuel system.

Additionally there are many factors that influence the fuels long term storage ability and the behaviour of fuel in different operating climates.

It is therefore important to ensure that only a good quality middle distillate fuel as specified in section 11.7 is used at all times. Fuel oil quality is especially important for high speed high performance diesel engines such as the VP185.

11.6 Residual Fuel Oil – Important Note

In no circumstances must any form of residual fuel be used with the VP185 engine.

11.7 MAN Diesel & Turbo UK Ltd Fuel Oil Specification

MAN Diesel & Turbo UK Ltd approves the use of any middle distillate fuel oil which complies with the following specification.

The following specification has been developed by MAN Diesel Turbo UK Ltd using a combination of various fuel oil standards and extensive running experience. These specifications safeguard the engine and help ensure efficient and reliable operation.

Description	Units	Limit	Value
Kinematic Viscosity at 40°C	**(cSt) / (mm^2/s)**	**Min**	1.5
		Max	5.50
Cetane Number	**-**	**Min**	45
Carbon Residue on 10% Distillation Residue	**(%) mass**	**Max**	0.30
Distillation Recovery at 250°C	**% (V/V)**	**Max**	65
Distillation Recovery at 350°C	**% (V/V)**	**Min**	85
or			
Minimum 90 %(V/V) recovered at	**°C**	**Max**	360
Flash Point (Pensky-Martens Closed Cup Test Method)	**(°C)**	**Min**	55
Water Content	**% (V/V)**	**Max**	0.05
	mg/kg	**Max**	590*
Particulate Matter Content	**mg/kg**	**Max**	24
	mg/l	**Max**	20.4*
or			
Total Contamination Content	**mg/kg**	**Max**	24
Ash	**%(m/m)**	**Max**	0.01
Sulphur Content	**%(m/m)**	**Max**	1.00
	mg/kg	**Max**	10,000**
Copper Corrosion 3 hrs at 100°C	**-**	**Max**	Class 1
Density at 15°C	**(kg/m^3)**	**Min**	800***
		Max	880***
Oxidation Stability	**(g/m^3)**	**Max**	25

Table 40: MAN Diesel & Turbo UK Ltd Fuel Oil Specification

*Values based on conversion assuming density of diesel to be 850 kg/m^3. When considering suitable fuel oils the actual density should be used for conversion to mg/kg and mg/l.

**Fuels used with sulphur content between 0.2% m/m (2000 mg/kg) and 1% m/m (10,000 mg/kg) must use an engine oil with min TBN of 12. See section 10.5 & 10.6 for allowable engine oil specification.

***Typical fuel oils used have a density of approx. 840 to 850 kg/m^3. Variance in density will have an effect on the volumetric fuel delivery for a given power.

11.8 Fuel Oil Standards

Fuel oils compliant with one of the following international / regional fuel oil standards are commonly available for industrial applications.

Fuel oil standards highlighted in green have been approved by MAN Diesel & Turbo UK Ltd having satisfied the specification shown in section 11.7 or having had satisfactory operational experience in service.

Fuel oil standards highlighted in amber partially meet the requirements in section 11.7, however with some shortfalls in specification and without extensive operational experience are not acceptable for immediate use. Therefore these fuel oils must be shown to exceed the requirements of the highlighted standard in order to meet any shortfalls in the MAN specification in section 11.7.

In these circumstances datasheets of the intended fuel oil must be submitted to MAN Diesel & Turbo UK Ltd for official approval before use.

Additional Requirements

Fuel oils which satisfy the MAN specification in section 11.7 meet the expectations of MAN Diesel & Turbo UK Ltd only. Any additional requirements will be the responsibility of the generator set owner/operator.

Fuel Oil Standard	Description	Standard Type	Criteria
EN 590: 2013 + AC:2014	Automotive Fuels - Diesel - Requirements & Test Methods	European	Fuel oil to meet the generally applicable requirements specified.
BS 2869:2010	Fuel Oils for Agricultural, Domestic & Industrial Engines & Boilers – Specification	British Standard	Fuel oils to meet class A2 and D middle distillate fuel categories only. Kerosene & Residual fuel categories are excluded.
Defence Standard 91-4 Issue 9	Fuel, Naval, Distillate NATO Code: F-76 Joint Service Designation DIESO F-76	MOD UK Standard	Fuel oil to meet the test requirements specified.
ISO 8217: 2012	Petroleum Products – Fuels (class F) – Specifications of Marine Fuels	International	Fuel oils to meet DMX, DMA, DMZ & DMB middle distillate fuel categories only. Residual fuel categories are excluded.
ASTM D975-15C	Standard Specification for Diesel Fuel Oils	International	Fuel oil to meet grades 1-D & 2-D middle distillate fuel categories only. Grade 4-D heavy distillate fuel is excluded.
Military Standard MIL-DTL-16884N	Detail Specification Fuel, Naval Distillate NATO symbol F-76	US Military Standard	Fuel oil to meet physical & chemical requirements specified.

Table 41: Commonly Available Fuel Oil Standards

12 Exhaust System

On an 12VP185 there are two main exhaust outlets 250mm in diameter. A suitable exhaust system should include either two 250mm diameter outlets or a single 350mm diameter combined outlet.

For a typical air & exhaust schematic see MAN drawing 2015D045.

12.1 Exhaust Bellows

To take up any relative movement between the flexibly mounted engine and the exhaust system suitable flexible exhaust bellows must be fitted. It is recommended that these are fitted as close to the engine as possible to provide the highest levels of isolation.

MAN Diesel & Turbo Ltd is able to offer stainless steel bellows. A representative example is shown in MAN drawing 2014D053.

12.2 Exhaust Bends

In support of a suitable exhaust system MAN Diesel & Turbo UK Ltd is able to offer standard steel or stainless steel 250mm diameter exhaust bends in either 45° or 90° forms or specific bends tailored to the installation. Offered bends can be fitted in any radial direction in steps of 30°.

A representative example is shown in MAN drawing 2014D044.

12.3 Exhaust Silencers

Most engine exhaust systems will require some level of silencing to reduce the engine exhaust noise. The standard material is typically mild steel however stainless steel can be specified at extra cost.

Most applications can be satisfied by one of the following types of silencer:

Absorption Type: Typically constructed with a straight through section with perforated holes surrounded by a sound deadening material. The straight through section provides a minimal restriction to gas flow whilst still achieving a level of noise reduction through exposure to the sound deadening material.

These can be complimented by secondary units if a higher degree of silencing is demanded.

Multi-Chamber Type: Typically constructed with multiple chambers using the bulk volume of gas in each chamber to provide a dampening effect. Additionally the exhaust gas is forced to take a non-direct path through each chamber providing further levels of noise dampening.

These silencers typically provide the high levels of noise reduction but also a higher resistance to gas flow. This must be considered by the set builder as this will increase exhaust back pressure.

Spark Arrestor Type: This type of silencer will have the performance of either an absorption or multi-chamber type silencer but with an added section or characteristic to remove any sparks from the exhaust gas flow. This is typically achieved by a centrifugal action caused by vanes or sections which force the gas to the outside edges of the silencer. The system will then have a trap which will capture any partially burning material which may have otherwise left the exhaust as a spark.

These silencers depending upon the type of silencing characteristic will offer medium to high levels of noise reduction but overall will typically provide the highest resistance to gas flow of all available silencer types. This must be considered by the set builder as this will increase exhaust back pressure.

Combined Silencer with SCR System – This type incorporates Selective Catalytic Reduction (SCR) technology. This type of silencer will offer noise reduction and a high NOx reduction required for stricter regulations. Depending upon application and the silencing characteristic of the combined system there may be an increased resistance to exhaust flow. This must be considered by the set builder as this will increase exhaust back pressure.

For more details of a SCR system see section 12.8.

12.4 Exhaust System Data – Continuous Ratings

	2165 kW - 1200 rpm	2165 kW – 1500 rpm	2200 kW – 1800 rpm
Exhaust Gas Volume Flow (m^3/s)	9.5	8.7	9.0
Exhaust Gas Mass Flow (kg/s)	4.9	4.9	5.1
Exhaust Gas Outlet Temperature (°C)	420	360	350

Table 42: Exhaust System Performance Data – Prime Ratings

12.5 Exhaust System Data – Prime Ratings

	2165 kW - 1200 rpm	2300 kW – 1500 rpm	2350 kW – 1800 rpm
Exhaust Gas Volume Flow (m^3/s)	9.5	9.2	9.3
Exhaust Gas Mass Flow (kg/s)	4.9	5.1	5.2
Exhaust Gas Outlet Temperature (°C)	420	370	360

Table 43: Exhaust System Performance Data – Prime Ratingsl

12.6 Exhaust System Data – Limited Time Ratings

	2165 kW - 1200 rpm	2520 kW – 1500 rpm	2600 kW – 1800 rpm
Exhaust Gas Volume Flow (m^3/s)	9.5	9.3	10.3
Exhaust Gas Mass Flow (kg/s)	4.9	5.2	5.5
Exhaust Gas Outlet Temperature (°C)	420	380	390

Table 44: Exhaust System Performance Data – Prime Ratingsl

12.7 Exhaust Back Pressure

Each engine rating is calculated on the basis of having a reference exhaust back pressure of 255 mm wg (25 mbar). Whilst there is some flexibility on the maximum allowable back pressure, increasing back pressure may require the engine to be de-rated.

In order to help minimise system back pressure the following guidelines have been provided.

- The exhaust system is to minimize (as best as possible) the use of sharp corners and the use of multiple corners or bends in short succession. These features create particular obstructions which lead to high exhaust back pressure.

- Whilst there is no restriction on total exhaust length the set builder should be aware that increasing length in addition to increasing the number of pipe bends may require an increase in exhaust pipe diameter to maintain allowable back pressures.

12.7.1 De-rate for Exhaust Back Pressure

Increasing exhaust back pressure whilst maintaining engine power output requires the engine to work harder. This means that increasing back pressure can also increase fuel consumption, exhaust emissions and exhaust temperatures. This is why it is important to minimise back pressure and why the engine may require de-rate above 255 mm wg (25 mbar). Higher levels can be accepted but must be referred to MAN Diesel & Turbo UK Ltd before they are used or assumed for use.

12.8 Selective Catalytic Reduction (SCR) System

SCR is an exhaust gas after-treatment system designed to significantly reduce NOx emissions typically used with the objective of achieving IMO tier III emission regulations. The principle operation is based upon a chemical reaction between NOx, Oxygen, Ammonia and a NOx reducing catalyst to produce just Nitrogen and Water.

In order to achieve this chemical reaction a typical system injects the engine exhaust gas with urea prior to passing through an SCR filter containing a NOx reducing catalyst. Typical systems can offer NOx reduction between 80 and 95%.

In order to support a typical SCR system there are a number of additional infrastructure requirements which must be considered by the set builder at a design stage.

Typical System Requirements

- **Storage Tank** – A level of urea consumption will be required for all engine operating conditions therefore a suitable supply must be stored locally to the engine.

- **Delivery** – Urea must be delivered at pressure to the exhaust ready for injection by means of supply piping and a pump.

- **Injection** – An exhaust injector is required to inject urea into the exhaust stream. Due to cooling requirements of the injector and due to the requirement to achieve effective atomisation of urea, air assisted injection using an air compressor is common.

- **SCR Catalyst** – The NOx reducing catalyst is designed to be an integral part of the exhaust system. The catalyst can be offered as a combined catalyst / silencer assembly or just as a catalyst in line with an existing silencer.

- **Control System** – As either a separate system or integrated as part of a larger control system SCR requires close control over a number of key parameters in order to determine the correct level of urea injection. A control system is typically made up of an injection control unit and additionally may include a post SCR NOx analyser to provide closed loop control.

The size of the system will depend primarily upon the size of the catalyst and the required urea consumption in order to achieve satisfactory NOx reduction.

The size of the catalyst is strongly influenced by exhaust temperature. There are several catalysts available to suit different exhaust temperature ranges, each with an associated NOx reducing efficiency. This efficiency determines the catalyst area and therefore size of the catalyst required to achieve the same level of NOx reduction

Consumption rate of urea is directly related to the level of NOx reduction required i.e. higher exhaust NOx concentrations will require a greater urea consumption.

The 12VP185 has a low sensitivity to exhaust back pressure and also has relatively low exhaust outlet temperatures ideal for the application of an SCR system.

In the application of an SCR system the 12VP185 exhaust back pressure limit can be increased from the standard limit of 255 mm wg (25 mbar) to 765 mm wg (75 mbar). Additionally the low exhaust outlet temperatures mean that the most effective NOx reducing catalyst can be used. Both these factors have a significant influence and means that the 12VP185 can be offered with a compact and minimal impact catalyst.

MAN is able to offer the 12VP185 with an SCR system. Please contact MAN Diesel & Turbo UK Ltd for more details.

13 Aspiration Air System

Induction air is often drawn from the engine room via engine mounted panel filters or via ducted air from engine room down takes. As air enters the engine it is compressed by 1st stage turbochargers. It is then subsequently compressed again by the 2nd stage turbochargers achieving high air density.

In order to restore any lost density air then flows to the on engine air after-cooler assembly before reaching the air manifolds.

For a typical air/exhaust schematic see MAN drawing 2015D045.

13.1 Air Restrictions

Any restriction to flow in the air ducting will have a negative effect on engine performance.

In order to ensure that rated engine outputs are maintained inlet depression must not exceed 152 mm wg (15 mbar). Systems that exceed this maximum recommended value may experience de-rate in engine output, increased fuel consumption and higher air manifold temperatures.

With respect to the above maximum inlet depression the following guidelines have been provided.

- System to minimize (as best as possible) the use of sharp corners and the use of multiple corners or bends in short succession. These features create particular obstructions which lead to high depression.

- Whilst there is no restriction on total air ducting length the set builder should be aware that increasing length in addition to increasing the number of ducting bends may require an increase in air ducting diameter to maintain allowable inlet depression.

13.1.1 De-Rate for Inlet Depression

Increasing inlet depression will decrease engine efficiency. Higher inlet depression can be accepted but must be referred to MAN Diesel & Turbo UK Ltd before they are used or assumed for use.

13.2 Aspiration Air System Data – Continuous Ratings

	1200 rpm – 2165 kW	1500 rpm – 2165 kW	1800 rpm – 2200 kW
Air Consumption – Volume Flow Rate (m^3/s)	4.0	4.0	4.2
Air Consumption – Mass Flow Rate (kg/s)	4.7	4.7	5.0

Table 45: Aspiration Air System Data – Continuous Ratings

13.3 Aspiration Air System Data – Prime Ratings

	1200 rpm –2165 kW	1500 rpm – 2300 kW	1800 rpm – 2350 kW
Air Consumption – Volume Flow Rate (m^3/s)	4.0	4.2	4.3
Air Consumption – Mass Flow Rate (kg/s)	4.7	5.0	5.1

Table 46: Aspiration Air System Data – Prime Ratings

13.4 Aspiration Air System Data – Limited Time Ratings

	1200 rpm – 2165 kW	1500 rpm – 2520 kW	1800 rpm – 2600 kW
Air Consumption – Volume Flow Rate (m^3/s)	4.0	4.3	4.5
Air Consumption – Mass Flow Rate (kg/s)	4.7	5.1	5.3

Table 47: Aspiration Air System Data – Limted Time Ratings

14 Radiated Heat

Heat is radiated to the surrounding air from the external surfaces of the engine, this must be dispersed to atmosphere by the engine room ventilation system.

The VP185 engine has no exposed exhaust surfaces and the bulk engine skin temperature remains below 100^{O}C except for a short air trunk at the low and high pressure turbocharger compressor outlets where typical maximum temperatures are about 200^{O}C. These pipes are lagged to provide operator protection.

Radiated heat at above 75% load is only 45 kW

These figures should be used to ensure that adequate ventilation is provided to satisfy any maximum engine room temperature requirements.

15 Engine Alarms & Protection

All new industrial engines include the following level of engine protection instrumentation as standard…

- Lubricating Oil Priming Level Probe
- Low Oil Pressure Alarm / Shutdown Switch
- High Oil Temperature Alarm / Shutdown Switch
- High Primary Water Temperature Alarm / Shutdown Switch
- High Secondary Water Temperature Alarm / Shutdown Switch
- Engine Over-Speed Trip & Air Shutdown Valves

The above is MAN Diesel & Turbo UK Ltd minimum recommended level of protection. This will ensure basic safeguarding of the engine from deteriorating operating conditions and can limit the extent of damage should a fault occur.

However it should be realised that in the event of a serious engine fault that the standard level of protection will only have limited effect. MAN Diesel & Turbo UK Ltd is able to offer additional protection to further safeguard the engine, see section 15.1.

The following details are typical of most applications. Actual list of alarms, protections and set points will be contract specific.

<u>Lubricating Oil Priming Level Probe</u>

Protection	System	Set Point	Unit
Engine Starting Block Oil Priming Level Not Achieved	Generator Control Unit	-	-

During the engine starting sequence a minimum level of oil priming must be achieved. If this level is not achieved within a pre-set time period the starting sequence is cancelled.

<u>Low Oil Pressure Alarm / Shutdown Switch</u>

Protection	System	Set Point	Unit
Warning Alarm Low Oil Pressure	Generator Control Unit	Contract Specific	bar
Automatic Shutdown Minimum Oil Pressure	Generator Control Unit	Contract Specific	bar

The Generator Control Unit typically has a hardwired dual step low oil pressure switch operating with 2 fixed set points. The allowable limits for low oil pressure will vary depending on the engine operating speed.

<u>High Oil Temperature Alarm / Shutdown Switch</u>

Protection	System	Set Point	Unit
Warning Alarm High Oil Temperature	Generator Control Unit	87	°C
Automatic Shutdown Maximum Oil Temperature	Generator Control Unit	90	°C

The Generator Control Unit typically has a hardwired duel step high oil temperature switch operating with 2 fixed set points.

High Primary Water Temperature Alarm / Shutdown Switch

Protection	System	Set Point	Unit
Warning Alarm High Primary Temperature	Generator Control Unit	91	°C
Automatic Shutdown Maximum Primary Temperature	Generator Control Unit	96	°C

The Generator Control Unit typically has a hardwired duel step high primary water temperature switch operating with 2 fixed set points.

High Secondary Water Temperature Alarm / Shutdown Switch

Protection	System	Set Point	Unit
Warning Alarm High Secondary Temperature	Generator Control Unit	68	°C
Automatic Shutdown Maximum Secondary Temperature	Generator Control Unit	73	°C

The Generator Control Unit typically has a hardwired duel step high secondary water temperature switch operating with 2 fixed set points.

Engine Over-Speed & Air Shutdown Valves

Protection	System	Set Point	Unit
Automatic Shutdown Max Engine Speed	Governor Speed Controller	Contract Specific	rpm
Air Shutdown Valves	Engine	-	-

It is typical for the Governor Speed Controller to include protection logic in the event of an engine over-speed. A dedicated speed probe will be used for general speed control but an additional speed probe may be used for dedicated monitoring for the over-speed protection function.

In the event of an engine over-speed the governor will revert to its no fuel setting and the on engine air shutdown valves will close. The air shutdown valves starve the supply of incoming air to provide a quick and efficient shutdown.

15.1 Optional Engine Alarms & Protection

Crank Space Oil Splash Monitor

Protection	System	Set Point	Unit
Warning Alarm High Temp Deviation	Generator Control Panel	5.5	°C
Automatic Shutdown Max Temp Deviation	Generator Control Panel	8.5	°C

The crank space oil splash monitor measures the oil temperature at each engine crank space and compares it to the mean temperature (of all crank spaces). Deviation from the mean temperature is then monitored to give a warning alarm and to provide shutdown protection if necessary.

Crank space oil temperature monitoring is very responsive and therefore provides a vital first defence to limit and potentially avoid engine damage or failure in the event of a serious fault.

CLOTS (Cylinder Liner Over Temperature Switch)

Protection	System	Set Point	Unit
Warning Alarm High Liner Temp	Governor Control Unit	115	°C

The CLOTS system monitors each cylinder liner temperature at the critical 1st piston ring reversal point. This is where the highest cylinder pressures are reacted by the 1st piston ring and therefore where oil lubrication is most critical. The system works on a fixed set point and a warning alarm is activated if any of the cylinders are operating above this point.

CLOTS is another system which can limit and potentially avoid engine damage or failure in the event of a serious engine fault.

After Valve Exhaust Temperature Monitoring

Protection	System	Set Point	Unit
Warning Alarm Temp Deviation	Monitoring System	+/-100	°C
Warning Alarm High Temp	Monitoring System	650	°C

The after-valve exhaust monitoring system continuously monitors exhaust temperatures to provide warning of any significant deviations between cylinders and / or high exhaust temperatures.

Each exhaust temperature is measured and compared to the mean temperature (of all cylinders). Deviation from the mean temperature is monitored to give a warning alarm if any measurement is either +100°C above the mean temperature or – 100°C below the mean temperature. Note this is not a total deviation between minimum and maximum exhaust values, only a deviation between each measurement and the mean temperature.

Additionally there is a high temperature warning alarm for any cylinder which exceeds 650°C. This alarm will operate regardless of whether there is a healthy temperature deviation between cylinders.

Both of the above alarms will not be commissioned until the mean exhaust temperature exceeds 320°C. This avoids transient conditions initiating false alarms.

Additional Requirements

The 12VP185 is equipped with numerous tappings and measurement points to fulfil any additional user specific requirements. For any additional requirements please contact MAN Diesel & Turbo UK Ltd.

16 Flexible Connections

16.1 Flexible Drive Couplings

It is MAN's recommendation to fit a coupling, which is torsionally, radially and longitudinally flexible, between the engine and generator. The flexible coupling reduces the level of torsional vibration transmitted to the generator and allows for some compensation of engine to generator misalignment.

In a rigid coupling arrangement the consequences of misalignment can cause critical damage to both the engine and generator. A flexible coupling reduces this risk and can alleviate restrictions upon installation.

It is important to understand that a flexible coupling is not intended to absorb permanent misalignment and should be in an unstressed state when at rest. Manufacturer's tolerances represent the minimum conditions for satisfactory operation, however the aim is to reduce alignment figures to as close to zero as practically possible. This will reduce the stress on the coupling elements and lead to longer life.

Running a flexible coupling misaligned will cause the coupling to run hot, reduce its life and waste power.

Various types are available but those most commonly used utilise flexible rubber elements and steel diaphragms to provide the necessary characteristics.

Flexible Drive Coupling manufacturers as used on the VP185…

- Vulkan
- Reich
- Centa
- Renold

16.2 Anti-Vibration Mounts (AV Mounts)

The engine is designed to run on four point AV mounts. These may be of commercial standard or of a more complex design for military applications. If requested MAN Diesel & Turbo UK Ltd can recommend the best type for the application concerned

AV Mount manufacturers as used on the VP185…

- Vulkan
- Christie & Grey
- Trelleborg
- Rubber Design

16.3 Engine to Generator Alignment

A fully detailed alignment procedure is included in every contract installation guide. This will take into account all of the relevant factors including type of AV mounts, type of flexible drive couplings, and any additional flexible connections.

16.4 Removal of Mountings

The method of removing AV mounts will vary with manufacture, please refer to manufacturer's instructions. For height adjustable type AV mounts the removal of the central stud will allow a sideways removal, minimizing the jacking requirements needed (local jacking required only).

However other types may not allow removal of the stud and therefore will require more substantial jacking arrangements to lift the engine to clear the AV mount stud.

16.5 Maintenance of AV Mounts

Generally speaking the AV mountings will not require maintenance or reconditioning in service during their expected lifetime unless misused or accidentally damaged.

Oil contamination and incorrect loading of mounts are typical causes for damage that will reduce the mounts expected lifetime. To ensure that rubber elements are in good condition and to ensure manufacturers maximum deflections are not exceeded mounts must be visually inspected and mount heights measured on a regular basis. Furthermore the set builder must protect as best as possible AV mounts from contact with oil and fuel.

Rubber elements showing signs of severe swelling or evidence of rubber to metal separation should be replaced. Where it is necessary to replace the rubber elements it is advised that the complete AV mounting is returned to the manufacturer.

Typical service life of AV mounts is 8 to 12 years with the actual lifetime dependent upon dynamic loading and mount environment.

16.6 Maintenance of Flexible Drive Coupling

Generally speaking the flexible drive coupling will not require maintenance or reconditioning in service unless misused or accidently damaged.

Oil contamination and operating with misalignment outside of manufacturers tolerances are typical causes for damage that will reduce the couplings expected lifetime. To ensure that the rubber element is in good condition and that maximum misalignment tolerances have not been exceeded, the coupling must be visually inspected and measured, and machinery alignment checks completed on a regular basis. Furthermore the set builder must protect as best as possible the coupling from contact with oil and fuel.

It is typical for manufacturers to provide criteria on allowable depth of cracks and “permanent set” which must be measured on a regular basis to assess the condition of the rubber element. Permanent set is the permanent deformation of the rubber element over time caused by the transmission of torque through the coupling.

Typical service life of flexible drive couplings is 10 years or 50,000 operating hours, at which point the coupling must be inspected to assess suitability for further use.

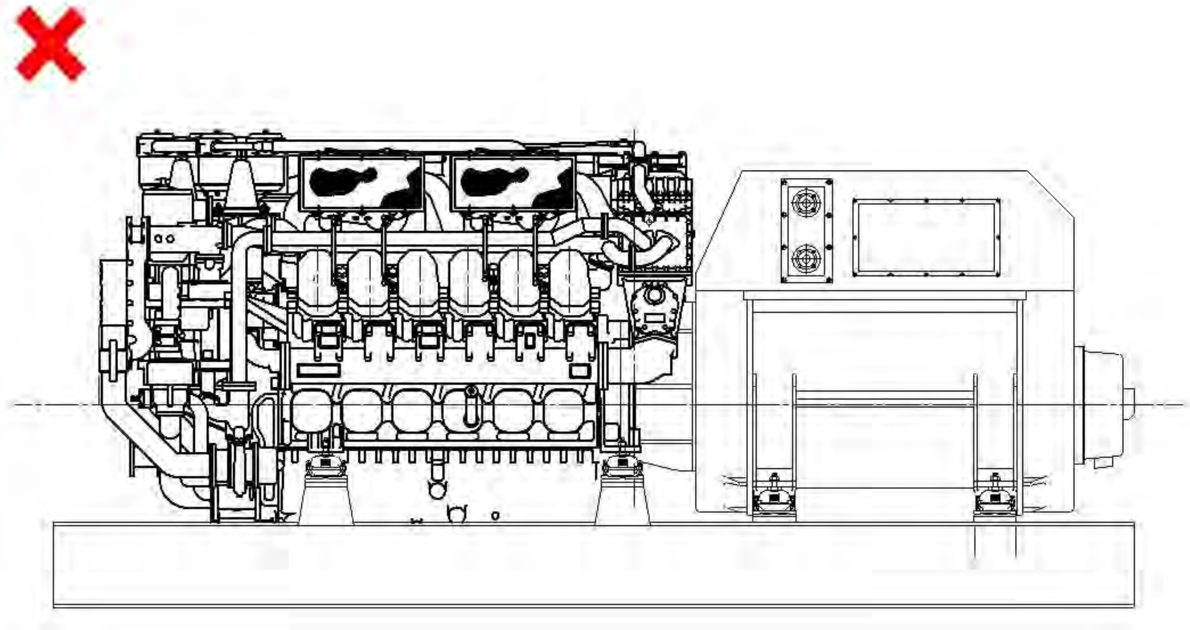
16.7 Installation Guidelines for Flexible Connections

The purpose of flexible connections is to isolate vibration between machinery (if applicable) and between machinery and the machinery room floor. Incorrect use of flexible connections will reduce the effect of isolation and in some cases fail to prevent excessive vibration or damage.

A key factor for consideration is the relative movement between machinery i.e. an isolated machine cannot be rigidly mounted (coupling or bell housing) to either a rigidly mounted or another isolated machine. All isolated machinery must be free to move within the allowance of the flexible connection. Therefore the engine and generator if isolated must be free to move together or alternatively rigidly mounted and then isolated under a common bedframe. In either case it is recommended a flexible drive coupling is used.

Example Installation – Not Recommended

In the example installation below both engine and generator have been resiliently mounted to a bedframe and then coupled with a flexible coupling and bell housing.



The critical aspect of this installation is that the bell housing unsupported as shown (other than the mating connections to engine and generator) is vulnerable to a leverage effect from both engine and generator. This is because both engine and generator are resiliently mounted and will move independently to each other.

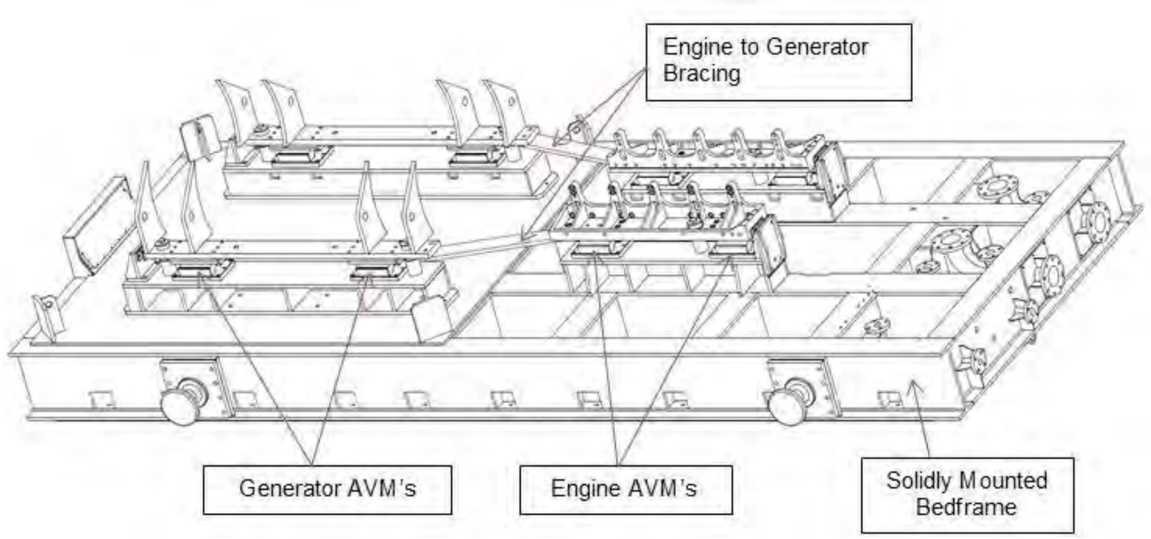
As a result of this leverage effect the bell housing is likely to suffer from critical damage upon which serious misalignment may occur.

Acceptable Solution

In order to remedy the installation of this leverage effect a form of engine to generator bracing must be implemented.

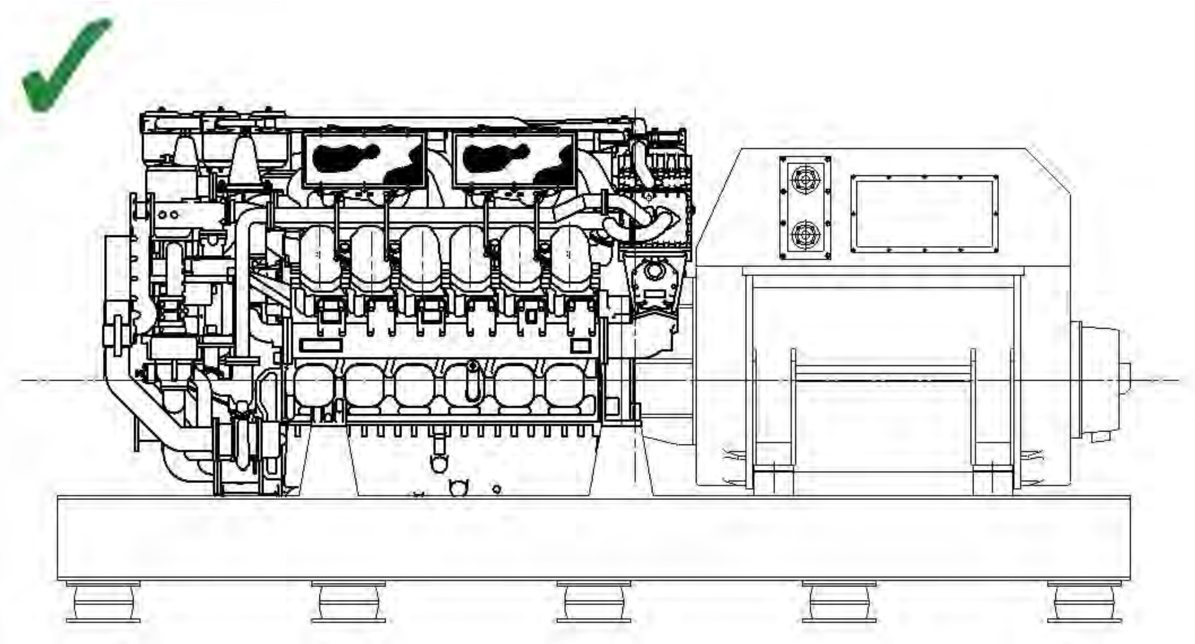
This can be achieved by bracing the engine and generator so that the relative movement is restricted. Alternatively the engine and generator could be rigidly mounted.

Example Engine to Generator Bracing



Example Installation 2 - Recommended

In the example installation below both engine and generator have been rigidly mounted to a bedframe and then coupled with a flexible coupling and bell housing. The bedframe has then been resiliently mounted.



17 Maintenance Procedures

In order to maximise the full benefit of the VP185's reliability and low through-life costs it is important to ensure that maintenance tasks are completed in a competent and timely manner against provided maintenance intervals.

Maintenance intervals are significantly affected by the operating profile of the vessel and the engine rating used. In general the higher the engine loading the sooner the engine will require overhaul.

17.1 Standard Maintenance Intervals

The following table shows the range of standard maintenance intervals. Actual maintenance intervals may change based upon the contract specific operating profile and engine rating.

Furthermore the VP185 engine control panel incorporates a power monitor to gauge the engine operating profile. This means maintenance intervals may also be adjusted during service.

SERVICE	E12	E13	E14	E15	**E16**	E17	E18	E20	E22	E24	E30
	EACH	EACH	EACH	EACH	**EACH**	EACH	EACH	EACH	EACH	EACH	EACH
A	150	160	175	190	**200**	215	225	250	250	250	250
B	1,500	1,625	1,750	1,875	**2,000**	2,125	2,250	2,500	2,750	3,000	3,750
C	3,000	3,250	3,500	3,750	**4,000**	4,250	4,500	5,000	5,500	6,000	7,500
D	6,000	6,500	7,000	7,500	**8,000**	8,500	9,000	10,000	11,000	12,000	15,000
E	12,000	13,000	14,000	15,000	**16,000**	17,000	18,000	20,000	22,000	24,000	30,000

Figure 9: Variation in Maintenance Intervals

The following table shows the typical maintenance intervals used for each power category.

	1	**2**	**3**	
Maintenance Task Group	**Continuous Power**	**Prime Power**	**Limited Time Power**	**Time Expired Period**
A	150	200	125	3 Months
B	1500	2000	1000	24 Months
C	3000	4000	2500	60 Months
D (Top)	6000	8000	5000	120 Months
E (Major)	12000	16000	10000	240 Months

Table 48: Maintenance Intervals - Typical

17.2 Maintenance Space Requirements

MAN Drawing No. 2012D052 defines the recommended maintenance envelope for the 12VP185. Within this recommended envelope it is possible through the use of MAN special tools to complete all maintenance tasks in 'situ'.

17.3 Engine Lifting Arrangements

MAN Drawing YN74403A shows details of the VP185 lifting assembly. Assembly consists of lifting brackets, shackles, chains, chain fittings, safety latches, and spreader bars.

17.4 Maintenance Tasks 12VP185 – Typical

The following table shows a typical maintenance schedule and the tasks to be completed at each interval period. The actual list of tasks at each interval will be contract specific.

Service	Work To Be Done	Spares Necessary
Daily	Check engine & actuator* oil levels	Relevant fluids as required Oil and fuel filter elements if indicated by differential oil pressure alarm.
	Check main gallery oil pressure, this should be more than 4.8 bar (70 lbf/in2) at above 1100 revs/min	
	Check coolant and fuel tank levels	
	Drain air start receiver*/check battery levels*	
	Check operation of instrument panels & ECP	
	Check for loose or damaged parts	
	Inspect condition of sacrificial anodes*	
A	Check operation of condensate drain valves	Relevant fluids as required Sample containers Air filter elements if condition poor
	Take engine coolant samples for analysis**	
	Take engine lubricating oil sample for analysis	
	Change engine lubricating oil if… 1. Viscosity falls below agreed limits 2. TBN value drops below agreed limits 3. TIM / Soot levels rise to 2.5% v/v	
	Drain water from fuel coalescer filter assembly*	
	Check alternator drive belt tension*	
	Lubricate the spindles in the over-speed air flap valves	
	Check air filter condition, clean or replace if necessary	
B	Check operation of over-speed trip (at reduced speed test setting)	Rocker cover gaskets if necessary Crankcase & fuel coalescer elements
	Check / adjust valve clearances	
	Change crankcase and fuel coalescer* filter elements	
	Lubricate fuel control linkages	
	Check condition of AV mountings and flexible pipes	
C	Minor service of unit pump-injectors.	Engine coolant as required Unit pump injector minor service kit (seals, joints etc.)
D Top Overhaul	Overhaul all unit pump injectors (locally or service exchange)	Relevant fluids as required. Overhauled unit pump injectors Overhauled cylinder heads Overhauled coolant pumps Overhauled starter motor Fuel pump service kit
	Overhaul all cylinder heads (locally or service exchange)	
	Overhaul primary and secondary coolant pumps (locally or service exchange)	
	Overhaul air starter* / electric starter* motor (locally or service exchange)	
	Remove all turbocharger cartridges, clean and inspect	
	Remove fuel feed pump & drive and service	
	Change governor lubricating oil and drive shaft seal	

	Check setting of engine lubricating oil relief valve	Governor drive shaft seal Top overhaul kit (all joints, seals etc.)
	Check condition of starter ring	
	Examine fuel control linkage for wear	
	Inspect over-speed air flap valves	
	Clean inlet pipework and manifolds	
	Service driven machinery as required	
E Major Overhaul	Complete overhaul of engine and ancillary equipment (Includes all work from top overhaul)	As above except overhauled assembles for all engine ancillary's Major overhaul kit (all joints, seals etc.)

Table 49: Maintenance Tasks – Typical

Tasks marked * are only applicable to some engine engines dependent upon specification
Tasks marked ** refer to engines using only a single corrosion inhibitor in the primary coolant system which requires regular testing to ensure correct pH levels.

17.5 Notes on Engine Preservation

All completed engines are preserved and protected in order to prevent corrosion and the ingress of foreign matter during transportation and storage.

Details of the preservation process, instructions for short term and long term storage and also instructions for protection during installation will be included in the contract specific operation and maintenance book.

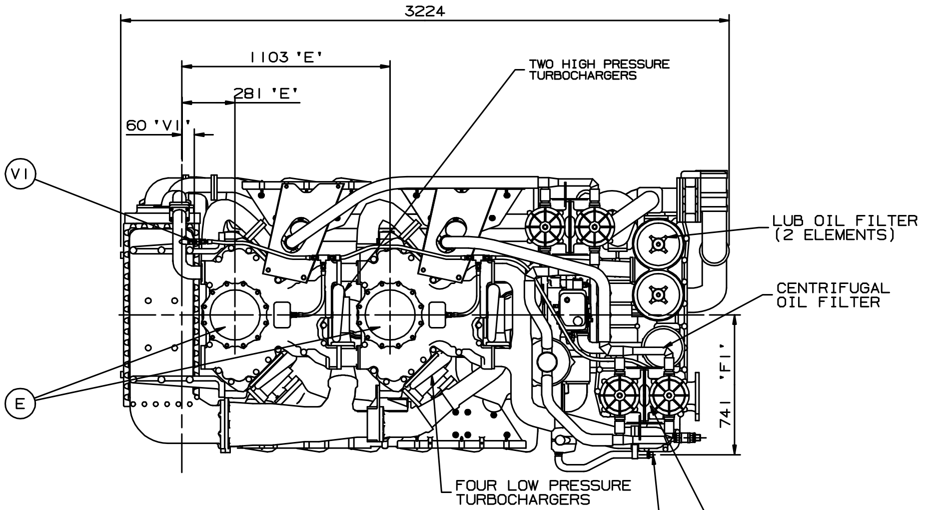
18 MAN Drawings

The following pages contain MAN drawings referenced throughout the guide.

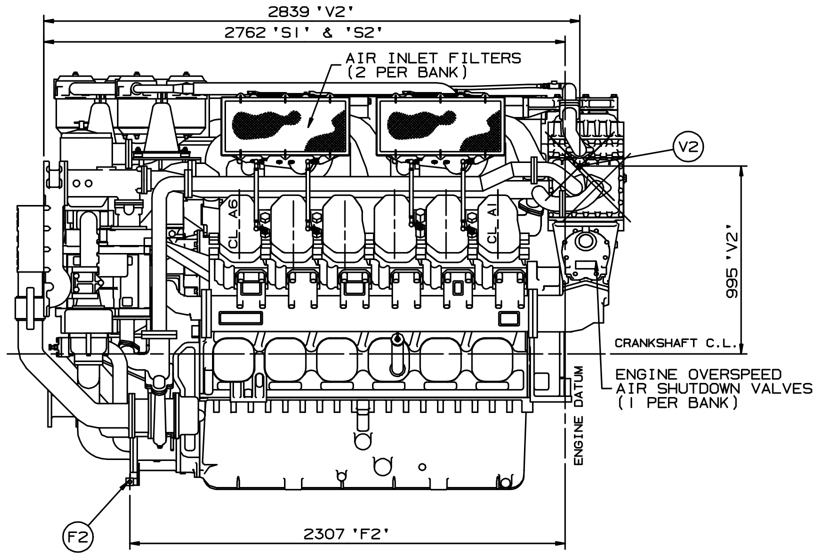
#	Description	Drawing No.
1	General Arrangement Drawing	2011D070
2	Primary Coolant Schematic	2015D049
3	Example Primary Coolant Pre-Heater	2014D065
4	Secondary Coolant Schematic	2015D044
5	Lubricating Oil Schematic	2015D046
6	Example Oil Priming Pump	2014D064
7	Example Oil Priming Pump Starter Panel	2016D056
8	Fuel Oil Schematic	2015D047
9	Example Fuel Coalescer System	2016D055
10	Air & Exhaust Schematic	2015D045
11	Example Exhaust Bellows	2014D053
12	Example Exhaust Bends	2014D044
13	Example Instrumentation Schedule	2015D043
14	Maintenance Space Requirements	2012D052
15	Engine Lifting Assembly	YN74403A
16	Schematic Key	2013D027

Table 50: List of MAN Referenced Drawings

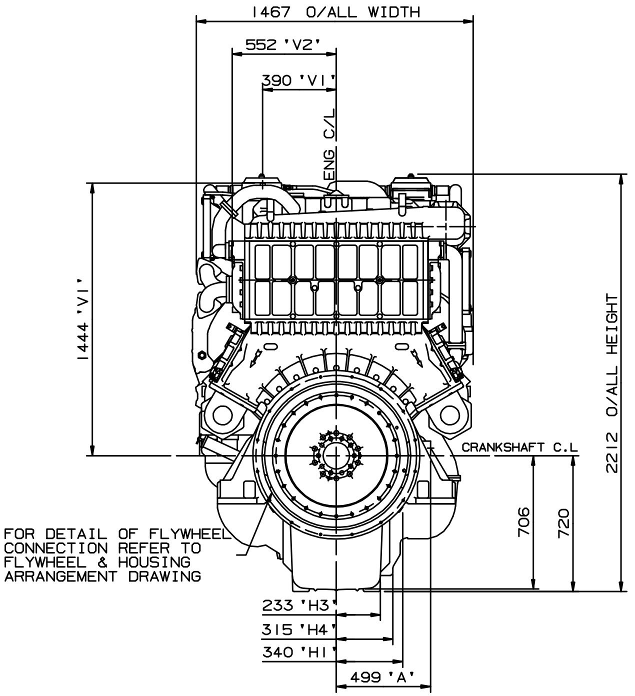
DRG. No. 2011D070



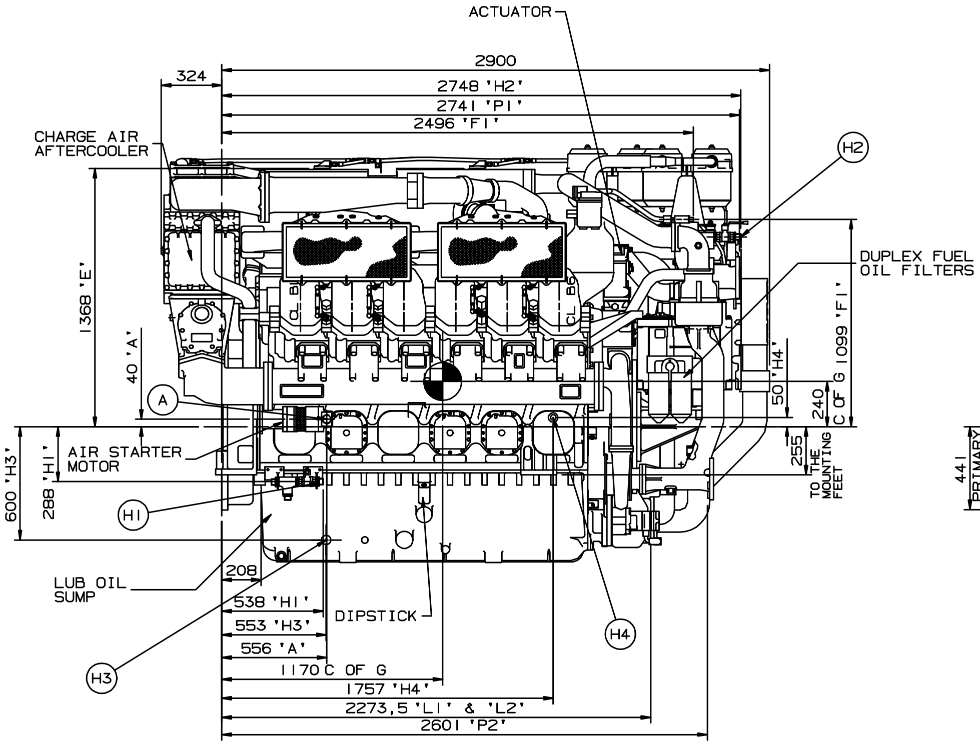
PLAN VIEW



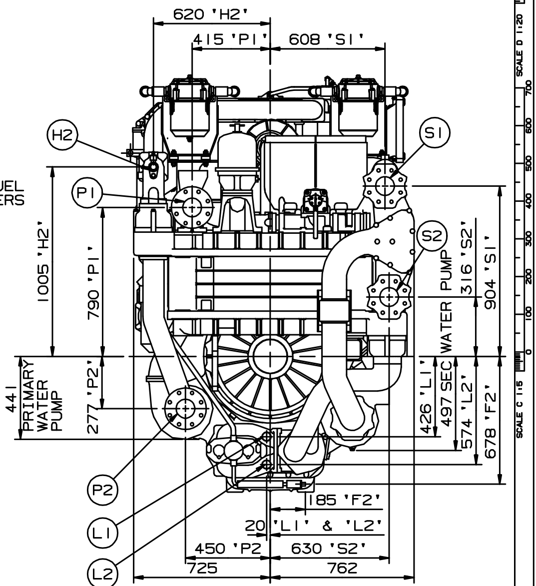
VIEW ON A BANK



DRIVE END VIEW



VIEW ON B BANK



FREE END VIEW

THIRD ANGLE PROJECTION

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MATERIAL AND HEAT TREATMENT

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:- ALL DIMENSIONS IN MILLIMETRES. THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779. SURFACES MARKED THUS √ TO BE MACHINED. SURFACE TEXTURE CLA VALUES IN MICROMETRES. LIMITS GIVEN THUS. UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0.4. GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

TITLE: GENERAL ARRANGEMENT 12VP185 INDUSTRIAL

DRAWING No./ PART No. 2011D070

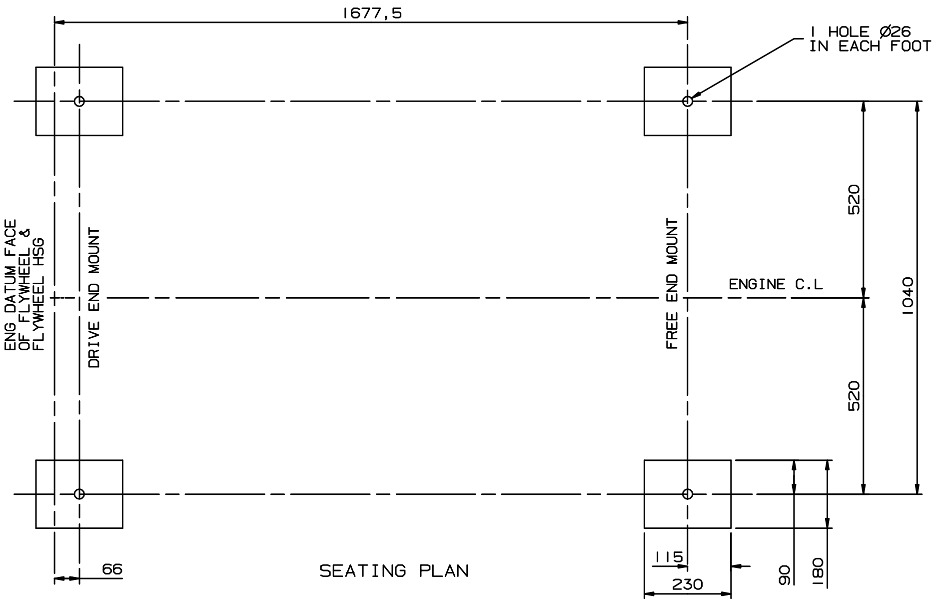
SHEET 1 OF 2 SHEETS

MAN

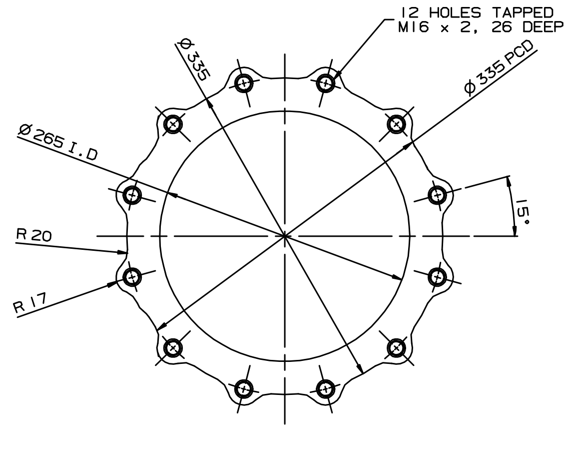
MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

DRG. No. 2011D070

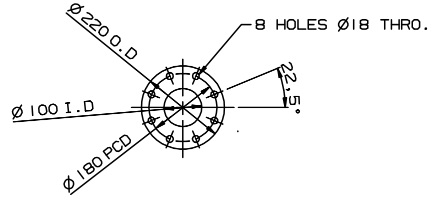


SEATING PLAN



DETAIL OF ENGINE CONNECTION 'E'
EXHAUST OUTLET (2 IN TOTAL).
FLANGE COMPATIBLE TO BS4504 PN6 250mm NOM.BORE
AND DIN 2631 250mm NOM.BORE.

NOTE:- P2 CONNECTION PRIMARY WATER INLET HAS IDENTICAL DRILLINGS AS BELOW, HOWEVER Ø18 HOLES ARE REPLACED WITH M16 TAPPINGS.



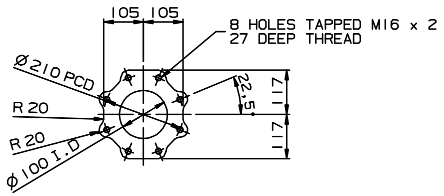
DETAIL OF ENGINE CONNECTIONS 'P1 AND P2'.
PRIMARY WATER INLET AND OUTLET. FLANGE 20mm THICK.
FLANGE COMPATIBLE TO BS4504 PN 10/16 100mm NOM.BORE
AND DIN 2633 100mm NOM.BORE.

ITEM	DESCRIPTION	QTY	REMARKS
A	AIR INLET TO STARTING MOTOR	1	G1.5 FEMALE PARALLEL. MAX 10 BAR TO MOTOR
E	EXHAUST OUTLET	3	SEE DETAIL
F1	FUEL OIL OUTLET	1	G3/4 MALE PARALLEL WITH 60° INTERNAL CONE
F2	FUEL OIL INLET	1	G3/4 MALE PARALLEL WITH 60° INTERNAL CONE
H1	HEATER SUCTION, PRIMARY WATER	1	G1 MALE PARALLEL
H2	HEATER DELIVERY, PRIMARY WATER	1	G1 MALE PARALLEL
H3	HEATER SUCTION, LUBRICATING OIL	1	G1 MALE PARALLEL
H4	HEATER DELIVERY, LUBRICATING OIL	1	G1 MALE PARALLEL
L1	LUB.OIL PRIMING PUMP SUCTION	1	G1.5 FEMALE PARALLEL
L2	LUB.OIL PRIMING PUMP DELIVERY	1	G1.5 FEMALE PARALLEL
P1	PRIMARY WATER OUTLET	1	SEE DETAIL
P2	PRIMARY WATER INLET	1	SEE DETAIL
S1	SECONDARY WATER OUTLET	1	SEE DETAIL
S2	SECONDARY WATER INLET	1	SEE DETAIL
V1	PRIMARY WATER VENTING CONNECTION	1	G3/8 FEMALE PARALLEL
V2	SECONDARY WATER VENTING CONNECTION	1	G3/8 FEMALE PARALLEL

WEIGHT ON ENGINE EXHAUST FLANGE "E" TO BE KEPT TO A MINIMUM. LUB. OIL PRIMING PUMP IS SUPPLIED LOOSE AND IS TO BE CONNECTED TO INDICATED BOSSES WITH FLEXIBLE PIPES (MAN SUPPLY).

IMPORTANT A G1,5 NON RETURN VALVE MUST BE INSTALLED ON THE DELIVERY PIPE TO THE ENGINE.

NOTE AN OFF-ENGINE HEADER TANK MUST BE PROVIDED. HEADER TANK TO BE OF 120 LITRES CAPACITY AND MUST BE MOUNTED 1 METRE ABOVE THE ENGINE FOR VENTING OF THE PRIMARY CIRCUIT.



DETAIL OF ENGINE CONNECTIONS 'S1 AND S2'.
SECONDARY WATER INLET AND OUTLET. FLANGE 20mm THICK.
FLANGE COMPATIBLE TO BS4504 PN 10/16 125mm NOM.BORE
AND DIN 2633 125mm NOM.BORE.

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MATERIAL AND HEAT TREATMENT
SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:- ALL DIMENSIONS IN MILLIMETRES. THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779. SURFACES MARKED THUS √ TO BE MACHINED. SURFACE TEXTURE CLA VALUES IN MICROMETRES. UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4. GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

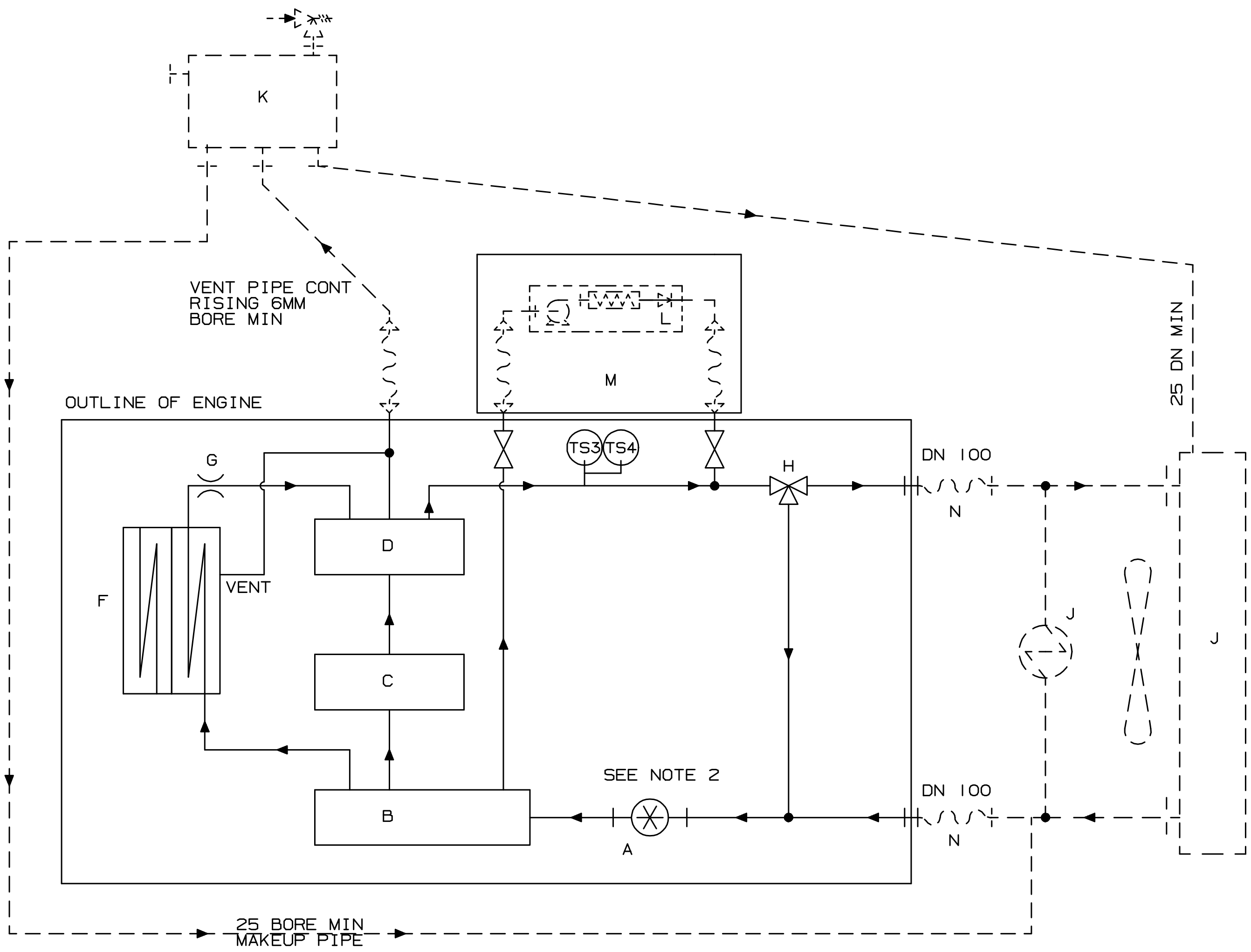
TITLE
GENERAL ARRANGEMENT
12VP185 INDUSTRIAL

DRAWING No./ PART No.
2011D070
SHEET 1 OF 2 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

DRG. No. 2015D049



ITEM	DESCRIPTION
A	ENGINE DRIVEN PRIMARY WATER PUMP
B	CYLINDER BLOCK
C	EXHAUST JACKETS
D	TURBOCHARGER HOUSING
E	
F	AFTERCOOLER
G	ORIFICE PLATE
H	THERMOSTATIC VALVE STARTS TO OPEN AT 79°C FULLY OPEN AT 88°C
J	RADIATOR/HEAT EXCHANGER (OPTIONAL)
K	HEADER TANK MIN CAPACITY 85 LITRES. COMPLETE PRESSURE CAP 1 BAR RATING WITH VACUUM RELIEF, LOW LEVEL SWITCH, MAKE-UP AND FILLING CONNECTIONS (SEE NOTE 1) (OPTIONAL)
L	THERMOSTATICALLY CONTROLLED PRIMARY WATER HEATER UNIT (OPTIONAL)
M	THERMOSTATICALLY CONTROLLED PRIMARY WATER HEATER UNIT WITH FLEXIBILES (OPTIONAL)
N	FLEXIBLE BELLOWS LENGTH 130 MM (OPTIONAL)

NOTES:-

1. THE HEADER TANK MAY BE INCORPORATED WITHIN THE RADIATOR WHICH MUST BE HIGHER THAN THE ENGINE TO ENABLE ADEQUATE VENTING.

2. PRIMARY WATER PUMP AVAILABLE HEAD FOR EXTERNAL COOLING CIRCUIT AT,

ENGINE SPEED OF 1200 RPM = 1.3 BAR AT A FLOW OF 105 CU M/HR

ENGINE SPEED OF 1500 RPM = 1.3 BAR AT A FLOW OF 105 CU M/HR

ENGINE SPEED OF 1800 RPM = 1.7 BAR AT A FLOW OF 125 CU M/HR

3. FOR INSTRUMENTATION SCHEDULE REFER TO DRG NO. 2015D043

4. FOR SCHEMATIC DRAWING SYMBOLS REFER TO DRG NO. 2013D027

5. ——— PIPING/EQUIPMENT - MAN SUPPLY

– – – PIPING/EQUIPMENT - CUSTOMER/OPTIONAL SUPPLY

FLEXIBLE PIPE - CUSTOMER/OPTIONAL SUPPLY

FLEXIBLE PIPE - MAN SUPPLY

6. THE TENDER AND NOT THIS DRAWING DEFINES THE SCOPE OF SUPPLY

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SCALE NTS
DRAWN M.KIRBY
DATE 14/09/2015
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MATERIAL AND HEAT TREATMENT

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

TITLE
PRIMARY WATER P&ID
12VP185 INDUSTRIAL

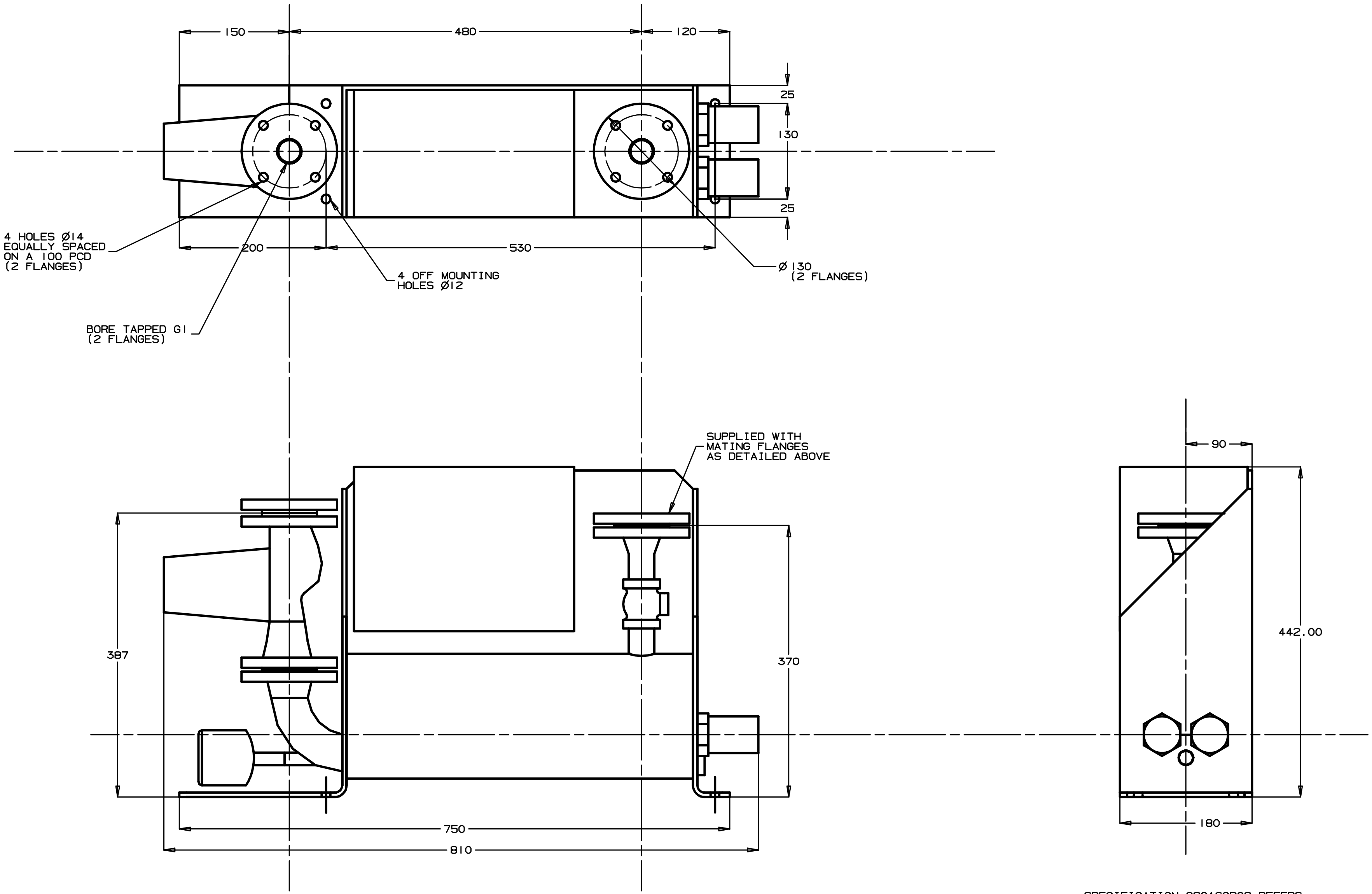
DRAWING No./ PART No.
2015D049
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

SCALE A 1:1

DRG. No. 2014D065



SPECIFICATION 980A69P08 REFERS

FOR WIRING DIAGRAM SEE 2014D066

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MATERIAL AND HEAT TREATMENT

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 38.85 / 38.85
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

TITLE: PRE-HEATER UNIT

DRAWING No./ PART No. 2014D065

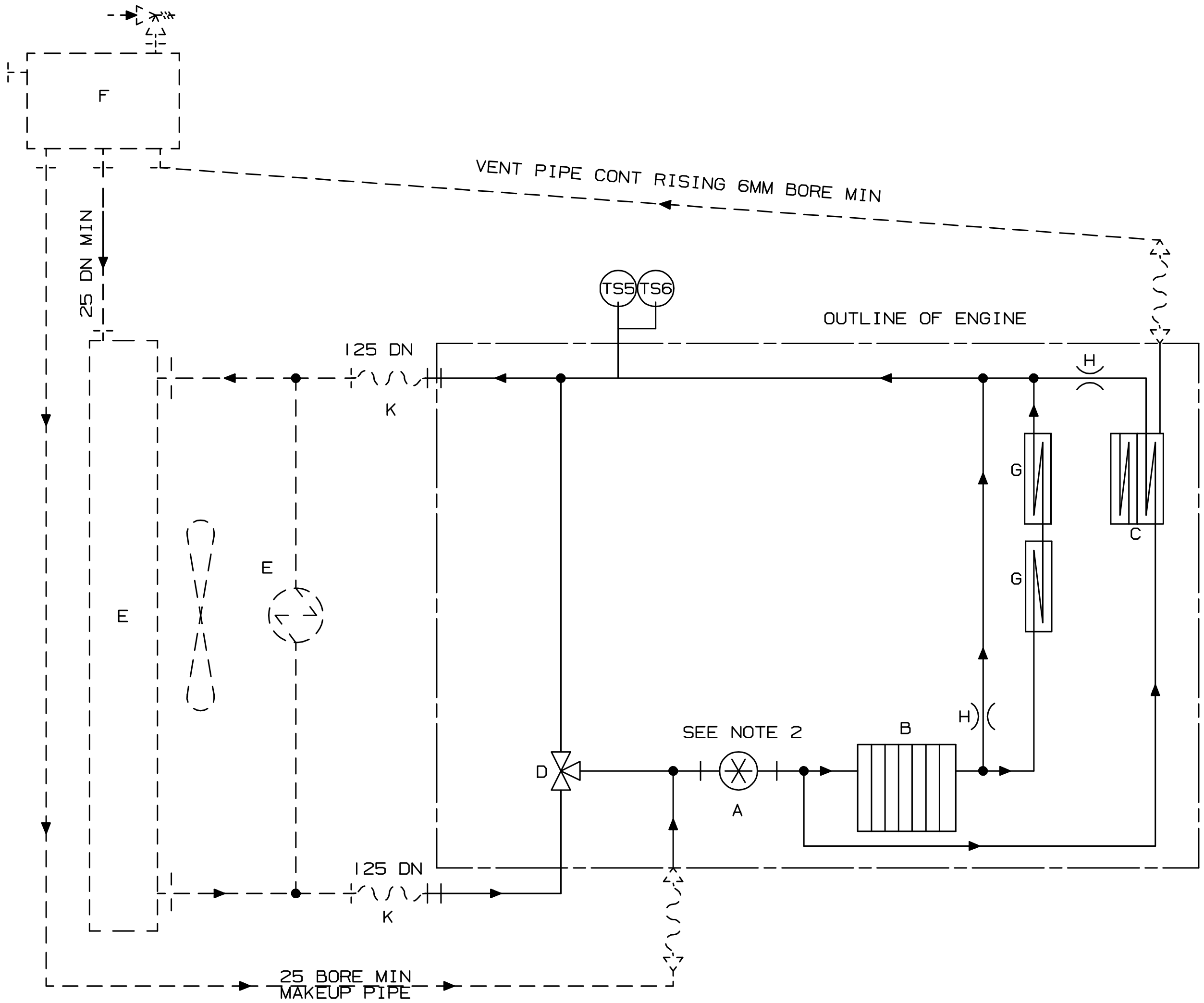
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338

CAD

DRG. No. 2015D044



ITEM	DESCRIPTION
A	ENGINE DRIVEN SECONDARY WATER PUMP
B	LUB OIL COOLER
C	AFTERCOOLER
D	THERMOSTATIC VALVE STARTS TO OPEN AT 35°C FULLY OPEN AT 46°C
E	RADIATOR/HEAT EXCHANGER (OPTIONAL)
F	HEADER TANK MIN CAPACITY 40 LITRES. COMPLETE PRESSURE CAP 1 BAR RATING WITH VACUUM RELIEF, LOW LEVEL SWITCH, MAKE-UP AND FILLING CONNECTIONS (SEE NOTE 1) (OPTIONAL)
G	INTERCOOLER
H	ORIFICE PLATE
J	
K	FLEXIBLE BELLOWS LENGTH 130MM (OPTIONAL)

NOTES:-

1. THE HEADER TANK MAY BE INCORPORATED WITHIN THE RADIATOR WHICH MUST BE HIGHER THAN THE ENGINE TO ENABLE ADEQUATE VENTING.

2. SECONDARY WATER PUMP AVAILABLE HEAD FOR EXTERNAL COOLING CIRCUIT AT,

ENGINE SPEED OF 1200 RPM = 2.2 BAR AT A FLOW OF 120 CU M/HR

ENGINE SPEED OF 1500 RPM = 2.2 BAR AT A FLOW OF 120 CU M/HR

ENGINE SPEED OF 1800 RPM = 3.2 BAR AT A FLOW OF 145 CU M/HR

3. FOR INSTRUMENTATION SCHEDULE REFER TO DRG NO. 2015D043

4. FOR SCHEMATIC DRAWING SYMBOLS REFER TO DRG NO. 2013D027

5. ——— PIPING/EQUIPMENT - MAN SUPPLY

- - - PIPING/EQUIPMENT - CUSTOMER/OPTIONAL SUPPLY

FLEXIBLE PIPE - CUSTOMER/OPTIONAL SUPPLY

FLEXIBLE PIPE - MAN SUPPLY

6. THE TENDER AND NOT THIS DRAWING DEFINES THE SCOPE OF SUPPLY

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MATERIAL AND HEAT TREATMENT

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

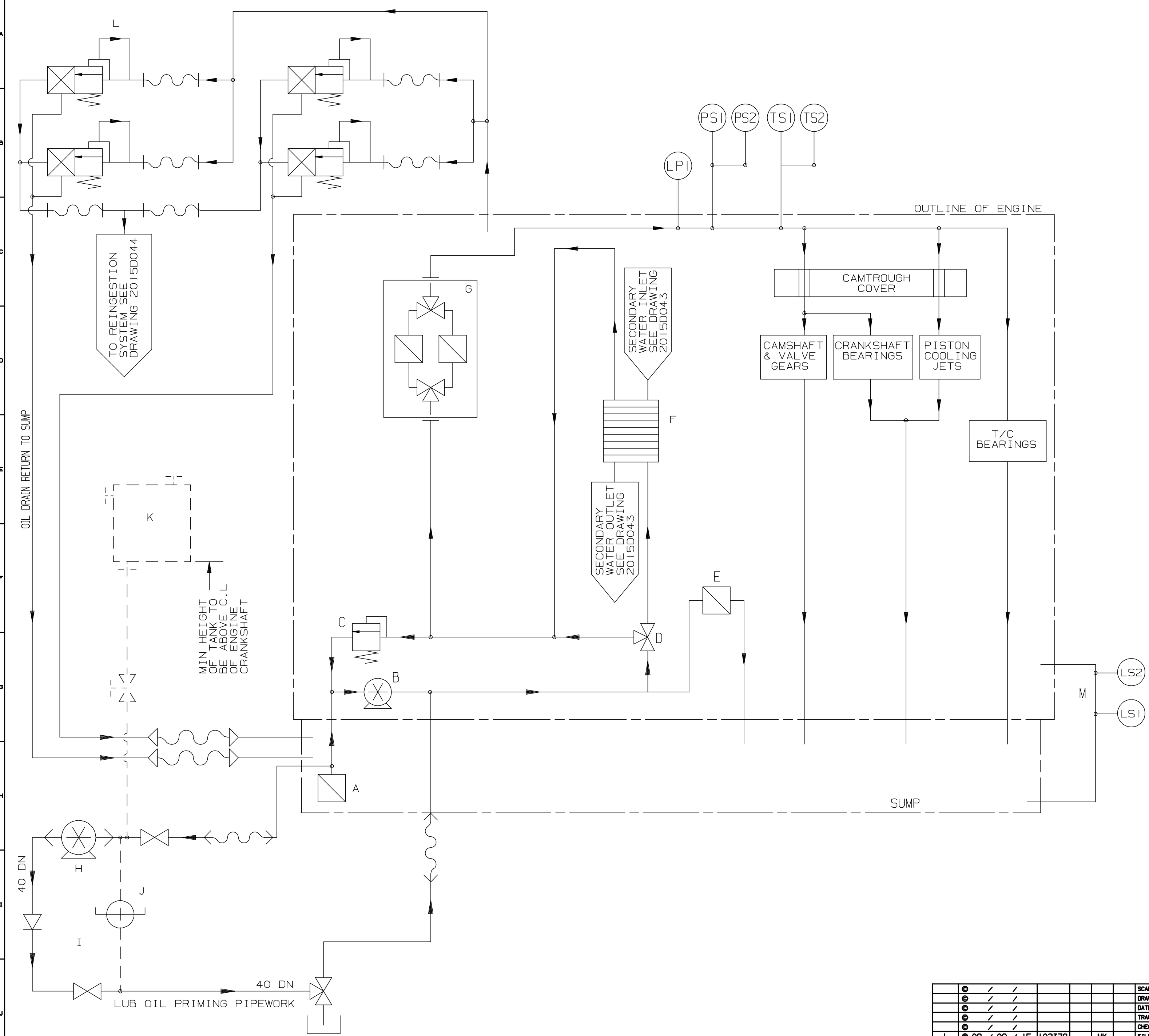
TITLE
SECONDARY WATER P&ID
12VP185 INDUSTRIAL

DRAWING No./ PART No.
2015D044
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

DRG. No. 2015D046



ITEM	DESCRIPTION
A	STRAINER (IN SUMP)
B	ENGINE DRIVEN LUB OIL PUMP
C	PRESSURE RELIEF VALVE
D	LUB OIL THERMOSTATIC VALVE
E	LUB OIL CENTRIFUGAL FILTER
F	LUB OIL PLATE COOLER
G	DUPLEX LUB OIL FILTER
H	MOTOR DRIVEN LUB OIL PRIMING PUMP (AIR DRIVEN OPTIONAL)
I	PIPEWORK, VALVES & FLEXIBLES INC 3 WAY SUMP EMPTYING VALVE & 'Y' TYPE STRAINER
J	LUB OIL HAND PRIMING PUMP (OPTIONAL)
K	CLEAN LUB OIL TANK (CUSTOMER SUPPLY, OPTIONAL)
L	RACOR COALESCER CRANKCASE BREATHER REINGESTION SYSTEM
M1	SUMP LEVEL SWITCH LOW
M2	SUMP LEVEL SWITCH HIGH

NOTES

1. FOR INSTRUMENTATION SCHEDULE, REFER TO DRAWING 2015D043
2. FOR SCHEMATIC DRAWING SYMBOLS REFER TO DRAWING 2013D027
3. ——— PIPING/EQUIPMENT-MAN DIESEL SUPPLY
   — — — PIPING/EQUIPMENT-CUSTOMER/OPTIONAL SUPPLY
   FLEXIBLE PIPE-MAN DIESEL SUPPLY
   FLEXIBLE PIPE-CUSTOMER/OPTIONAL SUPPLY
4. THE TENDER AND NOT THIS DRAWING DEFINES THE SCOPE OF SUPPLY.

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MATERIAL AND HEAT TREATMENT: N/A

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 35.65 / 35.55
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

SIMILAR TO DRG.Nos. 2009D056

TITLE
LUB OIL P & ID
12VP185 INDUSTRIAL

DRAWING No./ PART No.
2015D046
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

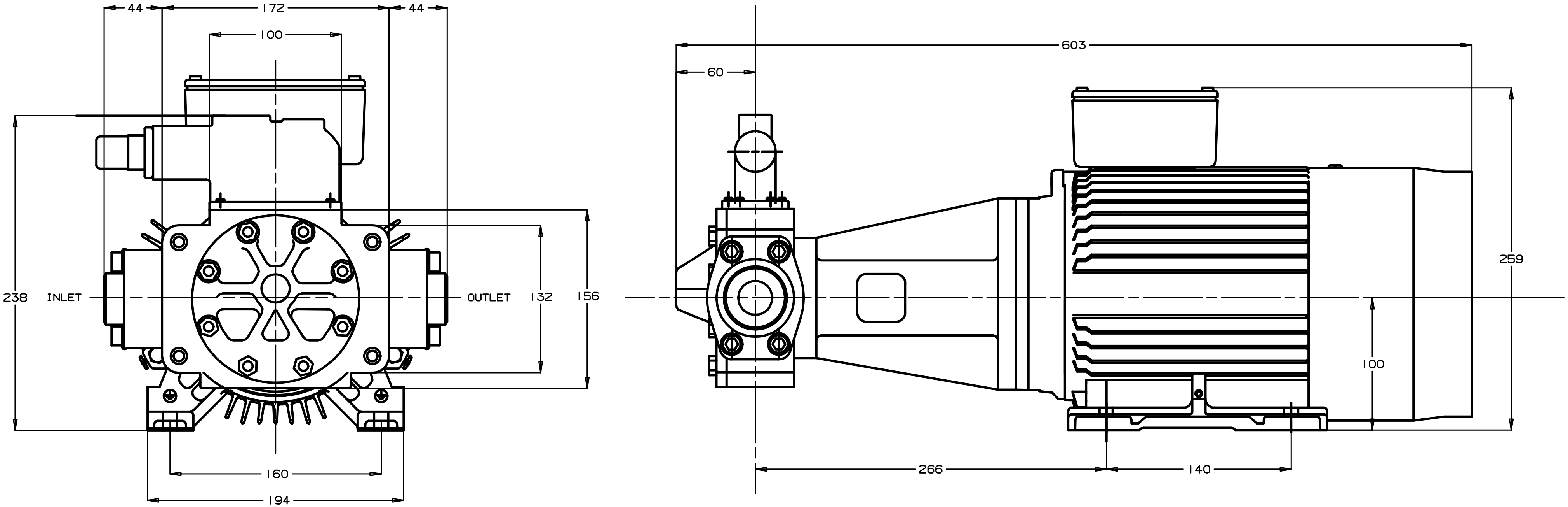
SIZE A0 841 X 1189mm
FORM No. D338
CAD

SCALE A 1:1

DRG. No. 2014D064

NOTE

INLET FLANGE AFS-106 G1-1/2
OUTLET FLANGE AFS-106 G1-1/2



SPECIFICATION 980A65P10BV REFERS

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MATERIAL AND HEAT TREATMENT: N/A

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 38.55 / 38.50
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

MAN

TITLE
LUB OIL
PRIMING PUMP

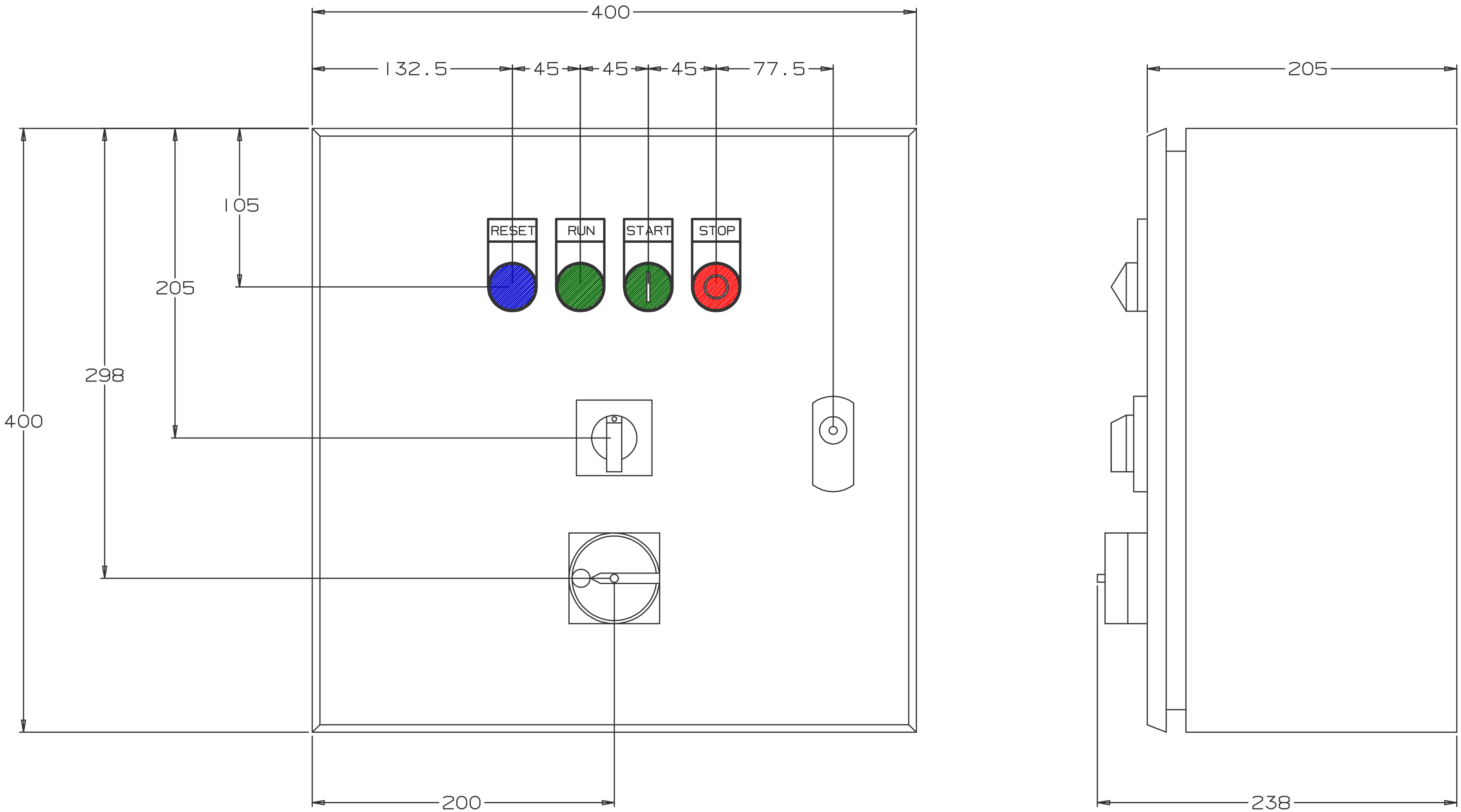
DRAWING No./ PART No.
2014D064
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

SCALE A 1:1 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220

DRG. No. 2016D056



MAN DIESEL & TURBO SPEC
970A52P13 REFERS

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MATERIAL AND HEAT TREATMENT: N/A

SIMILAR TO DRG.Nos.: N/A

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

TITLE: PRIMING PUMP STARTER BOX

DRAWING No./ PART No. 2016D056

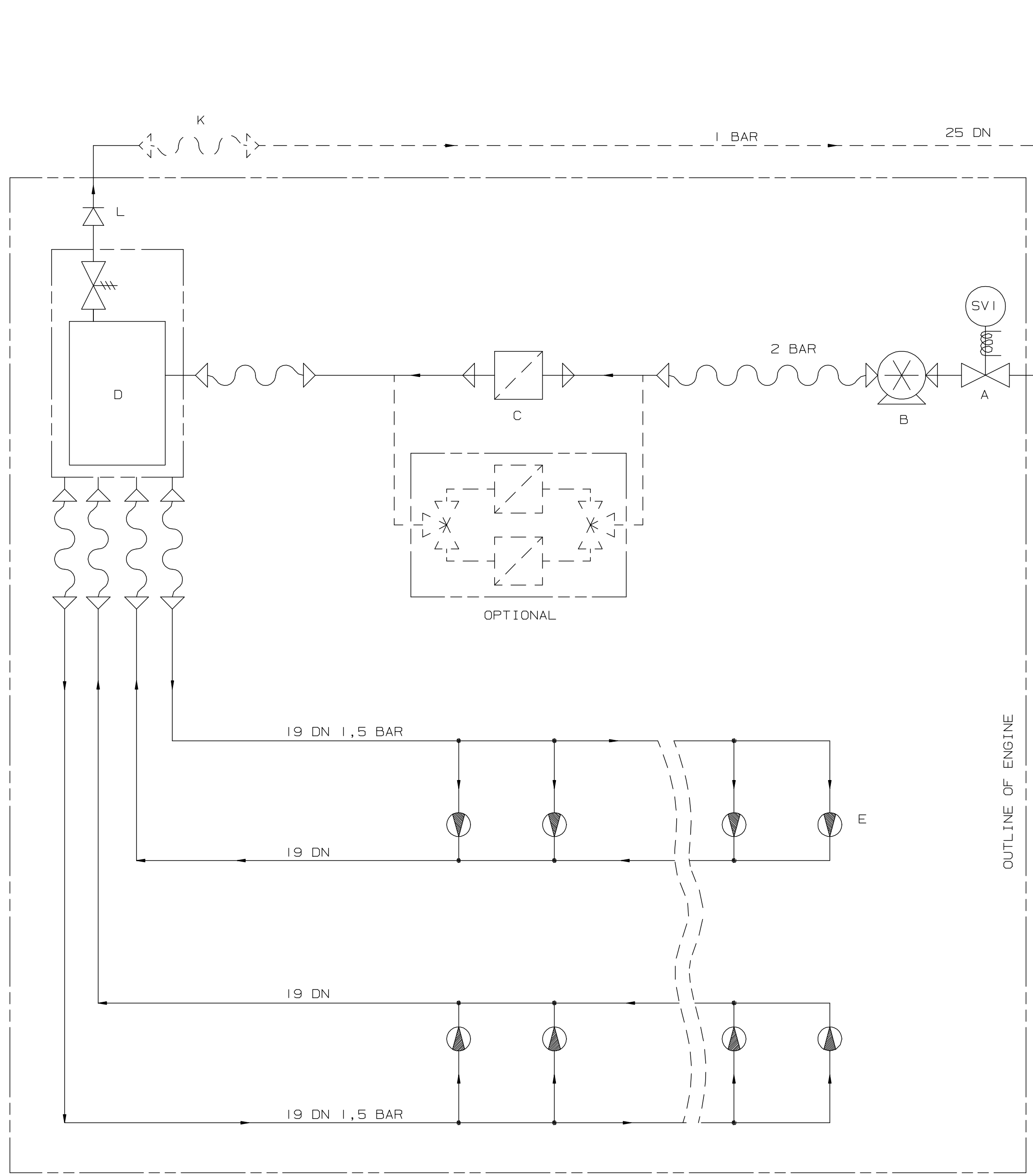
SHEET 1 OF 1 SHEETS

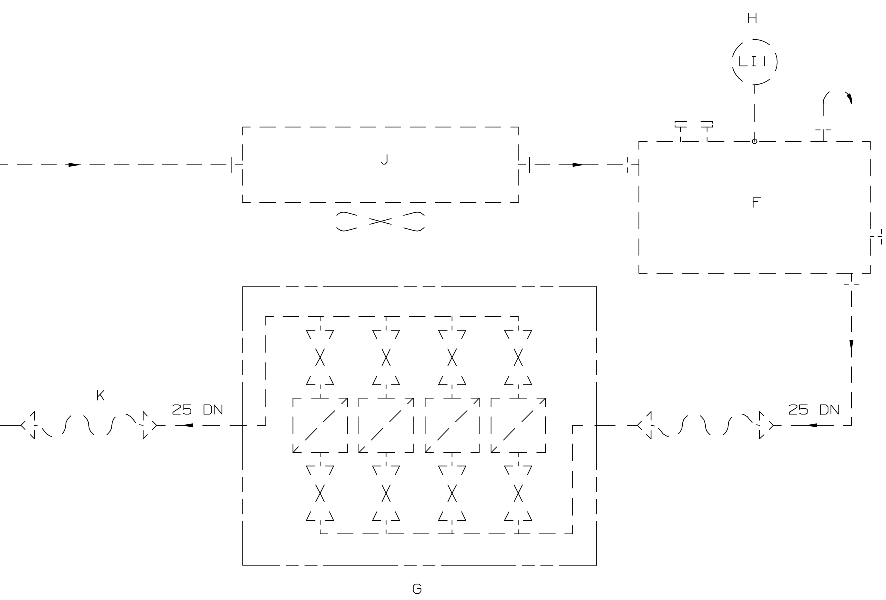
MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338

CAD

DRG. No. 2015D047





ITEM	DESCRIPTION	REMARKS
A	FUEL VALVE SOLENOID	SEE SV1 ON WIRING DIAGRAM
B	ENGINE DRIVEN FUEL LIFT PUMP	SEE NOTE 1
C	SIMPLEX FUEL OIL FILTER (OPTIONAL DUPLEX)	
D	FUEL OIL RESERVOIR C/W PRESSURISING VALVE	
E	UNIT PUMP INJECTOR	
F	FUEL TANK (SEE NOTE 2)	CUSTOMER SUPPLY
G	FUEL OIL COALESCER (OPTIONAL)	
H	FUEL TANK CONTENTS GAUGE	CUSTOMER SUPPLY
J	FUEL OIL COOLER (OPTIONAL)	
K	FLEXIBLES SUPPLY AND RETURN (OPTIONAL)	
L	NON-RETURN VALVE	

NOTES:-

1. FUEL LIFT PUMP
   MAX SUCTION LIFT 2M WG
   MAX SUCTION HEAD 3.5M WG

   PUMP FLOW 1.30 CU M/HR AT 1200 RPM
   PUMP FLOW 1.30 CU M/HR AT 1500 RPM
   PUMP FLOW 1.57 CU M/HR AT 1800 RPM

   RETURN FLOW 0.83 TO 1.24 CU M/HR AT 1200 RPM
   RETURN FLOW 0.79 TO 1.24 CU M/HR AT 1500 RPM
   RETURN FLOW 1.03 TO 1.50 CU M/HR AT 1800 RPM

2. FUEL TANK CAPACITY
   IN ANY INSTANCE THE SMALLEST TANK TO BE 4000 Litres TO MINIMISE THE HEATING EFFECT OF RETURNING FUEL (SYSTEM WITH NO FUEL COOLER)

3. FOR INSTRUMENTATION SCHEDULE, REFER TO DRAWING 2015D043

4. FOR SCHEMATIC DRAWING SYMBOLS, REFER TO DRAWING 2013D027

5. —— PIPING/EQUIPMENT - MAN SUPPLY
   – – PIPING/EQUIPMENT - CUSTOMER SUPPLY
   FLEXIBLE PIPE - MAN SUPPLY
   FLEXIBLE PIPE - CUSTOMER SUPPLY

6. THE TENDER AND NOT THIS DRAWING DEFINES THE SCOPE OF SUPPLY

THIRD ANGLE PROJECTION

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LATEST ISSUE CANCELS PREVIOUS ISSUES ISSUE NUMBER THUS ⑤ SHOWS LOCATIONS OF ALTERATION

SCALE N/A
DRAWN M.KIRBY
DATE 25/08/2015
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CHECKED IWD
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APPROVED DESIGN IWD PRODUCTION

MATERIAL AND HEAT TREATMENT N/A

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 38,95 / 38,85
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

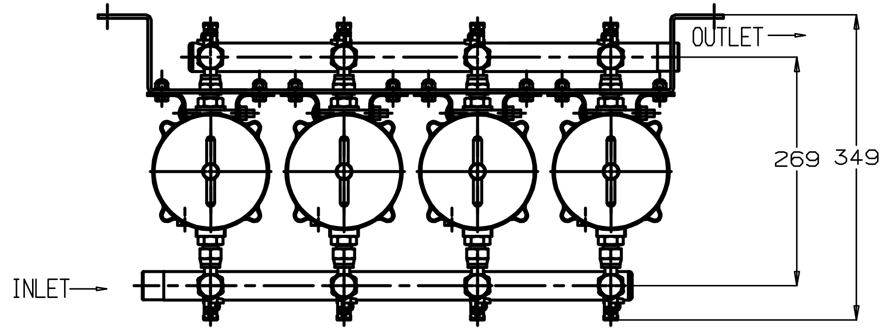
TITLE
FUEL OIL P & ID
12VP185 INDUSTRIAL

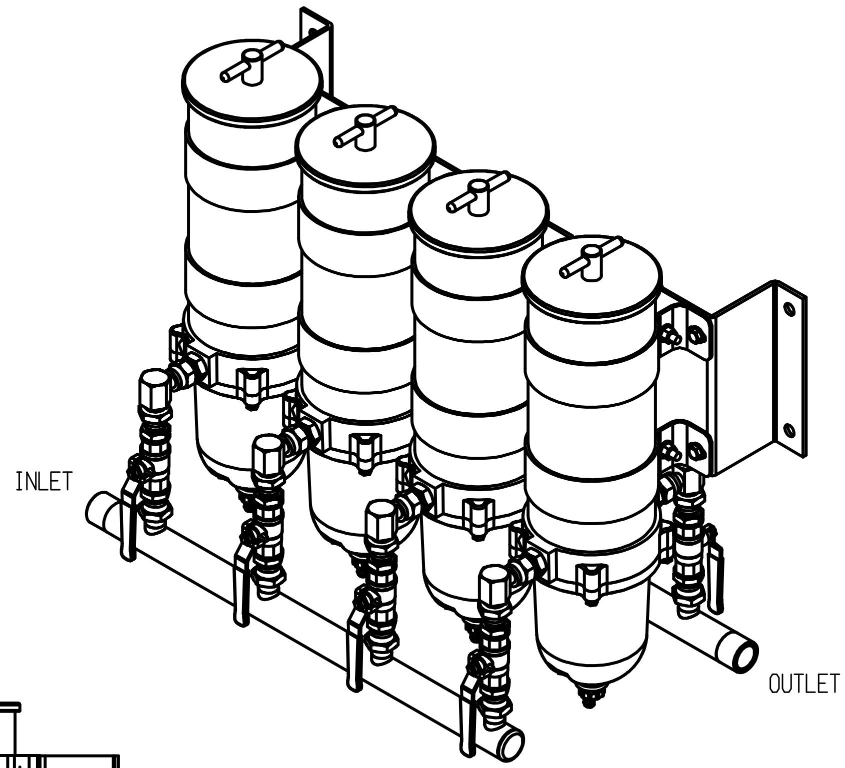
DRAWING No./ PART No.
2015D047
SHEET 1 OF 1 SHEETS

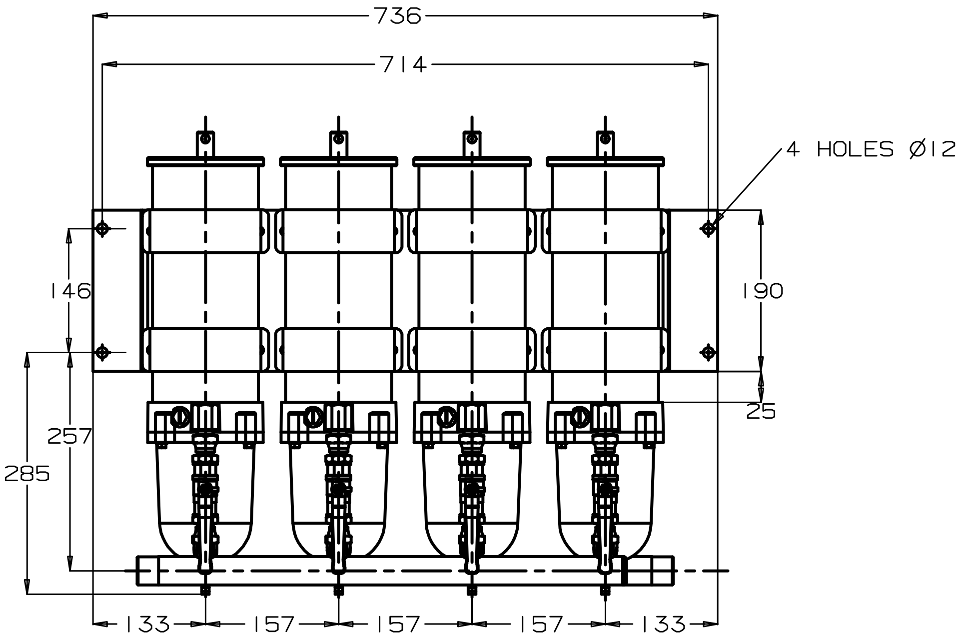
MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

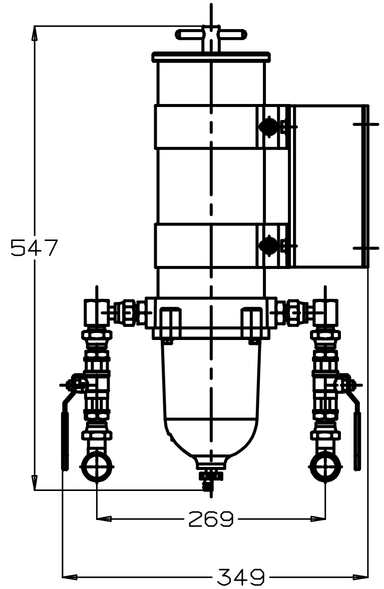
SIZE A0 841 X 1189mm
FORM No. D338
CAD

DRG. No. 2016D055









NOTES:

1. A CLEARANCE OF 260MM MUST BE ADDED TO O/ALL HEIGHT TO FACILITATE ELEMENT REMOVAL.

2. REPLACEMENT ELEMENTS MUST BE GENUINE RACOR 2020 SM, TM OR PM TO GUARANTEE PERFORMANCE.

3. MANIFOLD THREADS ARE 1" BSP PARALLEL.

4. FILTER PORT THREADS ARE 7/8" SAE.

5. THREADS ON INTERCONNECTING FITTINGS ARE 1/2" BSP PARALLEL.

6. ON METAL BOWL FILTERS USE ONLY RACOR WATER LEVEL ALARM UNITS.

SPECIFICATION 940A80 REFERS

THIRD ANGLE PROJECTION

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ISSUE NUMBER THUS ⓪ SHOWS LOCATIONS OF ALTERATION

SCALE	1:1
DRAWN	M.KIRBY
DATE	02/11/2016
TRACED	
CHECKED	IWD
FILMED	
APPROVED DESIGN	IWD
APPROVED PRODUCTION	

MATERIAL AND HEAT TREATMENT: N/A

SIMILAR TO DRG.Nos.: N/A

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 38.05 / 38.65
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

TITLE: FUEL COALESCER FILTER ASSY

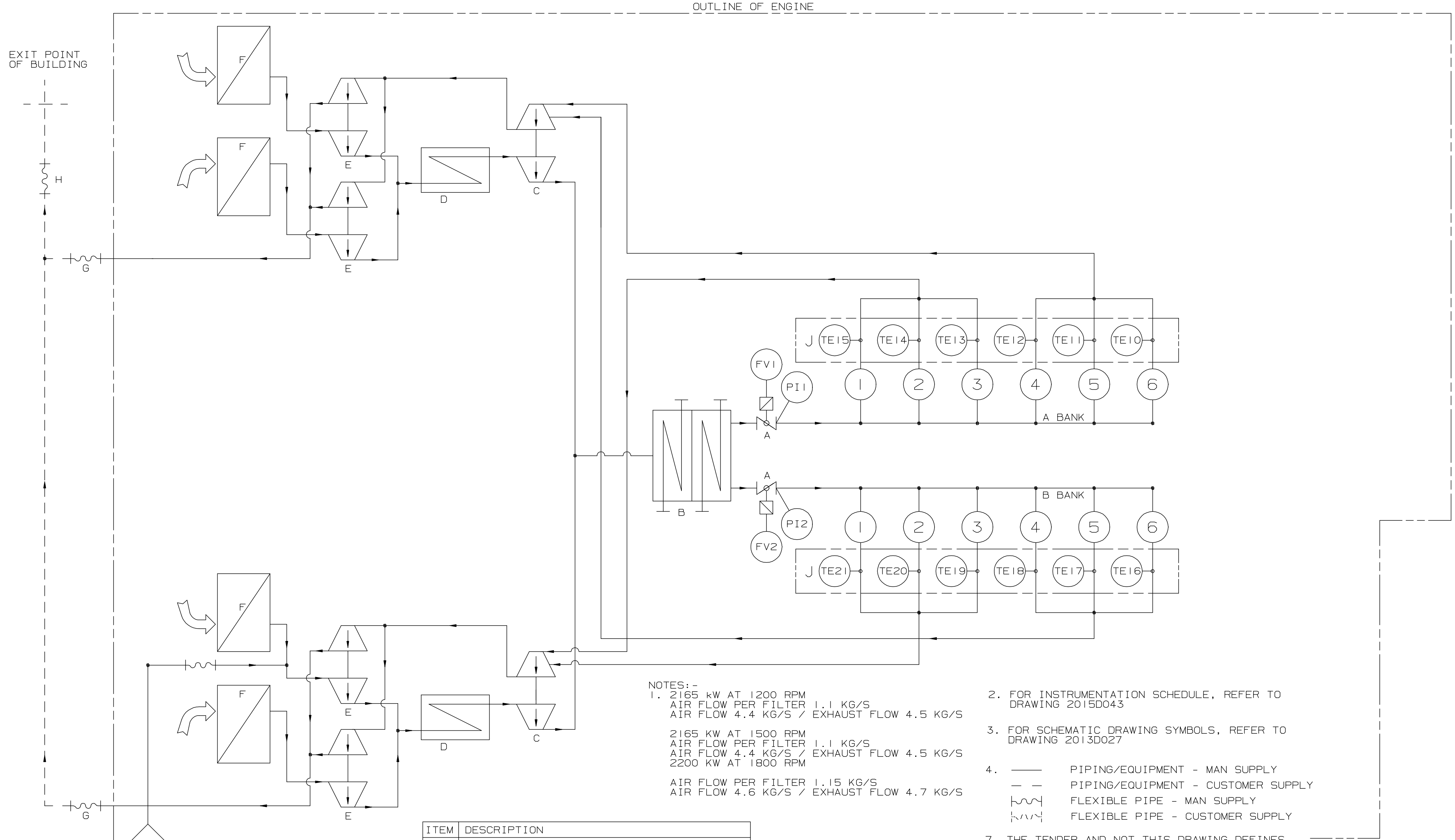
DRAWING No./ PART No.: 2016D055

SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

DRG. No. 2015D045



NOTES:-

1. 2165 kW AT 1200 RPM
   AIR FLOW PER FILTER 1.1 KG/S
   AIR FLOW 4.4 KG/S / EXHAUST FLOW 4.5 KG/S

   2165 KW AT 1500 RPM
   AIR FLOW PER FILTER 1.1 KG/S
   AIR FLOW 4.4 KG/S / EXHAUST FLOW 4.5 KG/S
   2200 KW AT 1800 RPM

   AIR FLOW PER FILTER 1.15 KG/S
   AIR FLOW 4.6 KG/S / EXHAUST FLOW 4.7 KG/S

2. FOR INSTRUMENTATION SCHEDULE, REFER TO DRAWING 2015D043
3. FOR SCHEMATIC DRAWING SYMBOLS, REFER TO DRAWING 2013D027
4. ——— PIPING/EQUIPMENT - MAN SUPPLY
   — — PIPING/EQUIPMENT - CUSTOMER SUPPLY
   FLEXIBLE PIPE - MAN SUPPLY
   FLEXIBLE PIPE - CUSTOMER SUPPLY
7. THE TENDER AND NOT THIS DRAWING DEFINES THE SCOPE OF SUPPLY

ITEM	DESCRIPTION
A	OVERSPEED SHUTDOWN VALVE (1 PER BANK)
B	AFTERCOOLER
C	HIGH PRESSURE TURBOCHARGER
D	INTERCOOLER
E	LOW PRESSURE TURBOCHARGER
F	AIR INLET FILTER
G	ENGINE EXHAUST OUTLET BELLOWS
H	EXHAUST DUCT BELLOWS
J	EXHAUST PYROMETRY SYSTEM

THIRD ANGLE PROJECTION

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LATEST ISSUE CANCELS PREVIOUS ISSUES
ISSUE NUMBER THUS ⑥ SHOWS LOCATIONS OF ALTERATION

SCALE N/A
DRAWN M.KIRBY
DATE 07/09/15
TRACED
CHECKED IWD
FILMED
APPROVED DESIGN IWD PRODUCTION

MATERIAL AND HEAT TREATMENT N/A

SIMILAR TO DRG.Nos. 2009D057

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

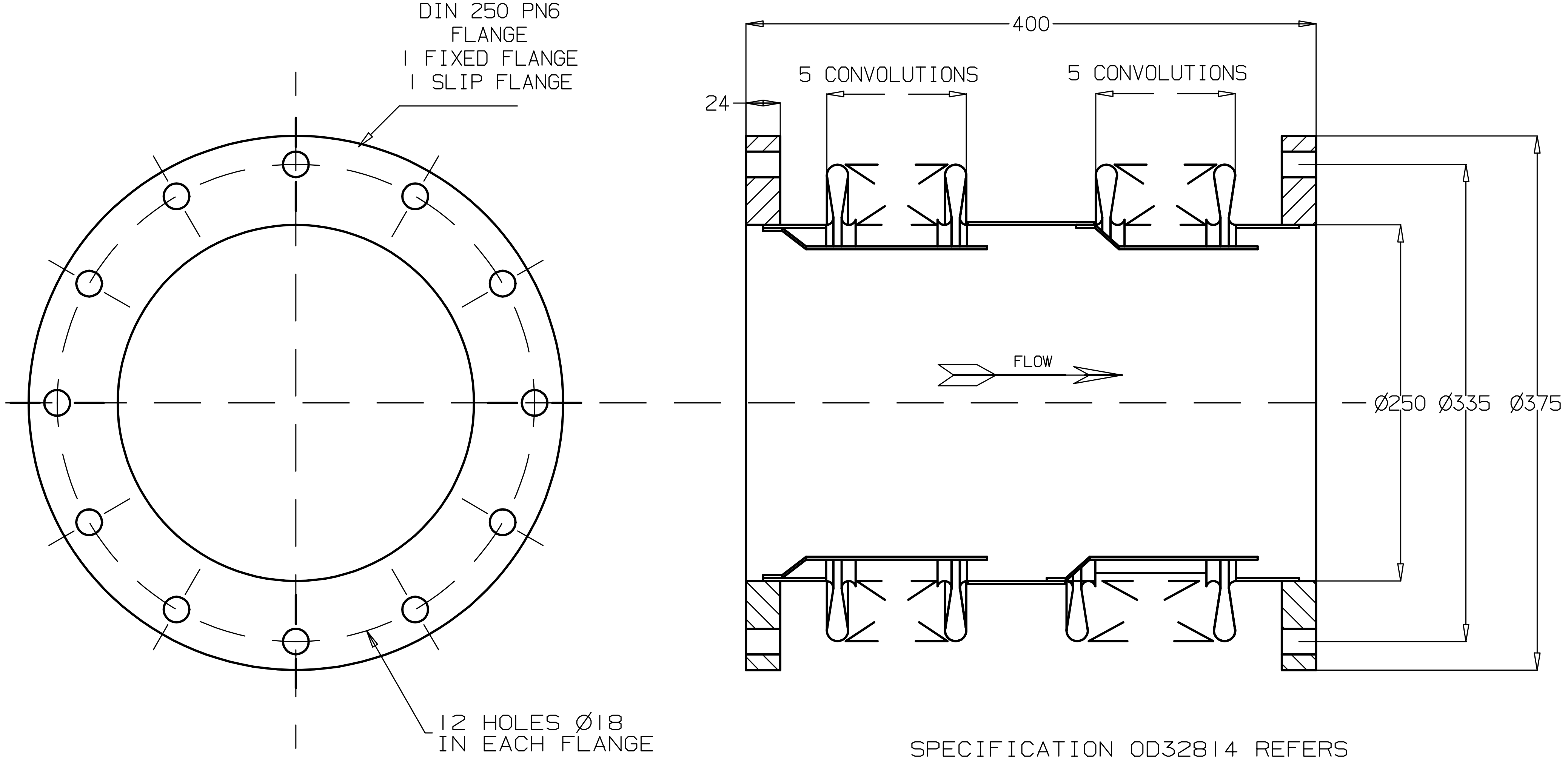
TITLE
EXHAUST/AIR P & ID
12VP185 INDUSTRIAL

DRAWING No./ PART No.
2015D045
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

DRG. No. 2014D053



SPECIFICATION OD32814 REFERS

THIRD ANGLE PROJECTION

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SCALE NTS
DRAWN M.KIRBY
DATE 20/11/14
TRACED
CHECKED IWD
FILMED
APPROVED: DESIGN IWD | PRODUCTION

MATERIAL AND HEAT TREATMENT: STAINLESS 316L

SIMILAR TO DRG.Nos.

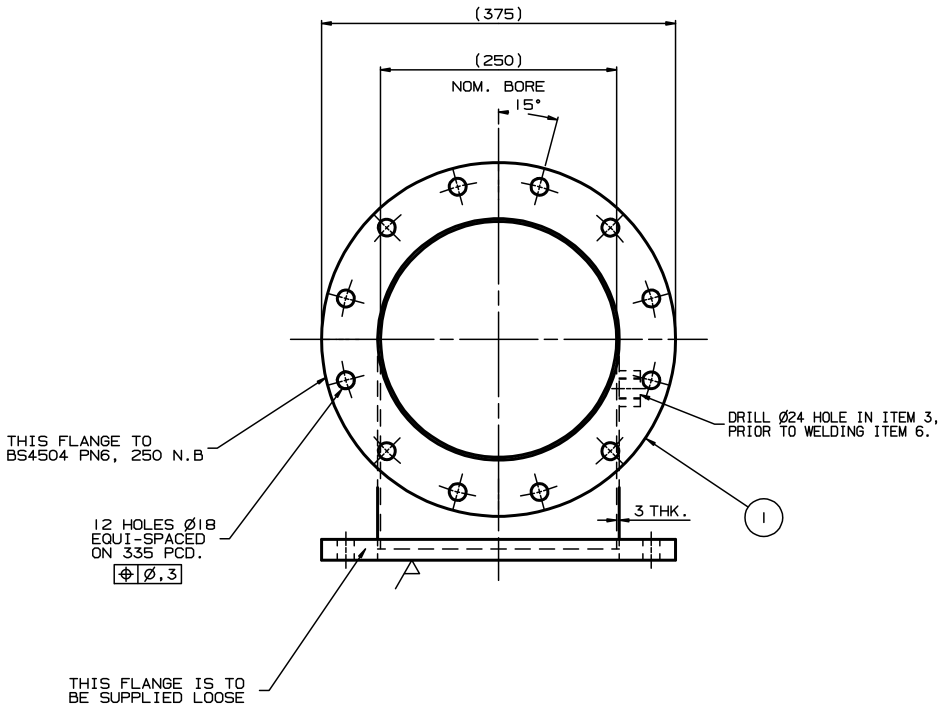
NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

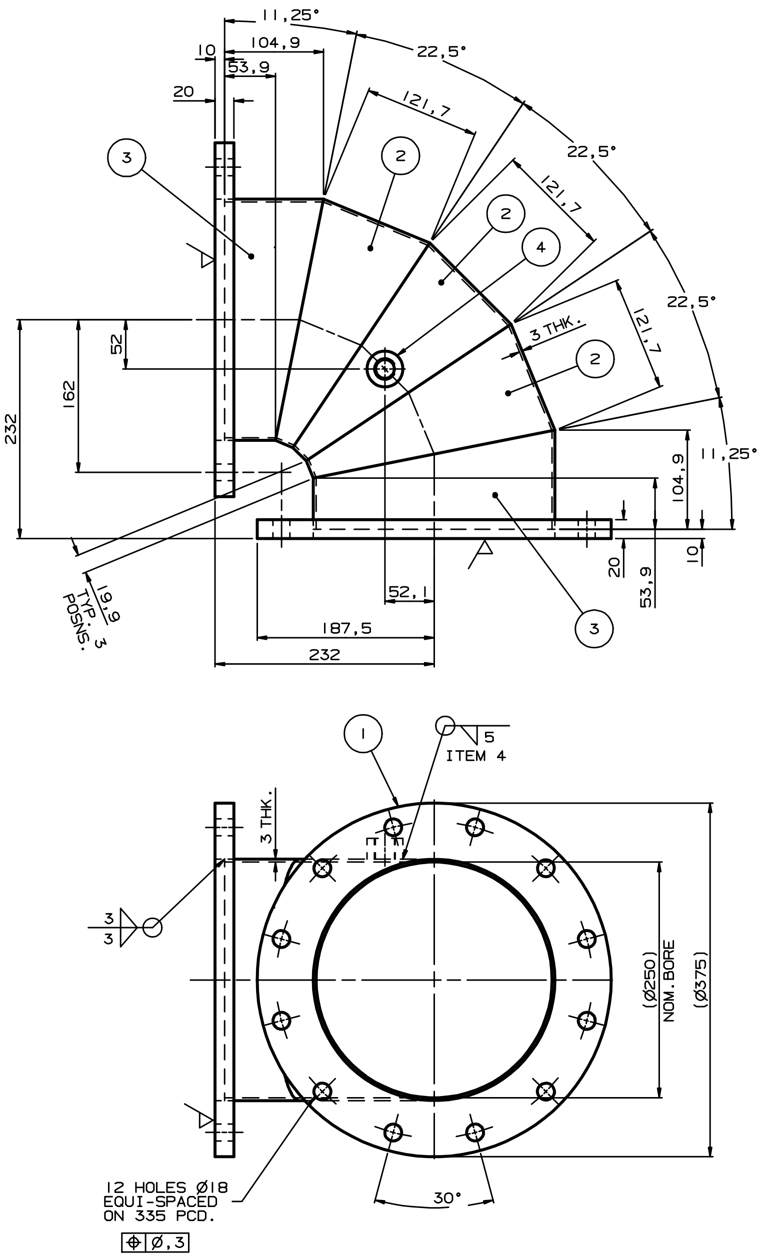
TITLE: EXHAUST BELLOW

DRAWING No./ PART No. 2014D053
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD





REMOVE ALL BURRS AND SHARP EDGES

ALL JOINTS TO BE BUTT WELDED UNLESS STATES OTHERWISE.

ITEM	PART No.	DESCRIPTION	QTY	REMARKS
1	2014D044P01	FLANGE	2	STAINLESS STEEL 316L
2	2914D044P02	PIPE, KNUCKLE SECTION	3	STAINLESS STEEL 316L
3	2014D044P03	PIPE, LONG SECTION	2	STAINLESS STEEL 316L
4	2014D044P04	BOSS	1	STAINLESS STEEL 316L

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SCALE 1:2
DRAWN I.DRAKE
DATE 27/10/2014
TRACED
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APPROVED — DESIGN: SLA — PRODUCTION:

MATERIAL AND HEAT TREATMENT

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 38,85 / 38,65
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

MAN

TITLE: EXHAUST OUTLET BEND ENGINE CONNECTION 12/18VP185 ENGINE

DRAWING No./ PART No. 2014D044

SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338

CAD

DRG. No. 2015D043

REF	PART NO.	DESCRIPTION	CHARACTERISTICS	REMARKS
SV1	0D31948P01	FUEL INLET VALVE SOLENOID	ENERGISE TO OPEN FUEL VALVE 24VDC 11.2 WATTS	
ST1	970A103P02	ENGINE SPEED PERCEPTION HEAD-SPEED SWITCH	SIGNALS ENGINE SPEED TO OVERSPEED SWITCH	FREE CONNECTOR: 970A103P03
SS1	970A103P06	ELECTRONIC SPEED SWITCH	INCLUDES 0-1mA OUTPUT SIGNAL FOR AN ENGINE RPM INDICATOR	SUPPLIED LOOSE, 1200 RPM ENGINES ONLY
	970A103P01	ELECTRONIC SPEED SWITCH	INCLUDES 0-1mA OUTPUT SIGNAL FOR AN ENGINE RPM INDICATOR	SUPPLIED LOOSE, 1500 RPM ENGINES ONLY
	970A103P04	ELECTRONIC SPEED SWITCH	INCLUDES 0-1mA OUTPUT SIGNAL FOR AN ENGINE RPM INDICATOR	SUPPLIED LOOSE, 1800 RPM ENGINES ONLY
FV1/FV2	0D32351	MAGNETIC SOLENOID	ENERGISE TO CLOSE AIR FLAP VALVES, 24VDC 15 WATTS EACH	
PI1/PI2	970A26P02	PROXIMITY SWITCH	NORMALLY OPEN WHEN FLAP IN OPEN POSITION 24VDC 200mA	
LP1	980A20P02	ENGINE LUB OIL PRIMING LEVEL PROBE	RISING LEVEL/SIGNAL OUTPUT MINUS POTENTIAL 24VDC 24 watts	FREE CONNECTOR 960A132P02
LS1	980A20P02	ENGINE LUB OIL SUMP LOW LEVEL PROBE	RISING LEVEL/SIGNAL OUTPUT MINUS POTENTIAL 24VDC 24 watts	FREE CONNECTOR 960A132P02
LS2	980A20P01	ENGINE LUB OIL SUMP HIGH LEVEL PROBE	FALLING LEVEL/SIGNAL OUTPUT MINUS POTENTIAL 24VDC 24 watts	FREE CONNECTOR 960A132P02
PS1	970A84P01	ENGINE LOW LUB OIL PRESSURE ALARM SWITCH	CONTACTS BREAK AT 4,14 BAR FALLING. CONTACTS RATED 5 AMP AT 24V DC	SWITCH 1
PS2		ENGINE LOW LUB OIL PRESSURE SHUTDOWN SWITCH	CONTACTS BREAK AT 3,45 BAR FALLING. CONTACTS RATED 5 AMP AT 24V DC	SWITCH 2
TS1	2002F017	ENGINE HIGH LUB OIL TEMPERATURE ALARM SWITCH	CONTACTS BREAK AT 87°C RISING. CONTACTS RATED 5 AMP AT 24V DC	SWITCH 1
TS2		ENGINE HIGH LUB OIL TEMPERATURE SHUTDOWN SWITCH	CONTACTS BREAK AT 90°C RISING. CONTACTS RATED 5 AMP AT 24V DC	SWITCH 2
TS3	990A16P01	ENGINE HIGH PRIMARY WATER TEMPERATURE ALARM SWITCH	CONTACTS BREAK AT 91°C RISING. CONTACTS RATED 5 AMP AT 24V DC	SWITCH 1
TS4		ENGINE HIGH PRIMARY WATER TEMPERATURE SHUTDOWN SWITCH	CONTACTS BREAK AT 96°C RISING. CONTACTS RATED 5 AMP AT 24V DC	SWITCH 2
TS5	2001F041P01	ENGINE HIGH SECONDARY WATER TEMPERATURE ALARM SWITCH	CONTACTS BREAK AT 75°C RISING. CONTACTS RATED 5 AMP AT 24V DC	SWITCH 1
TS6		ENGINE HIGH SECONDARY WATER TEMPERATURE SHUTDOWN SWITCH	CONTACTS BREAK AT 80°C RISING. CONTACTS RATED 5 AMP AT 24V DC	SWITCH 2
TE10-TE21	0D32754P01	AFTER VALVE EXHAUST THERMOCOUPLE	RANGE 0-800°C OUTPUT 4-20mA	
ETL1	0D32755P01	EXHAUST THERMOCOUPLE CABLE LOOM A BANK		
ETL2	0D32755P02	EXHAUST THERMOCOUPLE CABLE LOOM B BANK		
SM1/SM2	0D32773P01	ELECTRIC STARTER MOTORS	24VDC 3500AMPS TOTAL IN-RUSH CURRENT 900AMPS TOTAL MOTORING CURRENT	
SR1/SR2	950A107P02	STARTER RELAYS	ENERGISE TO RUN STARTER MOTORS 24VDC 2.5A TOTAL	
IR1	920A46P01	INTERPOSING RELAY	ENERGISE TO START ENGINE 24VDC 20mA	
TS7-TS18	0D32559	CYLINDER LINER OVER TEMPERATURE SWITCH	BIMETALLIC SWITCH CONTACTS BREAK AT 115°C RISING	

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LATEST ISSUE CANCELS PREVIOUS ISSUES
ISSUE NUMBER THUS ⑥ SHOWS LOCATIONS OF ALTERATION

SCALE NTS
DRAWN M.KIRBY
DATE 08/09/2015
TRACED
CHECKED IWD
FILMED
APPROVED DESIGN IWD PRODUCTION

MATERIAL AND HEAT TREATMENT

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 38.85 / 38.65
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

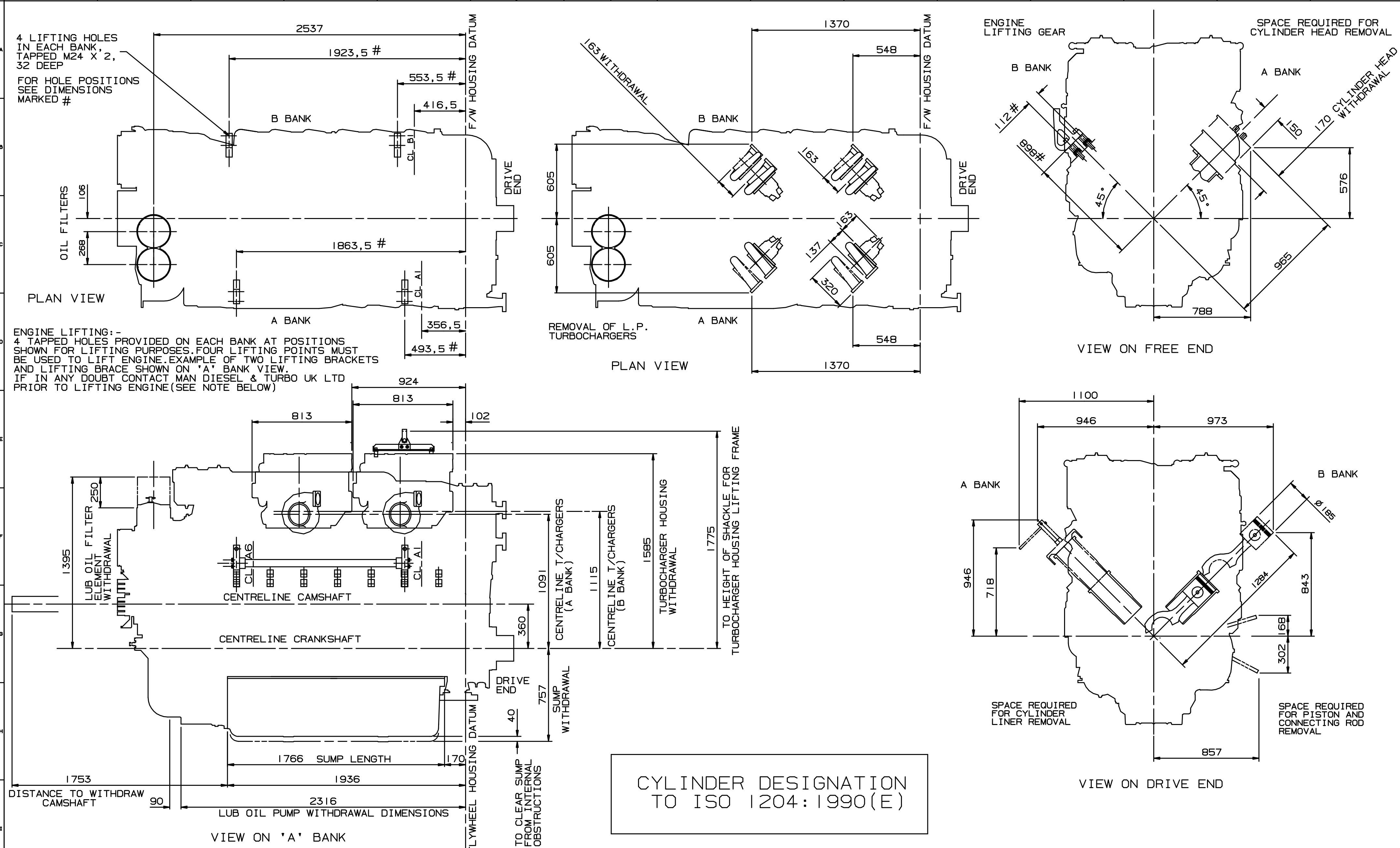
TITLE
INSTRUMENTATION SCHEDULE 12VP185TCG

DRAWING No./ PART No.
2015D043
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

DRG. No. 2012D052



NOTE:-
ALL DIMENSIONS SHOWN GIVE MINIMUM CLEARANCES FROM MATING FACE AND ANY INTERNAL OBSTRUCTION THE ITEM MUST THEN BE REMOVED FROM THE OVERALL ENGINE ENVELOPE (eg AFTER SUMP HAS DROPPED,SUFFICIENT SIDE CLEARANCE IS REQUIRED TO REMOVE SUMP FROM INSTALLATION)
IT IS ASSUMED THAT ALL CONNECTION PIPEWORK HAS BEEN REMOVED.

THE USE OF CORRECT LIFTING GEAR IS ESSENTIAL IN ORDER TO AVOID DAMAGE WHEN LIFTING (MAN DIESEL & TURBO UK Ltd. LIFTING GEAR PART NUMBER YN74403)
IF IN ANY DOUBT REGARDING LIFTING OF ENGINE CONTACT MAN DIESEL & TURBO UK LTD.

ENGINE OUTLINES SHOWN MAY VARY WITH APPLICATION

THIRD ANGLE PROJECTION

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LATEST ISSUE CANCELS PREVIOUS ISSUES
ISSUE NUMBER THUS © SHOWS LOCATIONS OF ALTERATION

SCALE 1:10
DRAWN J. WEBB
DATE 06/06/2012
TRACED
CHECKED IWD
FILMED
APPROVED DESIGN IWD PRODUCTION

MATERIAL AND HEAT TREATMENT

SIMILAR TO DRG.Nos. 2010D006

NOTES APPLICABLE UNLESS STATED OTHERWISE:- ALL DIMENSIONS IN MILLIMETRES. THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779 SURFACES MARKED THUS √ TO BE MACHINED SURFACE TEXTURE CLA VALUES IN MICROMETRES. LIMITS GIVEN THUS
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0.4 GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

TITLE
MAINTENANCE ENVELOPES FOR 12VP185T ENGINE

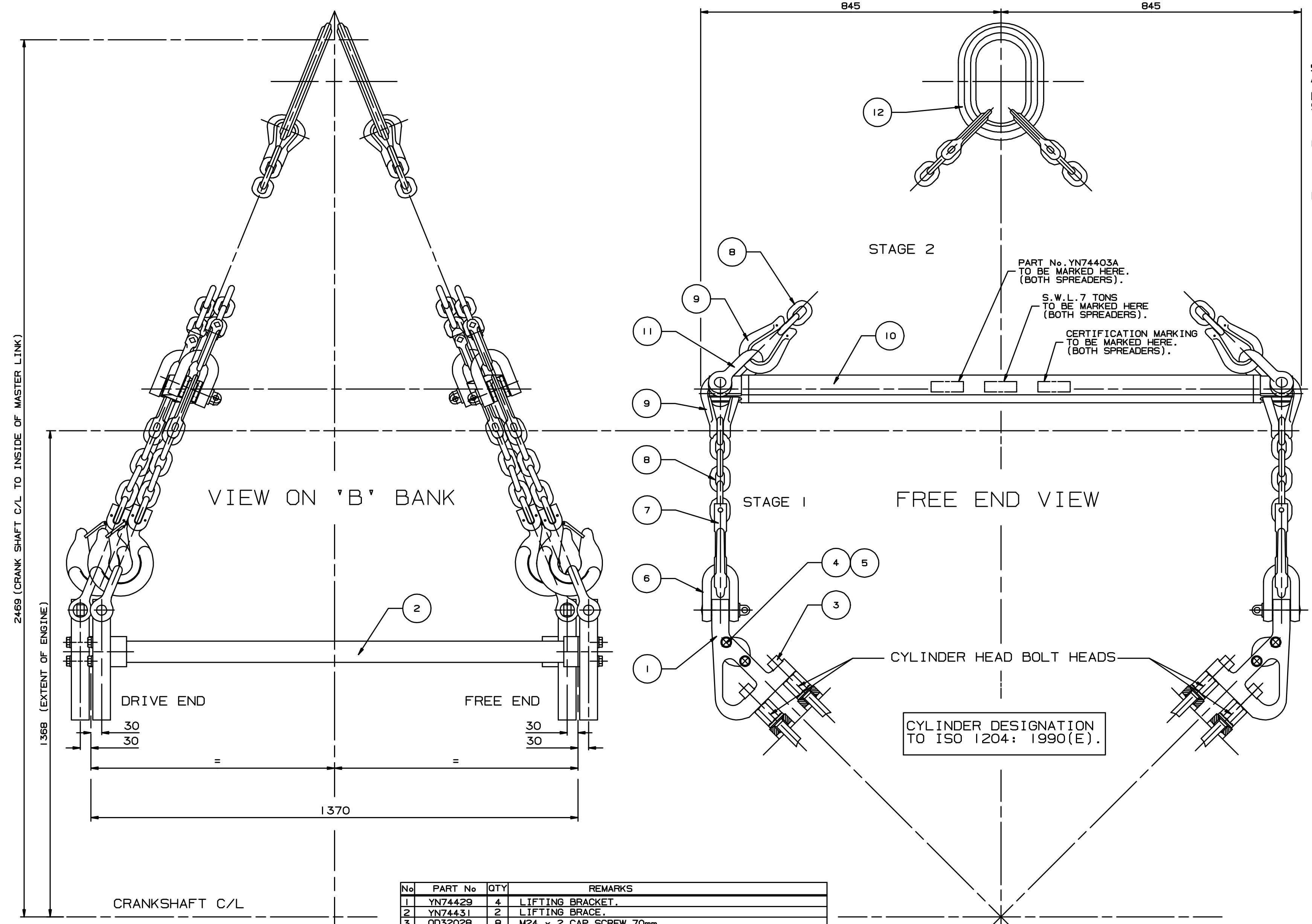
DRAWING No./ PART No.
2012D052
SHEET | OF | SHEETS

MAN Diesel Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A0 841 X 1189mm
FORM No. D338
CAD

SCALE A 1:1

DRG. No. YN74403A



LIFTING DETAIL:

STAGE 1 OF THE LIFTING ARRANGMENT ARE AS FOLLOWS:

DISTANCE FROM RAD OF HOOK TO RAD OF KUPLER = 577mm
I.E. 6 CHAIN LINKS.

(THIS IS COMMON FOR BOTH LEGS BOTH SIDES)

STAGE 2 OF THE LIFTING ARRANGMENT ARE AS FOLLOWS:

DISTANCE FROM RAD OF SHACKLE TO RAD OF MASTER LINK = 1004mm
I.E. 16 CHAIN LINKS.

(THIS IS COMMON FOR BOTH LEGS BOTH SIDES)

12VP185 LIFTING SYSTEM

NOTE: BRACKETS FOR LIFTING YN74429 WILL BE SITUATED ON THE EXTREME CYLINDER HEAD BOLTS AT THE FREE END, AND ONE CYLINDER IN FROM THE DRIVE END.

18VP185 LIFTING SYSTEM

NOTE: BRACTETS FOR LIFTING YN74429 WILL BE SITUATED EQUALLY ABOUT THE CYLINDER HEADS.

I.E. 3RD SET OF BOLTS IN FROM THE DRIVE END OR THE FREE END.

IMPORTANT

LIFTING ASSEMBLY SHALL BE SUBJECTED TO A PROOF LOADING OF 21 TONS. PROOF TEST CERTIFICATION WILL ACCOMPANY EACH LIFTING ASSEMBLY.

WORKS AND PLANT LIFTING TACKLE SECTION TO ARRANGE PROOF LOADING AND CERT--IFICATION.

THE FOLLOWING ITEMS ARE TO BE MARKED ON EACH HALF OF THE LIFTING SYSTEM:
PART No.
S.W.L.
CERT'INFO.

SAFE WORKING LOAD: 14 TONS.

PROOF LOAD: 21 TONS.

No	PART No	QTY	REMARKS
1	YN74429	4	LIFTING BRACKET.
2	YN74431	2	LIFTING BRACE.
3	0D32028	8	M24 x 2 CAP SCREW 70mm.
4	ST310117	8	M16 HEX HEAD BOLT 70mm long.
5	0D28916	8	SCHNORR WASHER M16.
6	0D32206	4	3 3/4 TON SHACKLE. (HW180/7).
7	0D32238	4	SAFETY LATCH HOOK.(KH16N).
8	0D32240	8M	16mm CHAIN ALL OVER SEE NOTES FOR LENGHS.(CN1132)
9	0D32239	12	KUPLER.(K16N).
10	YN74432A	2	SPREADER BAR.
11	0D32373	4	5 TON SHACKLE. (HW180/8).
12	0D32241	2	MASTER LINK.(KM-E).

SAFETY CRITICAL

THIS IS A CATEGORY A1 COMPONENT AND REQUIRES CERTIFICATION IN ACCORDANCE WITH PAXMAN DIESELS STANDARD 950583.

THIRD ANGLE PROJECTION

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LATEST ISSUE CANCELS PREVIOUS ISSUES
ISSUE NUMBER THUS ⓔ SHOWS LOCATIONS OF ALTERATION

SCALE 1:4
DRAWN S.CLARKE
DATE 06/09/2000
TRACED
CHECKED IWD
FILMED
APPROVED DESIGN IWD | PRODUCTION

MATERIAL AND HEAT TREATMENT

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS ✓ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 38.05 / 38.95
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

SIMILAR TO DRG.Nos. YN74403

TITLE: VP185 LIFTING ASSEMBLY

DRAWING No./ PART No. YN74403A

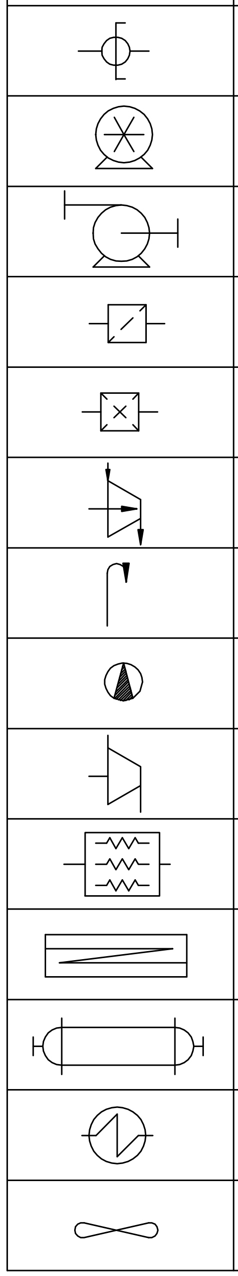
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

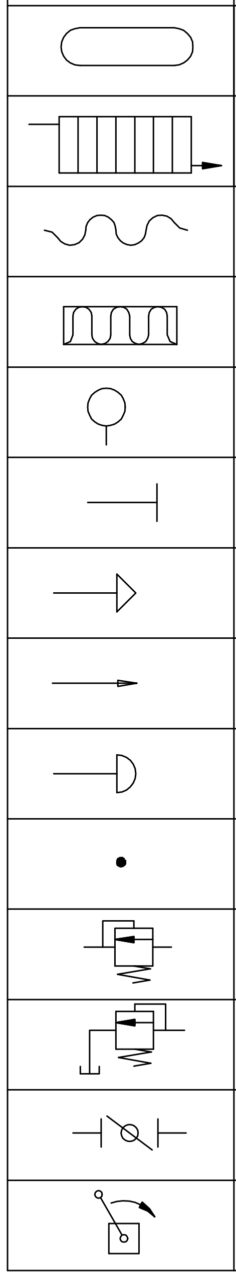
SIZE A0 841 X 1189mm
FORM No. D338

CAD

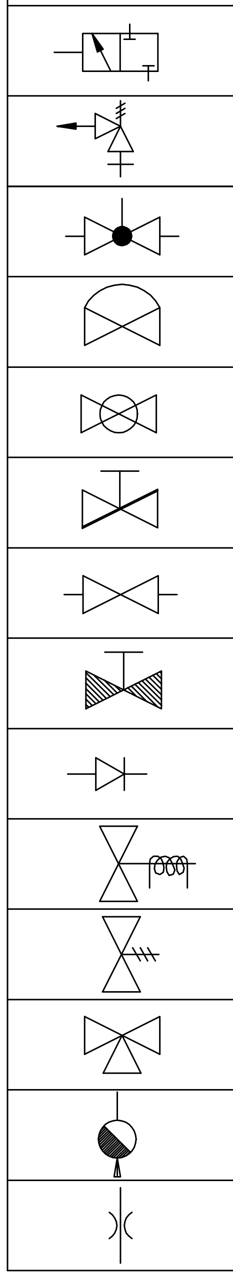
DRG. No. 2013D027



SYMBOL	DESCRIPTION
	HAND PUMP
	PUMP (POSITIVE DISPLACEMENT)
	PUMP (CENTRIFUGAL)
	FILTER
	COALESCER
	COMPRESSOR (CENTRIFUGAL)
	OPEN VENT
	INJECTOR PUMP
	AIR STARTER MOTOR
	ELECTRIC HEATER
	AIR INTERCOOLER
	HEAT EXCHANGER
	TURBO COOLING JACKET
	FAN



SYMBOL	DESCRIPTION
	AIR RECIEVER
	PLATE TYPE HEAT EXCHANGER
	FLEXIBLE PIPE
	BELLOWS
	INSTRUMENTAION POINT
	FLANGE
	SCREWED CONNECTION
	FLOW
	COMPRESSION JOINT
	JUNCTION
	PRESSURE REDUCING VALVE
	PRESSURE RELIEF VALVE
	FLAP VALVE
	ACTUATOR



SYMBOL	DESCRIPTION
	RELAY VALVE
	PRESSURE CAP
	GLOBE VALVE
	DIAPHRAGM VALVE
	BALL VALVE
	BUTTERFLY VALVE
	VALVE
	DRAIN VALVE
	CHECK VALVE
	SOLENOID VALVE
	PRESSURISING VALVE
	THERMOSTATIC VALVE
	AUTOMATIC AIR VENT
	FLOW RESTRICTION ORIFICE

THIRD ANGLE PROJECTION

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ISSUE NUMBER THUS ⑥ SHOWS LOCATIONS OF ALTERATION

SCALE N/A
DRAWN M. JACKAMAN
DATE 11/12/2013
TRACED
CHECKED IWD
FILMED
APPROVED — DESIGN: IWD | PRODUCTION

MATERIAL AND HEAT TREATMENT

SIMILAR TO DRG.Nos.

NOTES APPLICABLE UNLESS STATED OTHERWISE:-
ALL DIMENSIONS IN MILLIMETRES.
THREADS TO BS 3643 6g 6H, PIPE THREADS TO BS 2779
SURFACES MARKED THUS √ TO BE MACHINED
SURFACE TEXTURE CLA VALUES IN MICROMETRES.
LIMITS GIVEN THUS 36,95 / 36,93
UNTOLERANCED MACHINED DIMENSIONS TO BE WITHIN ± 0,4
GEOMETRICAL TOLERANCES & SURFACE FINISH IN ACCORDANCE WITH BS 308

TITLE
SCHEMATIC DRAWING KEY

DRAWING No./ PART No.
2013D027
SHEET 1 OF 1 SHEETS

MAN Diesel & Turbo UK Ltd
Port Lane, Hythe Hill, COLCHESTER CO1 2HW.

SIZE A1 594 x 841 mm
FORM No. D339
CAD

SCALE A 1:1 SCALE B 1:2 SCALE C 1:5 SCALE D 1:20