Department for Infrastructure
An Roinn Bonneagair
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Schedule 1 Specification

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DFI Roads and Rivers – Strangford Lough Ferry Service

Design, Supply and Installation of a Diesel Particulate Filtration System for MV Strangford II

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1. INTRODUCTION

The Northern Ireland Department for Infrastructure (DfI) operates two vehicle and passenger ferries that provide the ferry service between Strangford and Portaferry near the entrance to Strangford Lough.

DfI requires the installation of Diesel Particular Filters (DPFs) in the exhaust systems of the two main diesel engines and two diesel generators of MV Strangford II and requires to contract with a single economic operator to design, manufacture, install and commission the four DPFs in the vessel. DfI requires that the installation of the DPFs is carried out with the vessel out of service and alongside in Strangford, Northern Ireland.

This document provides the technical requirements for the project and the supporting background information and is to be read in conjunction with the other tender documents.

2. BACKGROUND

The ferry MV Strangford II operates a vehicle and passenger service across the mouth of Strangford Lough between Strangford and Portaferry in Northern Ireland. Since entering service in early 2017 exhaust from the ferry's engines and generators has been observed to contaminate the vessel's exterior paintwork with soot particles and also gets drawn back into the engine rooms via the ventilation system, clogging the inlet filters. Soot deposits are visible around the exhaust outlets in the hull side and when the exhaust systems have been opened up for maintenance soot deposits have been found within, appearing especially heavy within the generator exhausts.

The vessel is fitted with two marine main diesel engines and two diesel powered generators. The duty cycle is short duration and repetitive, the ferry crosses from one side to the other in about 5-6 minutes with both the main propulsion engines and one generator running, the other generator is shut down. During the crossing the generator is supplying electrical loads only; these are generally quite low consisting of lighting and power.

When the ferry reaches the slipway the engines are used just to hold it in place whilst the generator powers a hydraulic pump via a power take-off to lower the ramp, as a result the generator is loaded briefly before dropping back to the light electrical load. In normal operation the whole trip takes about 15 minutes so there are four crossings in an hour and the ferry runs for up to 15 hours a day.

The vessel is fitted with 'wet' exhaust systems to the main engines and generators. The generator exhaust passes through a silencer as part of the riser assembly whilst the main engine exhaust passes directly to a sprayhead where the exhaust gases are mixed with a spray of seawater which cools the exhaust and allows the use of non-metallic exhaust components downstream, and gives a quieter exhaust. Low exhaust noise is very important due to nearby residences.

Following a feasibility study of alternative methods to reduce soot contamination it has been decided that the preferred approach is to tackle the soot at source and prevent as much as possible from entering the environment. Consequently the decision has been made to fit diesel particulate filters (DFPs) to the main engines and generators. It is desired to retain the wet exhaust system downstream of the DPFs to maintain the low exhaust noise levels.

Monitoring and analysis of the main engine and diesel generator exhaust gases was undertaken in November 2018, the results of which are presented later for use in DPF and system specification.

Back pressure and exhaust gas temperature trials were conducted in representative conditions in June 2019, the results of which are also presented later for use in DPF and system specification.

The purpose of this document is to present a scope of supply and sufficient technical detail and background information to permit a comprehensive and detailed formal quote to be provided in response to an invitation to tender. To this end the existing installation is detailed, results of analysis and trials presented and the requirements for the DPFs and associated systems listed. An indicative scope of work and indicative DPF layout are presented for information only.

3. REQUIREMENTS

a) Following contract award all works from design and approval to sea trials and acceptance to be complete within 16 weeks, to include vessel out of service time of no more than 4 weeks.

b) The design, manufacture, install and commissioning of Diesel Particular Filters (DPFs) in the exhaust systems of the two main diesel engines and two diesel generators of MV Strangford II. The Economic Operator shall deliver a complete, fully warrantied and supported installation to DfI.

c) The installation, including removal and correct disposal of redundant items will be carried out alongside the ferry terminal at Strangford. An indicative sequence of installation is contained within annex D for information only, this is not exhaustive and the contractor shall be required to generate their own work instructions.

d) Risk assessments, safe methods of working, COSHH and any other health and safety issues regarding the installation shall be the responsibility of the Economic Operator. Supply of all necessary PPE and access equipment shall be the responsibility of the Economic Operator.

e) Removal and correct disposal from the Strangford ferry terminal of all redundant items, materials and packaging etc. generated in the course of the installation shall be the responsibility of the Economic Operator. Prior to removal of redundant items DfI must be consulted in the event that they may be required to be retained as spares.

f) The installation must retain the wet exhaust systems, with modification to, and relocation of components arising from the DPF installation as necessary but kept to a minimum. An indicative scheme is contained within annex E, this is for information only, is not exhaustive and the eventual arrangement will be determined by the contractor. A PDF copy is available on request.

g) Periodically increased exhaust temperatures arising from regeneration shall be mitigated to prevent damage to the rubber hoses of the wet system. This may be by means of new sprayheads, the design of which ensures that the temperature of the exhaust gases at the elevated levels developed during regeneration are reduced sufficiently to permit the use of flexible rubber exhaust hose as per the current wet system.

h) New GRP waterlocks shall be provided as part of the installation if the system geometry prevents re-use of the existing items.

i) Systems associated with the DPF installation must be proven in the marine environment.

j) Regeneration must not, under any circumstances, generate CO (carbon monoxide).

k) Installation of the DPFs must not compromise existing main engine emissions to ensure continued compliance with IMO Tier 2 requirements and Marpol.

l) Installation of the DPFs must not increase the noise levels during operation. Noise readings are recorded periodically by DfI and can be made available.

m) All materials and fastenings must be suitable for a marine environment.

n) The installation will be under survey by the local Lloyd’s Register surveyor. Type approval is not required for the DPFs but any relevant certification shall be made available.

o) Fuel and electrical systems required for the DPF installation, and their connection to the vessels existing systems must meet the requirements of Lloyd’s Register LR 100A1 rules.

p) Cummins published back pressure limits must not be exceeded. On completion a trial will be conducted with Cummins engineers to verify the back pressure values of the system.

q) The DPFs shall be sized in accordance with the measured PM values. Particular note must be taken of the high levels of particulate found in the generator exhaust.

r) Anticipated frequency of regeneration must be declared, with an explanation of the relationship between the filter capacity provided and the regeneration intervals.

s) Regeneration shall be automatic, with a visual indication of operation. Preferably an easily accessible electronic log shall be generated recording frequency and duration of regeneration cycles.

t) Suitable bellows must be installed to permit engine and generator movement during operation without damage to the exhaust system.

u) 2" BSP bosses shall be provided with blanking plugs and seals upstream and downstream of the DPF for later exhaust gas analysis if required. The bosses shall be positioned clear of obstructions to allow insertion of a probe similar to that shown in section 6.

v) DPF elements shall be sized to permit removal for deep cleaning as a group not less than once every 12 months, so that this may coincide with the ferry's annual maintenance period. An explanation of how the filters are accessed and removed is required. If there is any detrimental effect on the efficiency of filters after deep cleaning it must be declared together with a prediction of cumulative effects on overall efficiency of particulate filtration. If there is any detrimental effect a forecast of number of deep cleaning cycles achievable before replacement of the filters must be provided.

w) DPF elements shall be easily removable for despatch for cleaning without the need to move equipment or services within the machinery space.

x) The weight of individual DPF elements should not exceed manual handling limits if possible.

y) All hangers required for the support of DPFs or other items, and all seatings for equipment etc shall be supplied, installed and finished by the DPF contractor.

z) Any hot work required to remove existing hangers or install new ones shall be conducted in a safe fashion liaising with the vessel's maintenance staff at all times and only with their permission.. A DfI Permit to Work (PTW) must be authorised by DfI's Marine Maintenance Engineer prior to work commencing.

aa) All hot surfaces of the DPFs and pipework shall be adequately lagged with an approved material.

bb) The vessel is classed with Lloyd's Register and the DPF installation will be subject to approval by the local LR surveyor. The Economic Operator is responsible for meeting this requirement and all associated costs.

cc) On completion of the installation all paintwork, finishes, displaced items etc shall be made good.

4. DELIVERABLES

The following items are to be provided:

a) Specification, design, manufacture and delivery to Strangford ferry terminal of all materials and components, the complete installation, making good, commissioning and trials of DPFs to both main engines and both generators.

b) Service, maintenance and crew training plans.

c) Spares list comprising operational spares and operational spares for the four DPFs installed and separately sufficient spare filter elements to allow complete replacement of those within one main engine DPF and one generator DPF.

d) Drawings and documentation to Lloyd's Register for approval and as-fitted drawings and documentation for the ships documentation pack.

e) A statement of the lifespan of the DPFs, based on the duty cycle described in this report.

f) Drawings and technical specifications of the DPF units, their location within the machinery space, preliminary schematic drawings of fuel and/or electrical systems including materials, standards, pipe sizes, cable sizes and circuit protection and details of connection to the vessels existing system where required, technical specifications and power requirements for pumps or electrical heating elements etc.

g) Weights of all major components and systems.

h) Drawings and specifications for components, systems, supporting structure and any other installation arrangements must be in sufficient detail to permit them to be submitted to the local LR surveyor for approval and for inclusion in the ships documentation pack. Drawings to be in AutoCad and PDF format.

i) Incorporation of any LR amendments arising during the installation and approval process, updating all drawings and documentation to as-fitted on completion and issue DfI with two CD ROMs and three paper copies. Drawings to be in AutoCad and PDF format and documents in Word 2010 and PDF.

j) An agreed commissioning and trials schedule including attendance by Economic Operator personnel. Trials to include operation of vessel with maximum weight at a range of speeds in normal conditions and be conducted alongside at Strangford ferry terminal and at sea in Strangford Lough as necessary. DfI's technical representatives will attend trials and accept the installation on behalf of DfI when satisfactory operation is demonstrated. In the event of any doubt that the reduction in levels of particulates does not meet the stated percentage the efficiency of the system will be verified by exhaust gas analysis. This will be at the supplier's expense only if the analysis proves the DPF does not meet the supplier's stated performance levels.

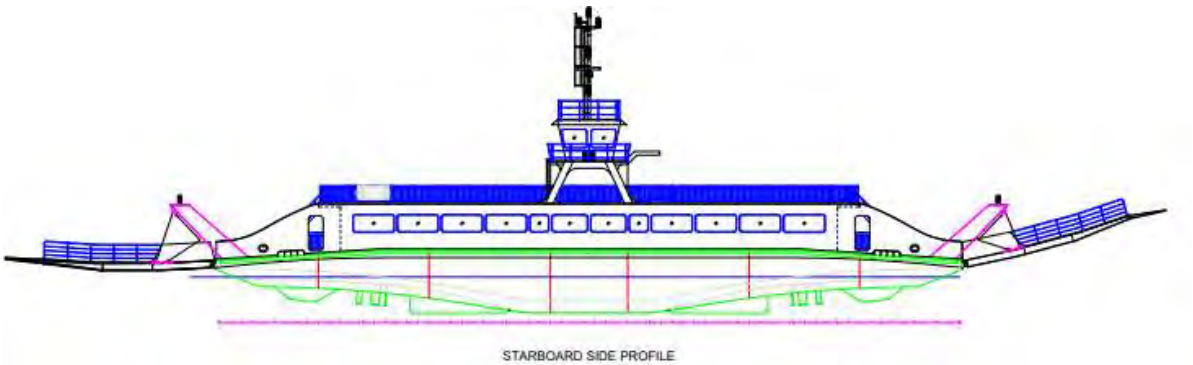
k) A 24 month warranty for components, materials and labour relating to the DPF installation, commencing from the date of acceptance. Exclusions from the warranty must be clearly stated.

l) A compliance matrix addressing all requirements of the scope of supply with supporting evidence of compliance.

5. EXISTING INSTALLATION

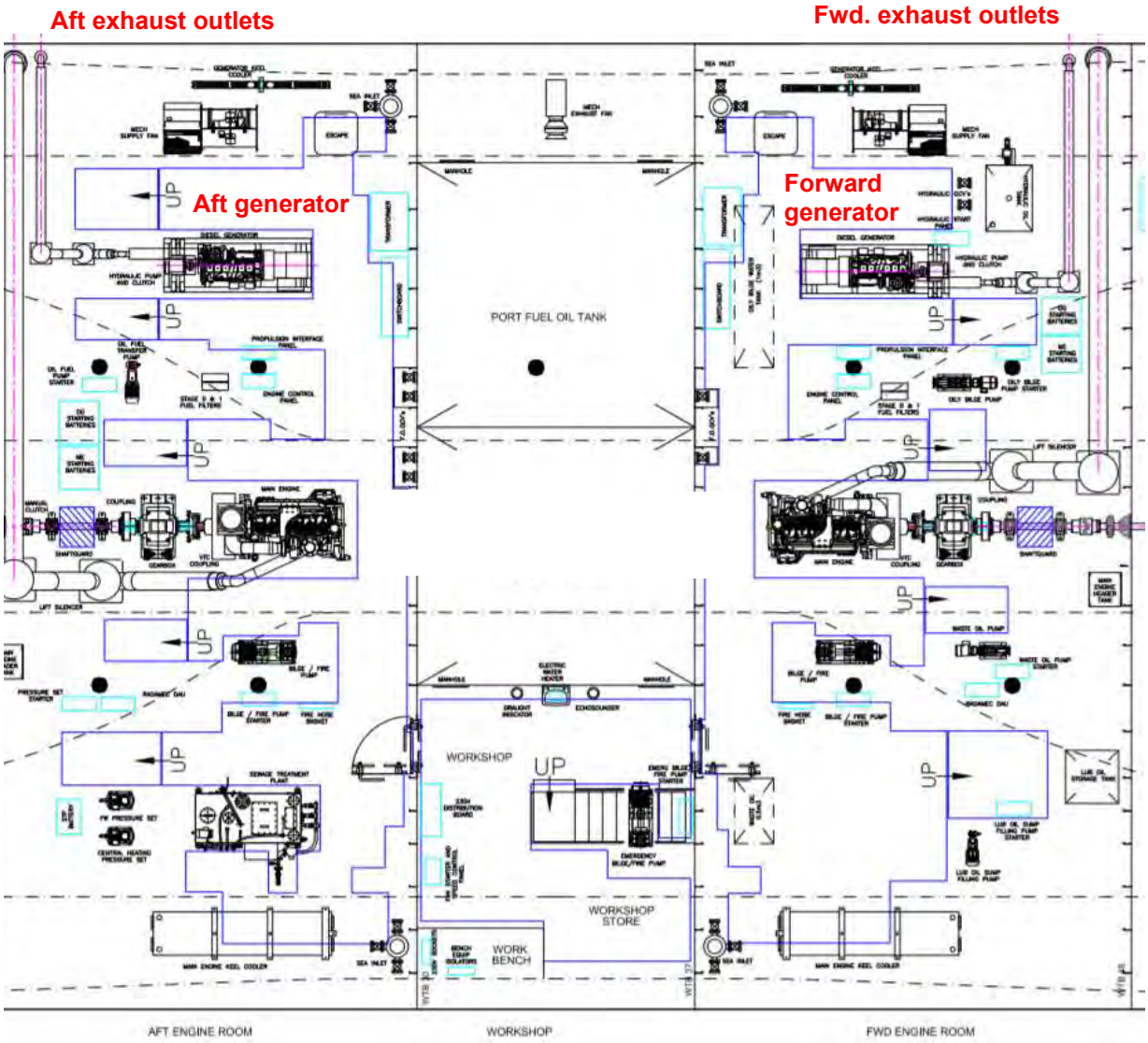
5.1 General arrangement of machinery spaces

The vessel is a double ended ferry as shown below.



STARBOARD SIDE PROFILE

Normal access to each machinery spaces is via a watertight door in the machinery space bulkhead. A flight of steps leads down from the main deck to the lower deck. To enable the removal of the engines or other large items a shipping route is provided for each machinery space via a large bolted panel in the main deck. The machinery spaces arranged are as shown below:



General arrangement of machinery spaces

Each machinery space contains a main engine and a generator.

5.2 Main engine exhausts

The main engines are Cummins QSK 19-M, rated at 559kW (750hp) at 1800rpm. The engine datasheet is contained in annex A.

Test bed exhaust data extracted from the datasheet is shown in the table below:

Exhaust gas flow (litres/sec)	Exhaust gas temperature (turbine out) (°C)	Exhaust gas temperature (manifold) (°C)
1814	454	595

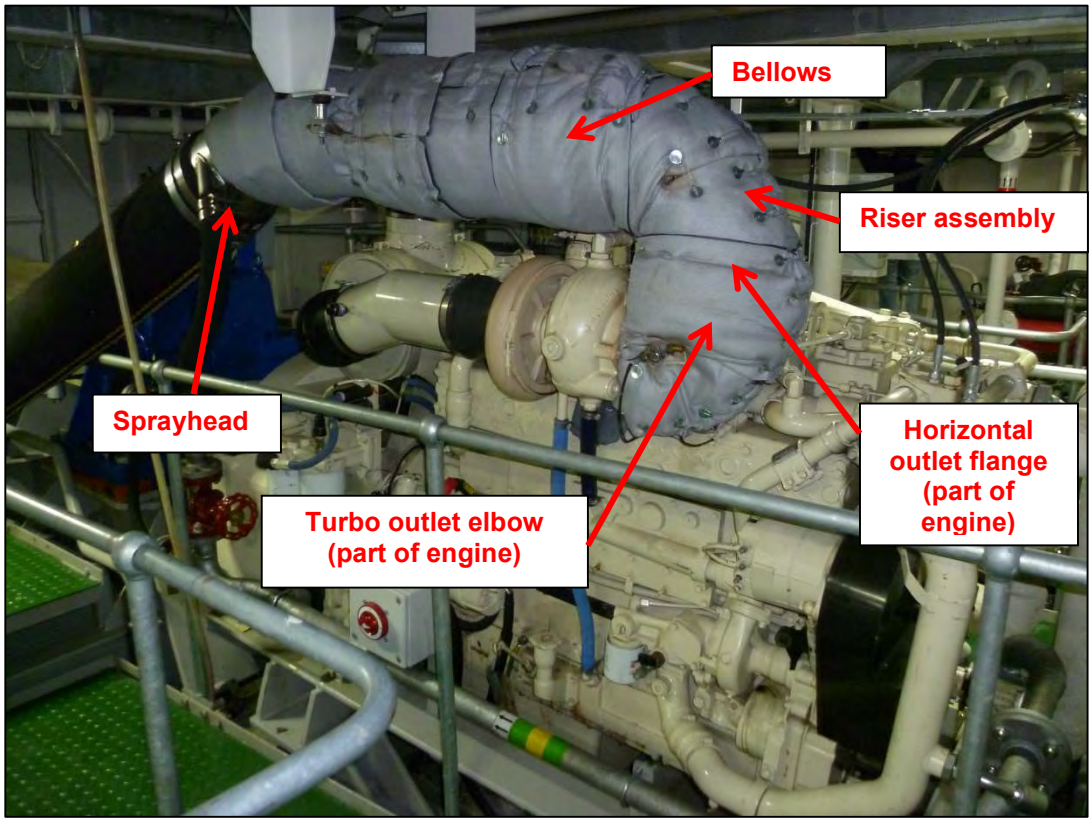
Photos of the existing arrangement are shown below. The forward main engine is shown; the aft main engine is similar.

A flanged pipe is bolted to the outlet elbow of the turbo charger, turning through 90° to a flexible bellows allowing for engine movement. Downstream of the bellows the exhaust is supported by a hanger attached to the vessels structure. A sprayhead fitting introduces seawater into the exhaust to cool it. The sprayhead fitting is arranged so that water cannot work its way back along the dry part of the exhaust. The cooled exhaust is then at a low enough temperature that rubber hoses and GRP components may be safely used.

The temperature rating of the rubber hose is 100°C (continuous).

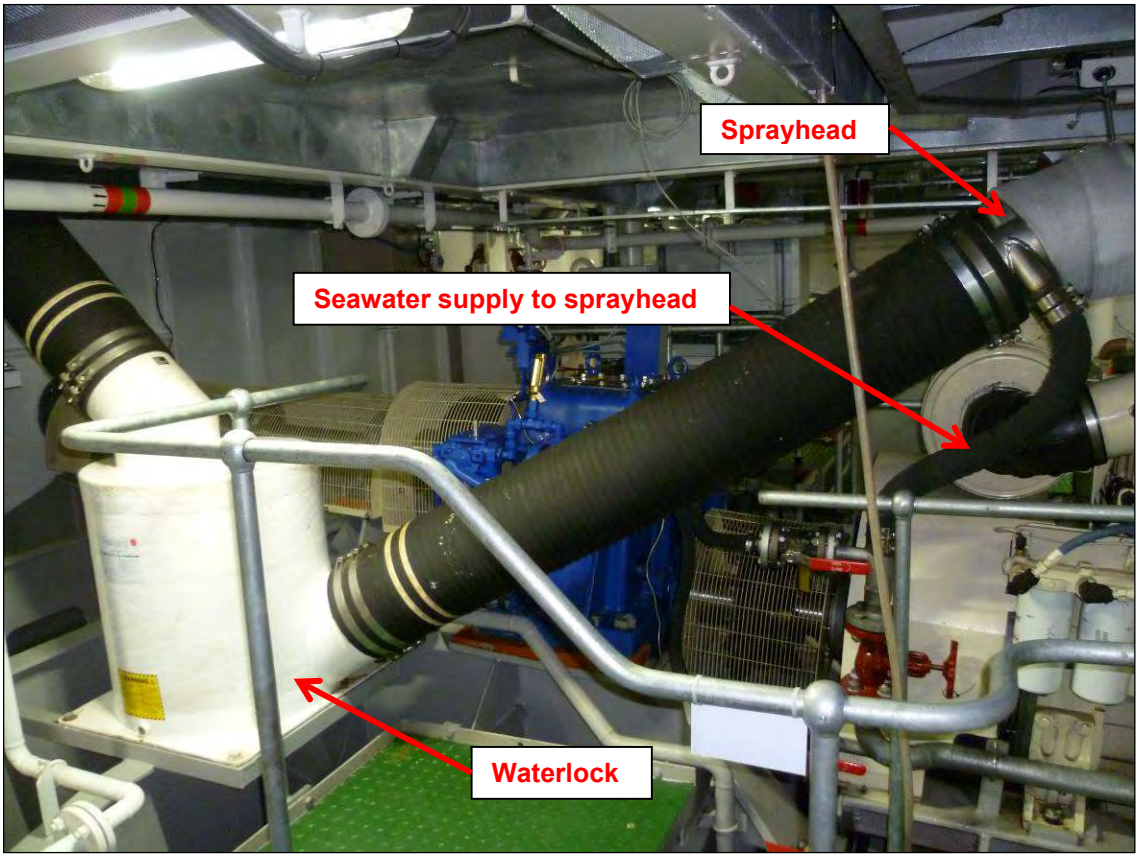
The exhaust, now a mixture of gases and seawater falls into a GRP waterlock which acts as a silencer. Periodically when the exhaust pressure is sufficient water is blown up out of the waterlock and into a GRP separator where the internal arrangement allows the separation of gas and water, the water draining out of the bottom to discharge through the hull below waterline and the gasses to pass along a GRP pipe to discharge through the hull above waterline. The separator also contributes to silencing the exhaust.

The mixing of the exhaust gasses and seawater is incomplete, hence a significant quantity of the particulates are carried through the pipe to discharge above waterline and disperse in the air, where they are visible as staining.

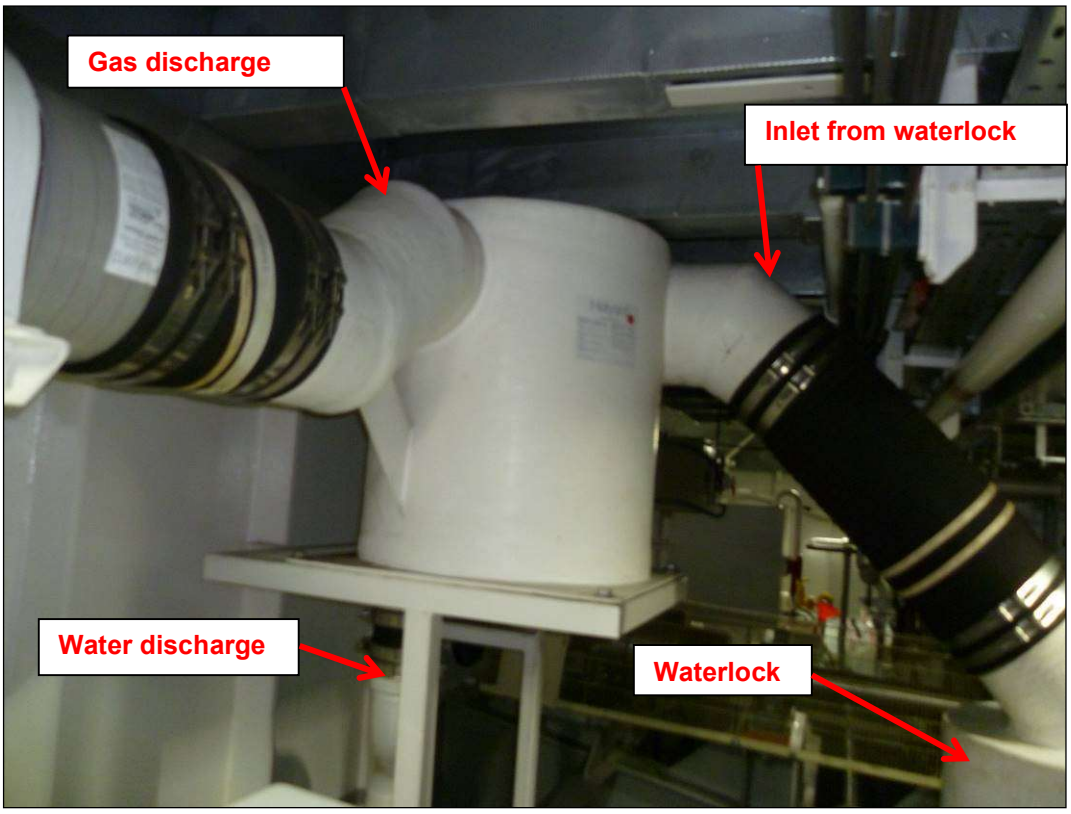


Fwd. main engine dry riser and bellows (lagged)

Fwd. main engine riser hanger



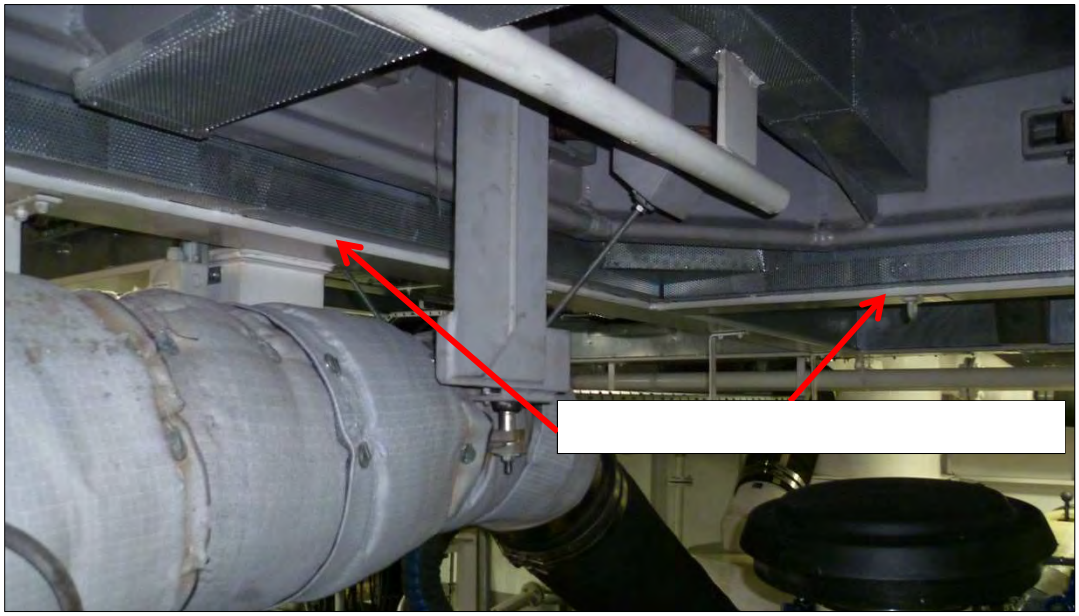
Fwd. main engine sprayhead, inlet hose to waterlock and GRP waterlock



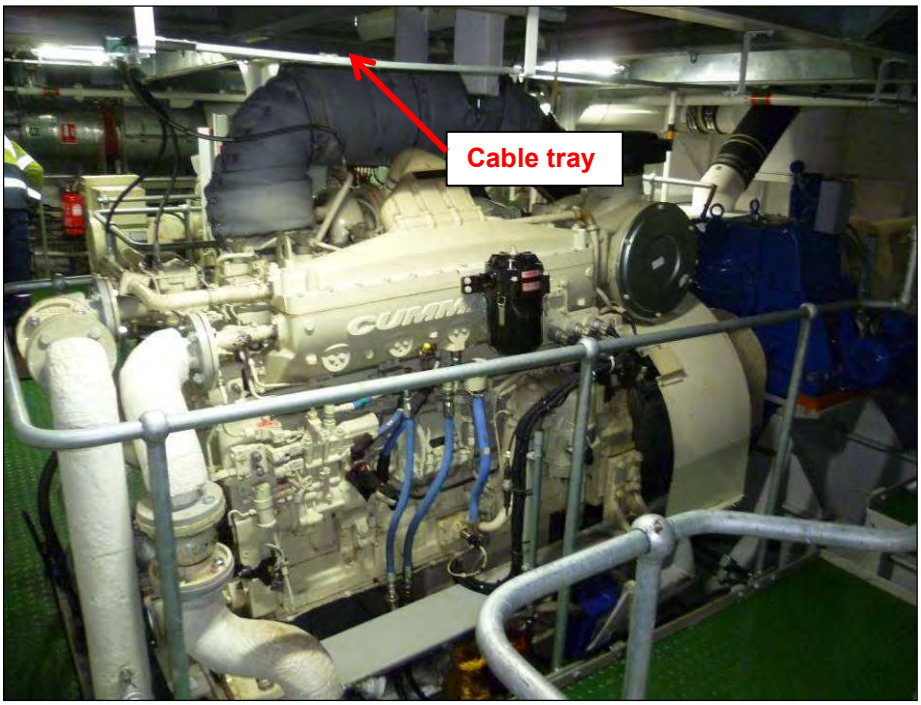
Fwd. main engine water separator

There are various items of structure, pipe and cable trays in the vicinity of the engines which may have to be taken into consideration with regard to DPF installation. These vary slightly between engine spaces and their potential effect on the installation will depend on the size and location of the proposed DPF.

Some examples are shown below, note that these are not exhaustive:



Deck structure surrounding engine shipping route hatch

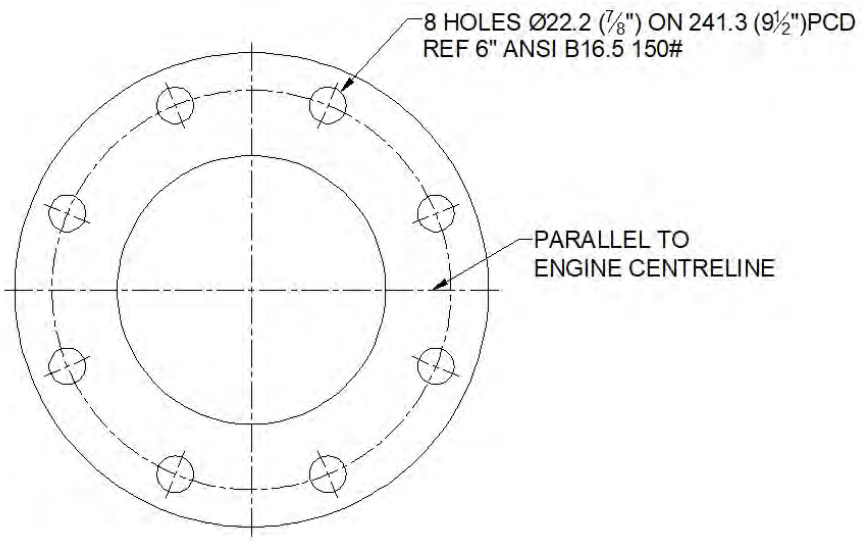


Fwd. engine cable tray

Aft engine hose tray

5.3 Main engine exhaust connection

The DPF inlet pipework must connect with the existing engine exhaust outlet flange, a 90° elbow that is connected to the outlet of the turbo charger. This flange lies in a horizontal plane. The flange pattern is a standard ANSI type as shown below:



Cummins normally acceptable inside diameter for the exhaust pipe is 152 mm (6”).

5.4 Main engine sprayhead connection

The sprayhead may be re-used if possible, although the angle may have to be changed depending on the revised installation, and only if the sprayhead provides adequate cooling to reduce the temperature of exhaust gases developed during regeneration to be within the temperature limit (continuous) of the flexible rubber exhaust hose.

The current sprayhead is welded to a stainless steel 304 tube 168.3mm outside diameter, 3.4mm wall thickness (6” schedule 10). The sprayhead accepts a 254mm (10”) bore rubber hose.

5.5 Main engine back pressure

Cummins maximum allowable back pressure is 75mm (3”) Hg.

The calculated back pressure of the existing system is 36.6mm (1.44”) Hg. Measured back pressure is given in section 7.

5.6 Generator exhausts

The generator engines are Cummins 6BT5.9-D(M), rated at 78kW (104hp) prime power at 1500rpm. The engine datasheet is contained in annex B.

Test bed exhaust data extracted from the datasheet is shown in the table below:

Exhaust gas flow (prime power) (litres/sec)	Exhaust gas flow (overload) (litres/sec)	Exhaust gas temperature (prime power) (turbine out) (°C)	Exhaust gas temperature (overload) (turbine out) (°C)
203	224	374	416

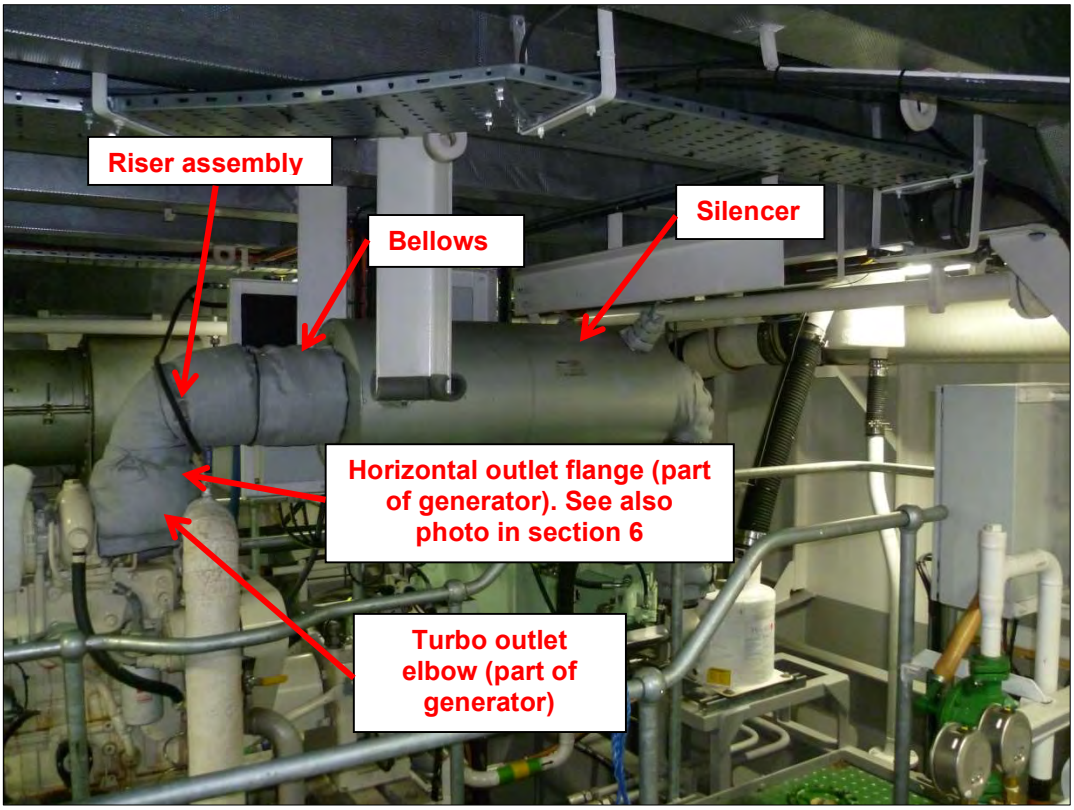
Photos of the existing arrangement are shown below. The forward generator is shown, the aft generator is similar.

A flanged pipe is bolted to the outlet elbow of the turbo charger, turning through 90° to a flexible bellows allowing for engine movement. Downstream of the bellows a silencer is fitted, supported by hangers attached to the vessels structure. A 90° elbow is fitted to the outlet end of the silencer with the sprayhead fitting facing vertically downwards.

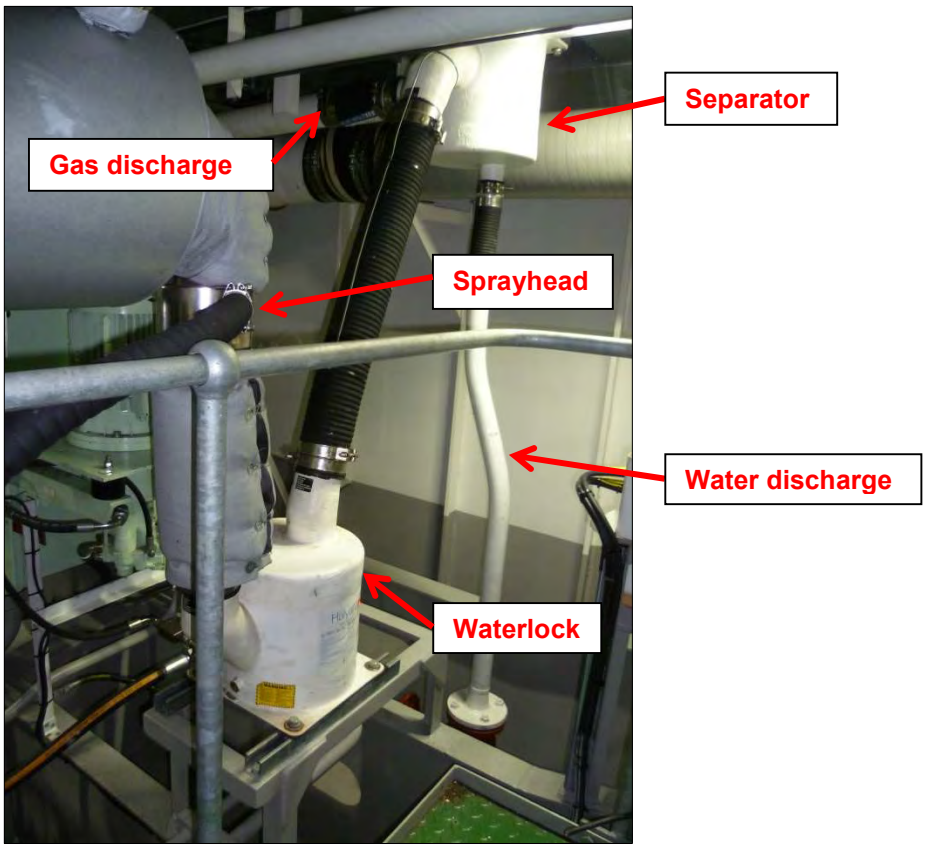
In principle the generators wet exhaust system is the same as the main engine system but on a smaller scale, comprising a GRP waterlock and separator, the water draining out of the bottom to discharge through the hull below waterline and the gasses passing along a GRP pipe to discharge through the hull above waterline.

The temperature rating of the rubber hose is 100°C (continuous).

As with the main engine mixing of the exhaust gasses and seawater is incomplete, and due to the load experienced by the generator the exhaust is high in particulates.



Fwd. generator riser assembly and silencer



Fwd. generator sprayhead, waterlock and separator

There are various pipes and items of equipment in the vicinity of the generators which may have to be taken into consideration with regard to DPF installation. These vary slightly between engine spaces and their potential effect on the installation will depend on the size and location of the proposed DPF.

Some examples are shown below, note that these are not exhaustive:

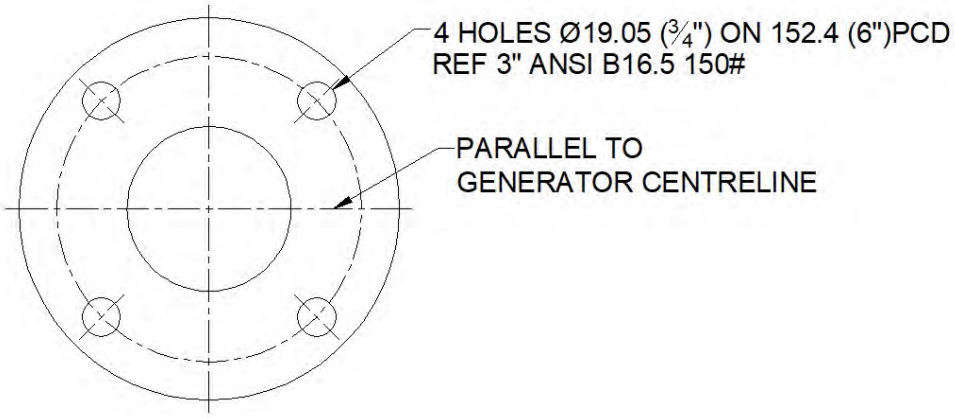
Seawater pipe

Width constraint on fwd. generator silencer

Hanger support structure

5.7 Generator exhaust connection

The DPF inlet pipework must connect with the existing generator exhaust outlet flange a 90° elbow that is connected to the outlet of the turbo charger. This flange lies in a horizontal plane. The flange pattern is a standard ANSI type as shown below:



Cummins recommended inside diameter for the exhaust pipe for industrial applications is 101.6mm (4”), however the existing installation is 73mm.

5.8 Generator sprayhead connection

The sprayhead may be re-used if possible, only if the sprayhead provides adequate cooling to reduce the temperature of exhaust gases developed during regeneration to be within the temperature limit (continuous) of the flexible rubber exhaust hose.

The current sprayhead is welded to a stainless steel 304 tube 76.2mm outside diameter, 1.6mm wall thickness (3” OD x 16SWG). The sprayhead accepts a 101.6mm (4”) bore rubber hose.

5.9 Generator back pressure

Cummins maximum allowable back pressure is 76mm (3”) Hg.

The calculated back pressure of the existing system is 30.8mm (1.21”) Hg. Measured back pressure is given in section 7.

5.10 Fuel supply

For DPF proposals using a diesel fired burner to achieve regeneration, subject to satisfactory design and approval fuel will be drawn from the vessels fuel system. A schematic of the fuel system is contained in annex C.

The diesel fuel used on the vessel is low sulphur, 10ppm.

5.11 Electrical supply

For DPF proposals using electrical elements to achieve regeneration, subject to satisfactory design and approval power will be drawn from the vessels electrical system. The generators are rated at 36kW each, for normal use, with a margin. Trials indicated a maximum power consumption of 38kW.

In normal operation power consumption is approximately 16kW, when the hydraulic pump is in operation this rises to approximately 25kW. Voltages available are 400V three phase and 230V single phase. Only one generator is run in normal operations the other being held as a stand-by. Use of generators is alternated to even out the hours run.

The shipbuilder’s electrical schematic drawings are held in a documentation pack and can be made available for reference if required.

6. EXHAUST GAS ANALYSIS

Monitoring and analysis of the main engine and diesel generator exhaust gases were undertaken by Envirocare in November 2018 with DfI's technical representatives in attendance. This involved fitting a probe into the dry part of the main engine and diesel generator exhaust systems to measure the chemical and particulate matter components of the exhaust gases. Results from the analysis relating to particulates are contained within annex F.

The table below shows the measured concentrations of total particulate matter in the exhaust gas of the forward main engine and forward diesel generator (refer to annex F).

	Total particulate matter concentration
Forward main engine	46.3 mg/Nm^3
Forward diesel generator	192.3 to 232.2 mg/Nm^3

Measured concentrations of total particulate matter

Note; mg/Nm^3 is milligrams (of particulate matter) per cubic metre of exhaust gas. The 'N' refers to the fact that the data is normalised to 'standard temperature and pressure' and is not Newtons.

It can be seen from the table above that the diesel generator's exhaust has a much higher concentration of particulates than the main engines. The exhaust gas monitoring measured the concentration or *density* of particulates *per cubic metre* of exhaust gas and the diesel generator engines have a concentration that is four to five times greater than that of the main engines.

However, the main engines are much larger and more powerful diesel engines than the diesel generator engines and hence have a much higher exhaust gas flow rate. To estimate the overall emission discharge rate the measured density was multiplied by the exhaust gas flow rate, as shown in the table below. The exhaust flow rates are from the engine datasheets (annex A and B) and are for the engines at maximum rated power.

	Measured PM density (mg/Nm3)	Exhaust flow rate (l/s)	Exhaust flow rate (m3/hr)	PM discharge rate (kg/hr)
Fwd main engine	46.3	1,814	6,530	0.30
Fwd diesel generator	212	203	731	0.15

Determination of PM emission discharge rates from exhaust gas monitoring measurements

It can be seen from the table above that the discharge rate of particulate matter for the main engines is twice that for the diesel generators. This result is based on the engines operating at their maximum rated power and when the vessel is in normal service this is not the case. The main engines are typically operating at half to three quarters power and the diesel generators are operating at around 25% rated power. The exhaust gas flow rate is related to the fuel burned and the engine running speed, so in reality it is likely that the PM discharge rate for the main engines is more than twice that for the diesel generator.

Inspection of the exhaust outlets indicates that the main engine and generator both have very sooty exhausts, see photograph below. It can be seen that the main engine exhaust discharges a greater quantity of soot than the diesel generator.

MV Strangford II fwd. exhaust outlets – diesel generator right, main engine left

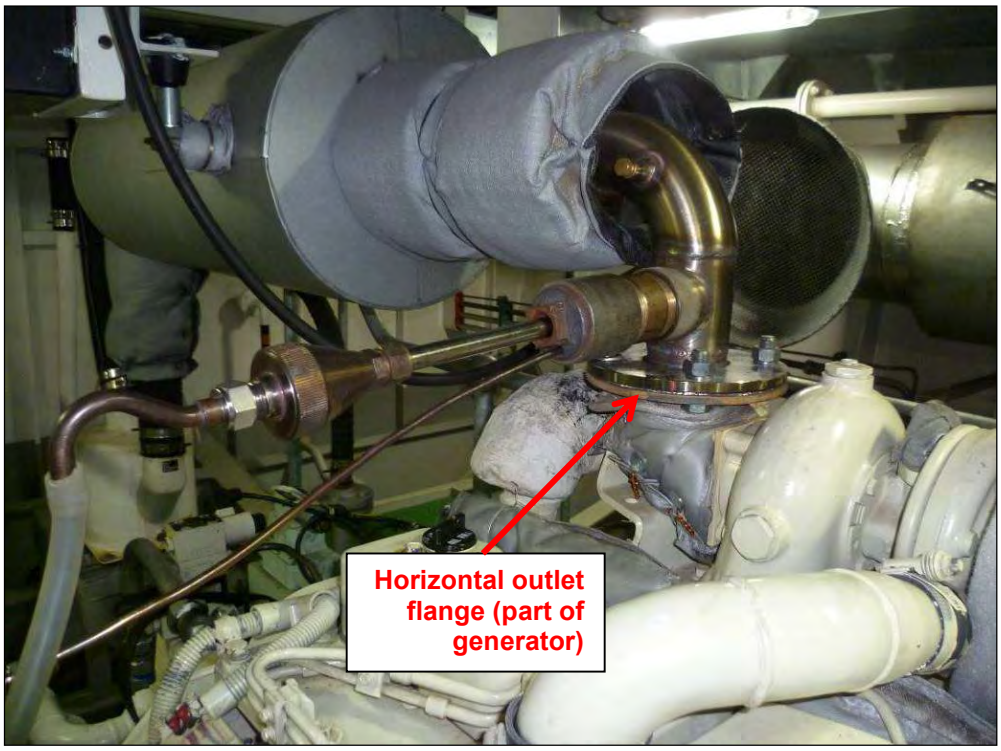
The higher PM discharge rate of the main engines than the diesel generator is compounded by the fact that when the ferry is in service both main engines are operating but only one diesel generator. So the total PM discharge of the two main engines is likely to be significantly greater than four times that of the single diesel generator.

In summary, the diesel generators have a much higher concentration of particulate matter in their exhaust gases, but the main engines have a much higher particulate matter discharge rate due to their much higher power and higher exhaust flow rate compounded by the fact that both main engines are operating with the vessel in service but only one diesel generator.

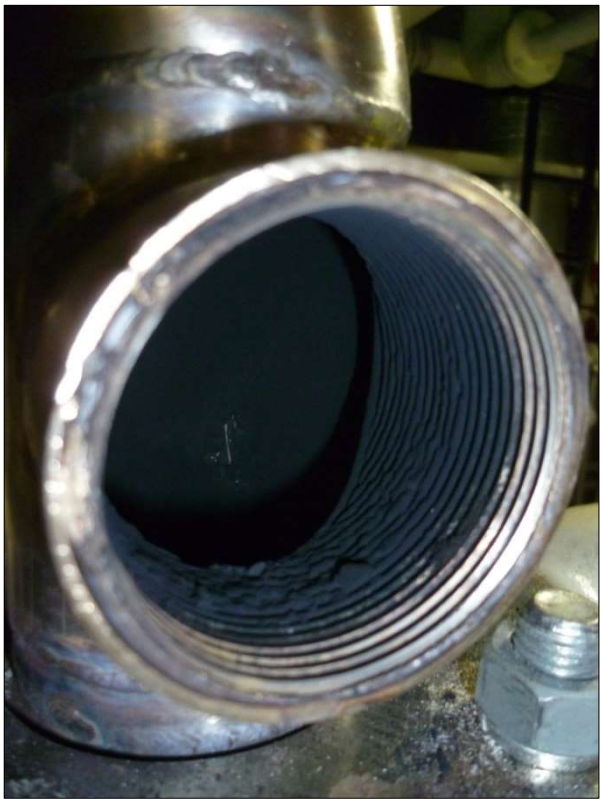
For information photos are shown below of the testing arrangements and soot deposits within the generator elbow removed for the purposes of the analysis. The elbow was replaced by a similar component with a 2” BSP boss to accept the test probe. The engine exhaust elbows were similarly treated.

For subsequent monitoring purposes each DPF installation requires 2” bosses in convenient, unobstructed locations upstream and downstream of the DPF for particulate matter measurements to determine efficiency of the filtration when required.

The bosses should be no thicker than 50mm. There must be 1m clear space to orientate and insert the probe; this may determine the location of the boss if there is any vessel structure or services in the way.



Probe fitted on generator exhaust



Soot deposits within boss on generator exhaust

7. BACK PRESSURE AND EXHAUST TEMPERATURE TRIALS

Notwithstanding the test bed exhaust gas temperatures it was considered that due to the operational profile the engine and, in particular the generator, exhaust gas temperatures were actually lower. To determine the back pressure and exhaust gas temperatures developed in service a series of trials with the ferry travelling between Strangford and Portaferry were conducted on the 20th June 2019, and the results presented below to assist with DPF design and specification:

Forward main engine:

	EXHAUST GAS TEMP OFF LOAD Degrees C	MAX EXHAUST GAS TEMP ON LOAD Degrees C	BACK PRESSURE OFF LOAD 1400 RPM inHg	BACK PRESSURE ON LOAD 1400 RPM inHg	ENGINE LOAD MIN/MAX
Strangford 10.45am	241	430	1.0	0.9	14% 51%
Portaferry 11.00am	314	438	1.0	0.55	24% 48%
Strangford 11.15am	221	427	0.9	0.9	14% 51%

Low water 10.00am. Start trial 10.45am. Engine at 1400rpm. Flood tide

Aft main engine:

	EXHAUST GAS TEMP OFF LOAD Degrees C	MAX EXHAUST GAS TEMP ON LOAD Degrees C	BACK PRESSURE OFF LOAD 1400 RPM inHg	BACK PRESSURE ON LOAD 1400 RPM inHg	ENGINE LOAD MIN/MAX
Portaferry 11.30am	268	458	1.1	1.2	19% 54%
Strangford 11.45am	290	429	1.1	1.2	22% 48%
Strangford 12.00am	255	444	1.1	1.2	15% 50%

Low water 10.00am. Start trial 11.30am. Engine at 1400 rpm. Flood tide

Both main engines, full pitch 1800rpm, vessel moving with the tidal flow of 6 knots:

	EXHAUST TEMP MAX Degrees C	BACK PRESSURE MAX inHg	ENGINE LOAD
Fwd. main engine	435	0.8	98%
Aft main engine	427	0.9	98%

Both main engines, full pitch 1800rpm, vessel moving against the tidal flow of 6 knots:

	EXHAUST TEMP MAX Degrees C	BACK PRESSURE MAX inHg	ENGINE LOAD
Fwd. main engine	445	0.8	91%
Aft main engine	442	1.0	97%

Generators:

	AVERAGE EXHAUST BACK PRESSURE AT 10kW LOAD inHg	AVERAGE EXHAUST BACK PRESSURE AT 44kW LOAD inHg	EXHAUST TEMP * 10kW LOAD Degrees C	EXHAUST TEMP * 44kW LOAD Degrees C
Fwd. generator	1.3	1.7	110	155
Aft generator	0.9	1.3	110	148

*6BT generators sets do not have an exhaust gas temperature thermal coupling, therefore exhaust temperature readings refer to the temperature of the exhaust elbow at the outlet, as read by a standard laser temperature sensor.

Exhaust back pressure was measured via a digital gauge; the pressures fluctuated during running of each engine due to the nature of the water injection system and waterlocks.

The pressures were data logged for approximately 15 seconds then an average reading established and recorded. At no time were any pressures sighted above 2.1in Hg.

It can be seen that due to the duty cycle the main engine exhaust gas temperatures fall whilst the engines are lightly loaded when loading and unloading at the slipway, rising as the vessel makes its way across the Lough. Generator exhaust gas temperatures are always low, since even when more highly loaded the generator diesel engine is still too large.

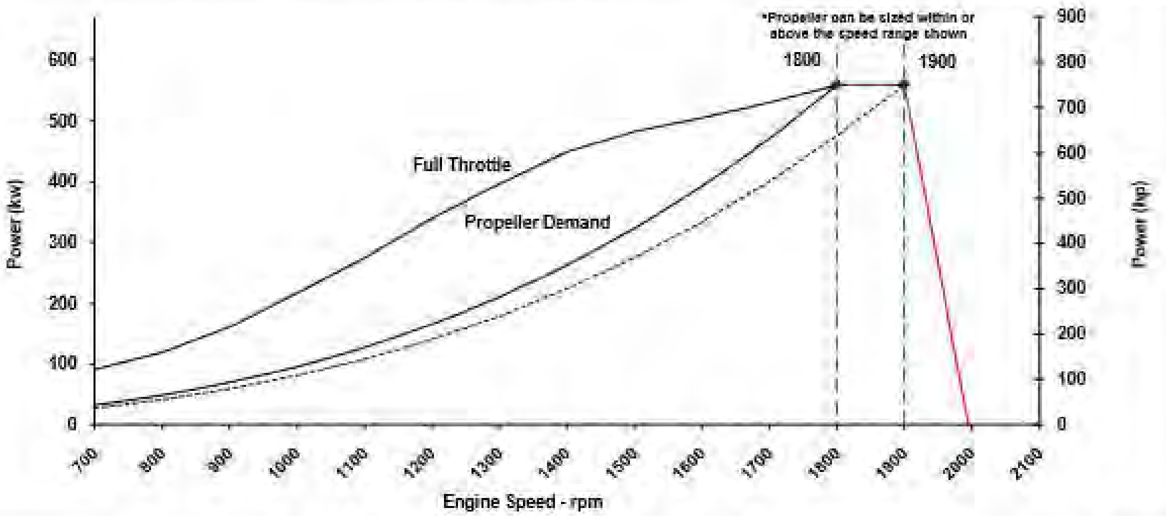
The duty cycle for a typical day is four crossings in an hour and the ferry runs for up to 15 hours a day. There are two ferries which are used alternately so either ferry may not be in continuous use. It may be assumed that the ferry operates at the frequency above for six months in a year.

8. ANNEX A – CUMMINS QSK 19-M DATASHEET

CUMMINS INC. Columbus, IN 47201 Marine Performance Curves	Basic Engine Model: QSK19-M	Curve Number: M-4533
	Engine Configuration: D193102MX03	CPL Code: 3455 — Date: 24-Aug-11

Displacement:	18.9 liter [1150 in³]		Rated:	559 kw [750 bhp]
Bore:	159 mm [6.25 in]		Rated:	1800 rpm
Stroke:	159 mm [6.25 in]		Rating Type:	Heavy Duty
Cylinders:	6		Aspiration:	Turbocharged / LTA
Fuel System:	Modular Common Rail (MCRS) with C3.0 Injectors			

CERTIFIED: This diesel engine complies with or is certified to the following agencies requirements:
EPA Tier 2 - Model year requirements of the EPA marine regulation (40CFR94)
EU Stage IIIa - EC Nonroad Mobile Machinery Directive (2004/26/EC)
IMO Tier II (Two) NOx requirements of International Maritime Organization (IMO), MARPOL 73/78 Annex VI, Regulation 13



Speed	Full Throttle				Propeller Demand					
	Power		Torque		Power		Torque		Fuel Consumption	
rpm	kw	(hp)	N·m	(ft-lb)	kw	(hp)	N·m	(ft-lb)	L/hr	(gal/hr)
1900	559	(750)	2811	(2073)						
1800	559	(750)	2966	(2188)	558.9	(749.5)	2965.0	(2186.9)	140.9	(37.2)
1700	530	(711)	2978	(2196)	470.8	(631.4)	2644.7	(1950.6)	118.6	(31.3)
1600	505	(677)	3015	(2224)	392.5	(526.4)	2342.7	(1727.9)	101.5	(26.8)
1500	483	(648)	3074	(2268)	323.4	(433.7)	2059.0	(1518.7)	83.4	(22.0)
1400	449	(602)	3062	(2259)	263.0	(352.6)	1793.6	(1322.9)	71.4	(18.9)
1300	397	(532)	2917	(2151)	210.5	(282.3)	1546.5	(1140.7)	58.0	(15.3)
1200	340	(456)	2704	(1995)	165.6	(222.1)	1317.8	(971.9)	46.1	(12.2)
1100	275	(368)	2384	(1758)	127.6	(171.1)	1107.3	(816.7)	35.4	(9.3)
1000	217	(291)	2071	(1527)	95.8	(128.5)	915.1	(675.0)	26.6	(7.0)
900	161	(216)	1707	(1259)	69.9	(93.7)	741.2	(546.7)	19.2	(5.1)
800	120	(160)	1426	(1052)	49.1	(65.8)	585.7	(432.0)	13.9	(3.7)
700	92	(123)	1248	(921)	32.9	(44.1)	448.4	(330.7)	10.0	(2.7)

* Cummins Full Throttle Requirements:
- Engine achieves or exceeds rated rpm at full throttle under any steady operating condition.
- [illegible]
- Engine achieves or exceeds rated rpm when accelerating from idle to full throttle.

Rated Conditions: [illegible]

Full Throttle curve represents power at the crankshaft [illegible]

Fuel Consumption is based on fuel of 35 deg. API gravity [illegible]

Heavy Duty (HD): [illegible]

CHIEF ENGINEER

1

Curve No.	**M-4533**
DS :	**D19-MX-1**
CPL :	**3455**
DATE:	**24-Aug-11**

General Engine Data

Engine Model		QSK19-M
Rating Type		Heavy Duty
Rated Engine Power	kW [hp]	559 [750]
Rated Engine Speed	rpm	1800
Rated Power Production Tolerance	±%	3
Rated Engine Torque	N·m [lb·ft]	2966 [2188]
Peak Engine Torque @ 1500 rpm	N·m [lb·ft]	3074 [2268]
Brake Mean Effective Pressure	kPa [psi]	1977 [287]
Indicated Mean Effective Pressure	kPa [psi]	3963 [575]
Maximum Allowable Engine Speed	rpm	2450
Maximum Torque Capacity from Front of Crank[2]	N·m [lb·ft]	2339 [1725]
Compression Ratio		15:1
Piston Speed	m/sec [ft/min]	9.5 [1875]
Firing Order		1-5-3-6-2-4
Weight (Dry) - Engine Only - Average	kg [lb]	2200 [4850]
Weight (Dry) - Engine With Heat Exchanger System - Average	kg [lb]	2336 [5150]
Weight Tolerance (Dry) Engine Only	3xStd Dev(±%)	10.0

Governor Settings

Default Droop Value	Refer to MAB 2.04.00-03/23/2006 for Droop explanation	5%
Minimum Droop Allowed		0%
Maximum Droop Allowed		16%
High Speed Governor Break Point	rpm	1900
Minimum Idle Speed Setting	rpm	550
Normal Idle Speed Variation	±rpm	10
High Idle Speed Range Minimum	rpm	1900
Maximum	rpm	1995

Noise and Vibration

Average Noise Level - Top	(Idle)	dBA @ 1m	82
	(Rated)	dBA @ 1m	93
Average Noise Level - Right Side	(Idle)	dBA @ 1m	85
	(Rated)	dBA @ 1m	99
Average Noise Level - Left Side	(Idle)	dBA @ 1m	85
	(Rated)	dBA @ 1m	98
Average Noise Level - Front	(Idle)	dBA @ 1m	87
	(Rated)	dBA @ 1m	100

Fuel System[1]

Avg. Fuel Consumption - ISO 8178 E3 Standard Test Cycle	l/hr [gal/hr]	99.2 [26.2]
Fuel Consumption at Rated Speed	l/hr [gal/hr]	140.4 [37.1]
Approximate Fuel Flow to Pump	l/hr [gal/hr]	378.5 [100.0]
Maximum Allowable Fuel Supply to Pump Temperature	°C [°F]	60.0 [140]
Approximate Fuel Flow Return to Tank	l/hr [gal/hr]	238.1 [62.9]
Approximate Fuel Return to Tank Temperature	°C [°F]	51.3 [124]
Maximum Heat Rejection to Drain Fuel	kW [Btu/min]	1.4 [78]

TBD= To Be Determined N/A = Not Applicable N.A. = Not Available

1 Unless otherwise specified, all data is at rated power conditions and can vary ± 6%.
2 No rear loads can be applied when the FPTO is fully loaded. Max PTO torque is contingent on torsional analysis results for the specific drive system. Consult Installation Direction Booklet for Limitations.
3 Heat rejection to coolant values are based on 50% water/50% ethylene glycol mix and do NOT include fouling factors. If sourcing your own cooler, a service fouling factor should be applied according to the cooler manufacturer's recommendation.
4 Consult option notes for flow specifications of optional Cummins seawater pumps, if applicable.
5 May not be at rated load and speed. Maximum heat rejection may occur at other than rated conditions.

CUMMINS ENGINE COMPANY, INC

COLUMBUS, INDIANA

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Propulsion Marine Engine Performance Data

Curve No.	M-4533
DS :	D19-MX-1
CPL :	3455
DATE:	24-Aug-11

Air System[1]	
Intake Manifold Pressure ....kPa [in Hg]	225 [66]
Intake Air Flow ....l/sec [cfm]	756 [1602]
Heat Rejection to Ambient ....kW [Btu/min]	50 [2865]
Exhaust System[1]	
Exhaust Gas Flow ....l/sec [cfm]	1814 [3,844]
Exhaust Gas Temperature (Turbine Out) ....°C [°F]	454 [849]
Exhaust Gas Temperature (Manifold) ....°C [°F]	595 [1,103]
Emissions (in accordance with ISO 8178 Cycle E3)	
NOx (Oxides of Nitrogen) ....g/kw·hr [g/hp·hr]	6.37 [4.75]
HC (Hydrocarbons) ....g/kw·hr [g/hp·hr]	0.08 [0.06]
CO (Carbon Monoxide) ....g/kw·hr [g/hp·hr]	1.31 [0.98]
PM (Particulate Matter) ....g/kw·hr [g/hp·hr]	0.06 [0.05]
Cooling System[1]	
Sea Water Pump Specifications ....MAB 0.08.17-07/16/2001	
Pressure Cap Rating (With Heat Exchanger Option) ....kPa [psi]	103 [15]
Max. Coolant Outlet Pressure from the Engine....kPa [psi]	207 [30]
Max. Pressure Drop Across Any External Cooling System Circuit ....kPa [psi]	34 [5]
Engines with Low Temperature Aftercooling (LTA)	
Single Loop LTA	
Coolant Flow to Cooler (with blocked open thermostat)....l/min [gal/min]	238 [63]
LTA Thermostat Operating Range (Start to Open) ....°C [°F]	66 [150]
LTA Thermostat Operating Range (Full Open) ....°C [°F]	80 [175]
Heat Rejection to Engine Coolant[3] ....kW [Btu/min]	446 [25400]
Maximum Coolant Inlet Temperature from LTA Cooler....°C [°F]	49 [120]

TBD= To Be Determined N/A = Not Applicable N.A. = Not Available

[1] Unless otherwise specified, all data is at rated power conditions and can vary ± 6%.
[2] No rear loads can be applied when the FPTO is fully loaded. Max PTO torque is contingent on torsional analysis results for the specific drive system. Consult Installation Direction Booklet for Limitations.
[3] Heat rejection to coolant values are based on 60% water/50% ethylene glycol mix and do NOT include fouling factors. If sourcing your own cooler, a service fouling factor should be applied according to the cooler manufacturer's recommendation.
[4] Consult option notes for flow specifications of optional Cummins seawater pumps, if applicable.
[5] May not be at rated load and speed. Maximum heat rejection may occur at other than rated conditions.

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9. ANNEX B – CUMMINS 6BT5.9-D(M) DATASHEET

CUMMINS INC.	Basic Engine Model:	Curve Number:	
Charleston, SC 29405	6BT5.9-D(M)	D(M)-90441	
Marine Performance Curves	Engine Configuration:	CPL Code:	Date:
	D402051MX02	1524	7-Jun-12

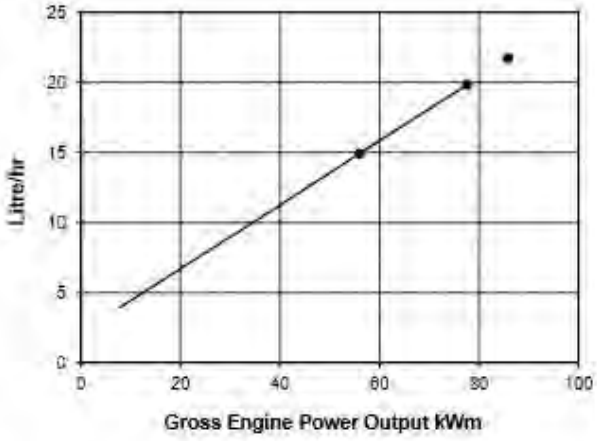
Displacement:	5.9 liter	[359.00 in³]		kW [hp] @ rpm
Bore:	102 mm	[4.02 in]	Advertised Power:	78[104]@1500
Stroke:	120 mm	[4.72 in]	Aspiration:	Turbocharged
Fuel System:	Stanadyne DB4		Exhaust Type:	Wet
Cylinders:	6			

CERTIFIED: This marine diesel engine complies with or is certified to the:
No Certification Issued

Engine Speed	Overload Capacity		Prime Power		Continuous Power	
RPM	kWm	BHP	kWm	BHP	kWm	BHP
1500	86	115	78	104	56	75

Engine Performance Data @ 1500 rpm

OUTPUT POWER			FUEL CONSUMPTION			
%	kWm	BHP	kg/kWh	Lb/ BHP-h	Liter/ hour	U.S. Gal/ hour
10% OVERLOAD CAPACITY						
110%	86	115	0.215	0.354	21.7	5.7
PRIME POWER						
100%	78	104	0.217	0.358	19.8	5.2
75%	58	78	0.226	0.371	15.4	4.1
50%	39	52	0.241	0.396	11.0	2.9
25%	19	26	0.289	0.475	6.6	1.7
10%	8	10	0.432	0.711	3.9	1.0
CONTINUOUS POWER						
80%	56	75	0.227	0.373	15	3.9



Rating Conditions: Ratings are in accordance with ISO 15550 and ISO 8528-5 reference conditions: air pressure at 100 kPa (29.61 in Hg), air temperature 25°C (77°F), and 30% relative humidity. The fuel consumption data is based on No. 2 diesel fuel weight at 0.85 kg/liter (7.001 lb/U.S. gal).

Power output curves are based on the engine operating with fuel system, water pump, and lubricating oil pump; not included are battery charging alternator, fan, optional equipment, and driven components.

Values from engine control modules and displayed on instrument panels are not absolute. Tolerance varies, but is generally less than +/-5% when operating within 30% of rated power.

Unless otherwise specified, tolerance on all values is +/-5%.

Prime Power Rating is applicable for supplying continual electrical power at varied load. The following are the Prime Rating parameters:

* Prime Power is available for an unlimited number of hours per year in a variable load application. Variable load should not exceed a 70% average of the Prime Power rating during any operating period of 250 hours.
* The total operating time at 100% Prime Power shall not exceed 500 hours per year.
* There is a 10% overload capability for a period of 1 hour within a 12 hour period of operation. Total operating time at 10% overload shall not exceed 25 hours per year.

TECHNICAL DATA DEPT.

CHIEF ENGINEER

Auxiliary Marine Engine Performance Data

		Curve No.	D(M)-90441		
		DS :	DS-4020		
		CPL :	1524		
		DATE:	7-Jun-12		
General Engine Data					
Engine Model		6BT5.9-D(M)			
Rating Type		Prime Power		Overload	
Rated Engine Power	kW [hp]	78	[104]	86	[115]
Governed Engine Speed	rpm		1500		
Rated HP Production Tolerance	±%		5		
Rated Engine Torque	N·m [lb·ft]	494	[364]	546	[403]
Default Idle Speed Setting	rpm		940		
Low Idle Speed Range Minimum	rpm		950		
Low Idle Speed Range Maximum	rpm		1150		
Brake Mean Effective Pressure	kPa [psi]	1055	[153]	1166	[169]
Compression Ratio			16.5:1		
Piston Speed	m/sec [ft/min]	6	[1180]		
Firing Order			1-5-3-6-2-4		
Friction Power	kW [hp]	13	[17]		
Steady State Stability Band at Constant Load	%		0.50		
Weight Dry - Engine Only	kg [lb]	426	[940]		
Weight Dry - Engine With Heat Exchanger	kg [lb]	508	[1120]		
Fuel System[1]					
Approximate Fuel Flow to Pump	l/hr [gal/hr]	123.2	[32.6]	123.2	[32.6]
Maximum Allowable Fuel Supply to Pump Temperature	°C [°F]	60	[140]	60	[140]
Approximate Fuel Flow Return to Tank	l/hr [gal/hr]	103.4	[27.3]	101.5	[26.8]
Approximate Fuel Return to Tank Temperature	°C [°F]	TBD		TBD	
Maximum Heat Rejection to Drain Fuel	kW [Btu/min]	TBD		TBD	
Fuel Rail Pressure	kPa [psi]	TBD		TBD	
Average Fuel Consumption- Emissions ISO 8178 D2 Test Cycle	l/hr [gal/hr]	10.7	[2.8]		
Air System[1]					
Intake Manifold Pressure	mm Hg [in Hg]	TBD		TBD	
Intake Air Flow	l/sec [cfm]	85	[180]	94	[200]
Heat Rejection to Ambient	kW [Btu/min]	11	[630]	12	[695]
Exhaust System[1]					
Exhaust Gas Flow	l/sec [cfm]	203	[430]	224	[475]
Exhaust Gas Temperature (Turbine Out)	°C [°F]	374	[705]	416	[780]
Exhaust Gas Temperature (Manifold)	°C [°F]	TBD		TBD	
Heat Rejection to Exhaust	kW [Btu/min]	51	[2900]	54	[3085]
Cooling System[1]					
Sea Water Pump Specifications	MAB 0.08.17-07/16/2001				
Pressure Cap Rating (With Heat Exchanger Option)	kPa [psi]	69	[10]		
Max. Pressure Drop Across Any External Cooling System Circuit	kPa [psi]	34	[5]		
Non-Aftercooled					
Coolant Flow To Engine Heat Exchanger/Keel Cooler					
At 5 psi Friction Head External to Engine	l/min [gal/min]	83	[22]		
Standard Thermostat Operating Range Start to open	°C [°F]	82	[180]		
Standard Thermostat Operating Range Full open	°C [°F]	95	[203]		
Heat Rejection to Engine Coolant[3]	kW [Btu/min]	60	[3400]	66	[3750]
Sea Water Flow @ 10 psi Pump Pressure	l/min [gal/min]	34	[9]		

TBD= To Be Determined N/A = Not Applicable N.A. = Not Available

[1] Unless otherwise specified, all data is at rated power conditions and can vary ± 5%.
[2] No rear loads can be applied when the PTO is fully loaded. Max PTO torque is contingent on torsional analysis results for the specific drive system. Consult Installation Direction Booklet for Limitations.
[3] Heat rejection to coolant values are based on 50% water/50% ethylene glycol mix and do NOT include fouling factors. If sourcing your own cooler, a service fouling factor should be applied according to the cooler manufacturer's recommendation.
[4] Consult option notes for flow specifications of optional Cummins seawater pumps, if applicable.

CUMMINS ENGINE COMPANY, INC
COLUMBUS, INDIANA

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Auxiliary Marine Engine Performance Data

				Curve No.	D(M)-80441	
				DS :	DS-4020	
				CPL :	1524	
				DATE:	7-Jun-12	
Emissions (in accordance with ISO 8178 Cycle D2)						
NOx (Oxides of Nitrogen)		g/kw-hr [g/bhp-hr]	0.000	[0.000]		
HC (Hydrocarbons)		g/kw-hr [g/bhp-hr]	83.279	[22.000]		
CO (Carbon Monoxide)		g/kw-hr [g/bhp-hr]	N/A			
PM (Particulate Matter)		g/kw-hr [g/bhp-hr]	82.288	[180.000]		
Emissions (in accordance with ISO 8178 Cycle E2)						
NOx (Oxides of Nitrogen)		g/kw-hr [g/bhp-hr]	N/A			
HC (Hydrocarbons)		g/kw-hr [g/bhp-hr]	34.089	[9.000]		
CO (Carbon Monoxide)		g/kw-hr [g/bhp-hr]	68.948	[10.000]		
PM (Particulate Matter)		g/kw-hr [g/bhp-hr]	0.000	[0.000]		
Cooling System[1]						
Ses Water Pump Specifications		MAB 0.08.17-07/16/2001				
Pressure Cap Rating (With Heat Exchanger Option)		kPa [psi]	69	[10]		
Engines without Low Temperature Aftercooling (LTA)						
Jacket Water Aftercooled Engines (JWAC)						
Coolant Flow to Main Cooler (with open thermostat)		l/min [gal/min]	0	[]		
Standard Thermostat Operating Range	Start to open	°C [°F]	0	[]		
	Full open	°C [°F]	0	[]		
Heat Rejection to Engine Coolant[3]		kW [Btu/min]	0	[]	0	[]
Singe Loop LTA						
Coolant Flow to Main Cooler (with open thermostat)		l/min [gal/min]	0	[]		
Standard Thermostat Operating Range	Start to open	°C [°F]	0	[]		
	Full open	°C [°F]	0	[3170397]		
Heat Rejection to Engine Coolant[3]		kW [Btu/min]	0	[]	0	[]
Maximum Coolant Inlet Temperature from LTA Cooler		°C [°F]	0	[]		
Two Loop Low Temperature Aftercooling (LTA)						
Main Engine Circuit						
Coolant Flow to Main Cooler (with open thermostat)		l/min [gal/min]	0	[]		
Standard Thermostat Operating Range	Start to open	°C [°F]	0	[]		
	Full open	°C [°F]	0	[]		
Heat Rejection to Engine Coolant[3]		kW [Btu/min]	0	[]	0	[0]
Aftercooler (LTA) Circuit						
Coolant Flow to LTA Cooler (with open thermostat)		l/min [gal/min]	0	[]		
LTA Thermostat Operating Range	Start to open	°C [°F]	0	[]		
	Full open	°C [°F]	0	[]		
Heat Rejection to Engine Coolant[3]		kW [Btu/min]	0	[]	0	[]
Maximum Coolant Inlet Temperature from LTA Cooler						
For Keel Cooled		°C [°F]	0	[]		
For Radiator @ 35° C [95° F] Ambient Air		°C [°F]	0	[]		
For Radiator @ 50° C [122° F] Ambient Air		°C [°F]	0	[]		
Engines with Radiator Cooling						
Coolant Flow to Radiator (Blocked open thermostat)		l/min [gal/min]	0	[]		
Standard Thermostat Operating Range	Start to open	°C [°F]	0	[]		
	Full open	°C [°F]	0	[]		
Heat Rejection to Engine Coolant[3]		kW [Btu/min]	0	[]	0	[]

TBD= To Be Determined N/A = Not Applicable N.A. = Not Available

[1] Unless otherwise specified, all data is at rated power conditions and can vary ± 5%.
[2] No heat loads can be applied when the PTO is fully loaded. Max PTO torque is contingent on torsional analysis results for the specific drive system. Consult Installation Direction Booklet for Limitations.
[3] Heat rejection to coolant values are based on 50% water/50% ethylene glycol mix and do NOT include fouling factors. If sourcing your own cooler, a service fouling factor should be applied according to the cooler manufacturer's recommendation.
[7] Consult option notes for flow specifications of optional Cummins seawater pumps, if applicable.

CUMMINS ENGINE COMPANY, INC.

COLUMBUS, INDIANA

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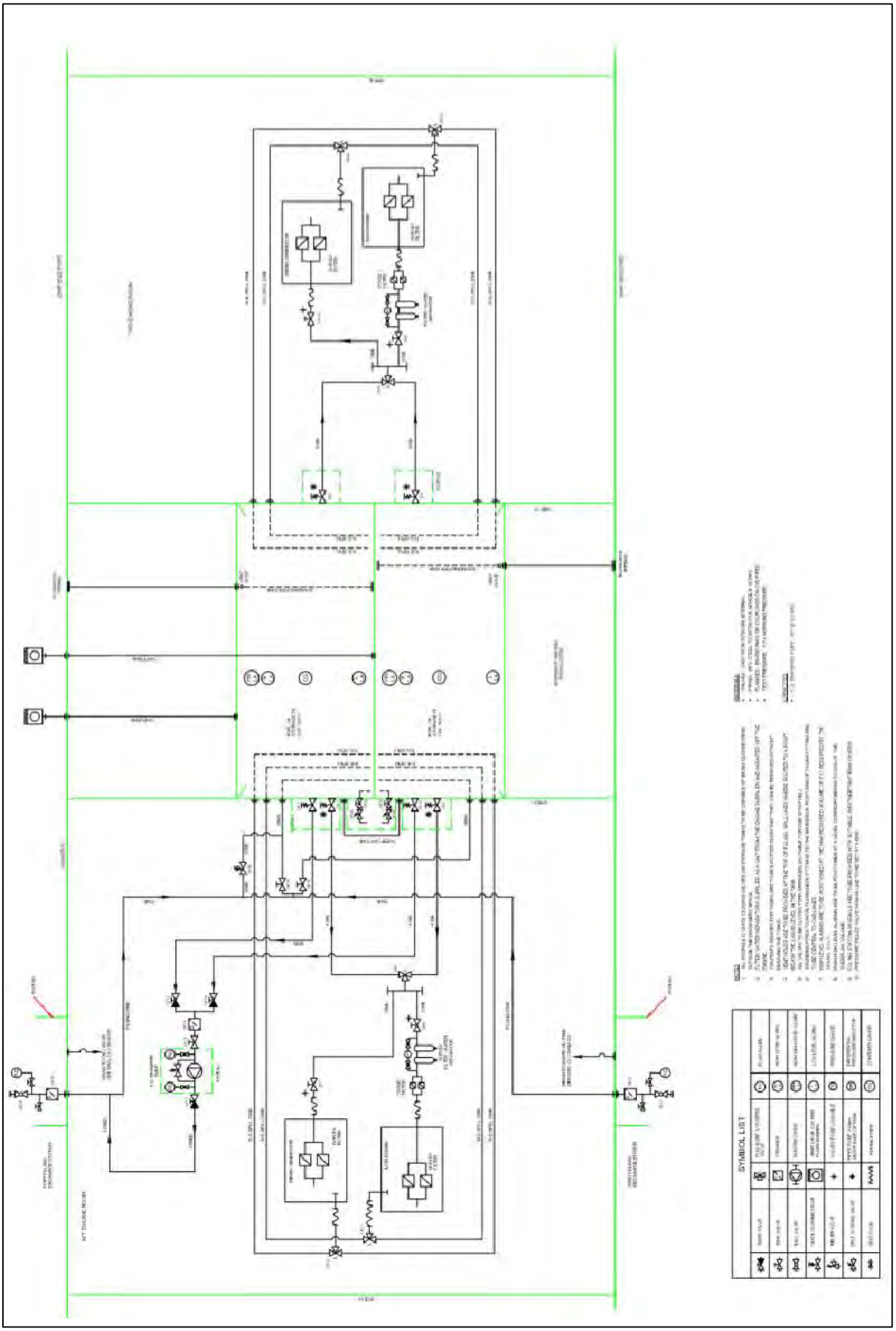
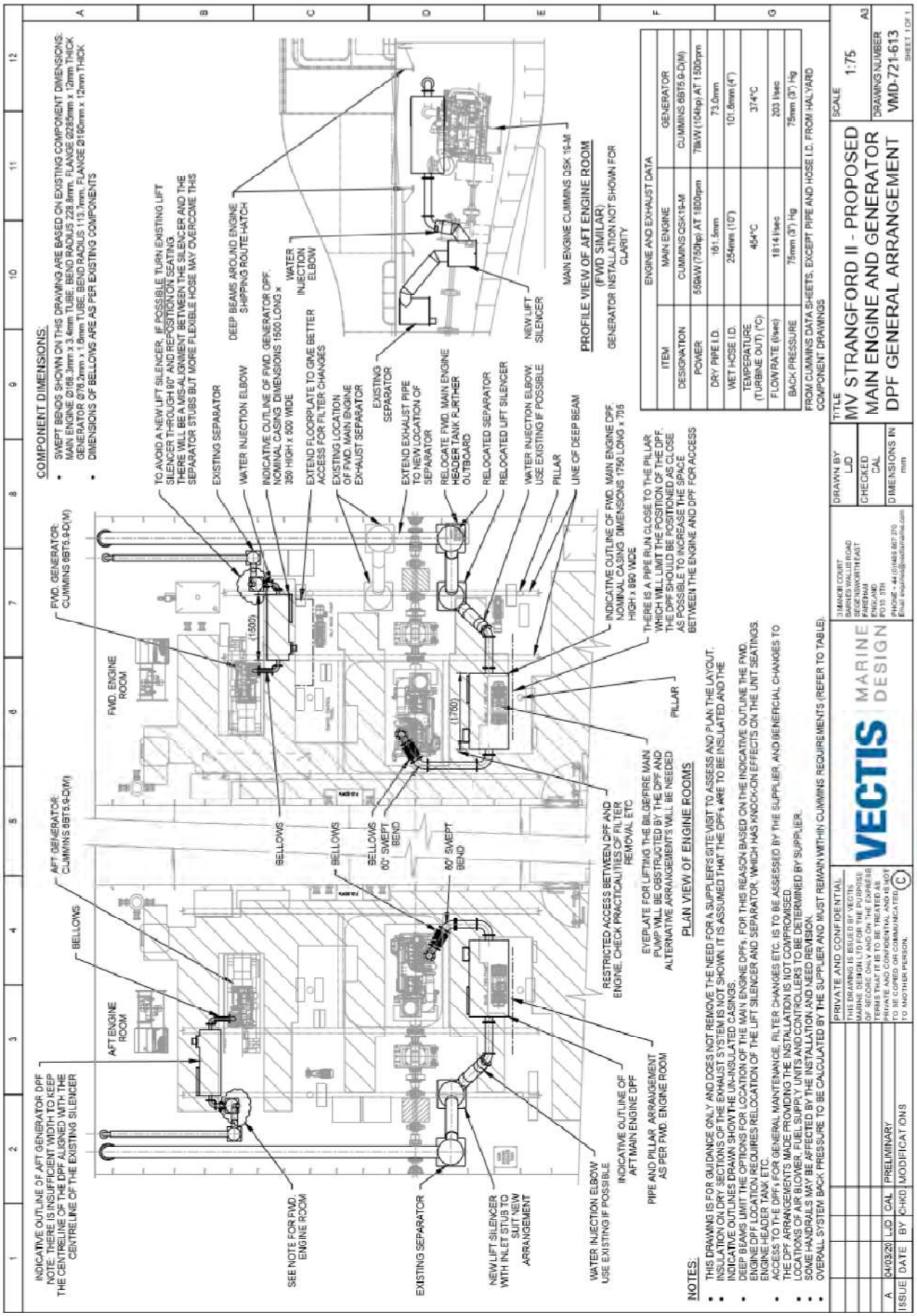
10. ANNEX C – FUEL SYSTEM SCHEMATIC



11. ANNEX D – INDICATIVE SEQUENCE OF INSTALLATION (INFORMATION ONLY)

- Make all necessary systems safe
- Disconnect and temporarily terminate services running in trays which require to be re-routed
- Remove trays, and other minor items as necessary
- Remove insulation and disconnect engine exhaust upstream of the water separators
- Unbolt GRP waterlocks
- Erect weatherproof shelters and unbolt engine shipping route hatches
- Remove unwanted exhaust system components and hoist out waterlocks
- Cut off redundant hangers and other structure etc
- Hoist in replacement waterlocks and DPFs
- Replace engine shipping route hatches and dismantle weatherproof shelters
- Temporarily support DPFs in position, dry fit components between engine and DPF and measure/template for new hangers
- Remove exhaust components and move DPFs out of the way if necessary, install new hangers
- Install DPFs
- Install GRP waterlocks
- Connect up dry and wet parts of the exhaust system, and water injection supply
- Fit insulation
- Reinstate trays and services, reconnect services and test. Replace any minor items disturbed during installation
- Install regeneration systems, including tapping into diesel fuel supply system or making electrical connections etc
- Painting, finishing and cleaning

12. ANNEX E – INDICATIVE LAYOUT OF DPFS (INFORMATION ONLY)



13. ANNEX F – EXHAUST GAS ANALSIS RESULTS

Fwd Main Engine

Entire Sampling Period

Substance to be Monitored	Periodic Monitoring Result	Units	Uncertainty	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method
Total Particulate Matter	**46.3**	mg/Nm³	0.8%	273K, 101.3kPa, dry	13/11/18	10:17-11:11	Based on BS EN 13284-1	None
Oxides of Nitrogen	**918.7**	mg/Nm³	1.9%	273K, 101.3kPa, dry	13/11/18	10:19-12:47	BS EN 14792	MCERTS
Carbon Monoxide	**224.2**	mg/Nm³	4.8%	273K, 101.3kPa, dry	13/11/18	10:19-12:47	BS EN 15058	MCERTS
Oxygen	**12.9**	%	4.3	273K, 101.3kPa, dry	13/11/18	10:19-12:47	BS EN 14789	MCERTS

Fwd Generator

Baseline – Generator running but no activity

Substance to be Monitored	Periodic Monitoring Result	Units	Uncertainty	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method
Total Particulate Matter	**205.1**	mg/Nm³	0.8%	273K, 101.3kPa, dry	14/11/18	15:50-16:01	Based on BS EN 13284-1	None
Oxides of Nitrogen	**421.7**	mg/Nm³	1.9%	273K, 101.3kPa, dry	14/11/18	15:50-16:01	BS EN 14792	MCERTS
Carbon Monoxide	**355.4**	mg/Nm³	3.5%	273K, 101.3kPa, dry	14/11/18	15:50-16:01	BS EN 15058	MCERTS
Oxygen	**16.6**	%	1.2%	273K, 101.3kPa, dry	14/11/18	15:50-16:01	BS EN 14789	MCERTS

Ramp operation – including engine warm up

Substance to be Monitored	Periodic Monitoring Result	Units	Uncertainty	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method
Total Particulate Matter	**192.3**	mg/Nm³	0.8%	273K, 101.3kPa, dry	14/11/18	14:32-14:54	Based on BS EN 13284-1	None
Oxides of Nitrogen	**504.8**	mg/Nm³	1.9%	273K, 101.3kPa, dry	14/11/18	14:32-14:54	BS EN 14792	MCERTS
Carbon Monoxide	**400.5**	mg/Nm³	3.5%	273K, 101.3kPa, dry	14/11/18	14:32-14:54	BS EN 15058	MCERTS
Oxygen	**16.4**	%	1.2%	273K, 101.3kPa, dry	14/11/18	14:32-14:54	BS EN 14789	MCERTS

Ramp operation – Multiple operation of ramps

Substance to be Monitored	Periodic Monitoring Result	Units	Uncertainty	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method
Total Particulate Matter	**220.0**	mg/Nm³	0.8%	273K, 101.3kPa, dry	14/11/18	15:08-15:18	Based on BS EN 13284-1	None
Oxides of Nitrogen	**510.2**	mg/Nm³	1.9%	273K, 101.3kPa, dry	14/11/18	15:08-15:18	BS EN 14792	MCERTS
Carbon Monoxide	**354.4**	mg/Nm³	3.5%	273K, 101.3kPa, dry	14/11/18	15:08-15:18	BS EN 15058	MCERTS
Oxygen	**16.3**	%	1.2%	273K, 101.3kPa, dry	14/11/18	15:08-15:18	BS EN 14789	MCERTS

Auxiliary equipment – Operation of pumps, and canteen facilities

Substance to be Monitored	Periodic Monitoring Result	Units	Uncertainty	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method
Total Particulate Matter	**232.2**	mg/Nm³	0.8%	273K, 101.3kPa, dry	14/11/18	15:27-15:39	Based on BS EN 13284-1	None
Oxides of Nitrogen	**548.8**	mg/Nm³	1.9%	273K, 101.3kPa, dry	14/11/18	15:27-15:39	BS EN 14792	MCERTS
Carbon Monoxide	**374.0**	mg/Nm³	3.5%	273K, 101.3kPa, dry	14/11/18	15:27-15:39	BS EN 15058	MCERTS
Oxygen	**15.9**	%	1.2%	273K, 101.3kPa, dry	14/11/18	15:27-15:39	BS EN 14789	MCERTS

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DFI ROADS AND RIVERS PROCUREMENT BRANCH

HANDOVER DOCUMENT

This Handover Document sets out the key aspects of the Contract including the management/monitoring Arrangements.

Contract Details	
Project Number and Title of Contract	**CfT:3370640 DFI Roads and Rivers - Strangford Lough Ferry Service - Design, Supply and Installation of a Diesel Particulate Filtration System for MV Strangford II**
Contract award date	19 March 2021
Contract Commencement date	22 March 2021
Contract duration and value (for Initial Contract Period)	The Contract shall take effect on the Commencement Date and shall run until the end of the warranty period. [redacted]
Total Contract duration and value (including options to extend)	As above
Name of Contractor(s)	HALYARD (M & I) LTD
Contractor's address	86 Cobham Road Ferndown Industrial Estate WIMBORNE BH21 7PQ
Contractor's point of contact	[redacted]
Contractor's telephone number	[redacted]
Contractor's email address	[redacted]
CoPE contact email address	pb2@infrastructure-ni.gov.uk

Security Requirements [if applicable]	
The Departmental ADSO advised that the Contractor required the security level opposite.	**Baseline Personnel Security Standard – Basic Disclosure**
The PM should ensure that the Contractor has achieved the correct level of security vetting prior to the commencement of the contract and that this level is maintained by the Contractor staff throughout the contract duration.	

Payment Terms and Invoicing Arrangements

The payment terms are as follows: -

Milestone payments will be made as follows;
1 Specification and design approval by MCA and Lloyds Register
2 Manufacture and delivery of entire system to Strangford Ferry Terminal
3 Installation and modifications on board MV Strangford II
4 Commissioning system including all sea trials, crew / staff training

Costs provided at tender stage will remain unchanged for the duration of the contract period.

Halyard CfT3370640 - Schedule 2 - Pricin

Halyard Estimated DPF fuel costs Stran

Invoices must be sent electronically to Account NI via structured PDF to

- **Billing Method = email invoices to invoices@accountni.gov.uk**

AccountNI Oracle CPA Number	6210135946

Key Performance Indicators

KPIs are as per Specification and Conditions of Contract

3. CfT3370640 -

2b. CfT3370640 -

Contract Management Procedures

Contract management should be in accordance with Central Procurement Directorate Procurement Guidance Note 01/12.

https://www.finance-ni.gov.uk/articles/procurement-guidance-notes-pgns

Where applicable the contract should be managed in line with the Monitoring Schedule, which is part of the Conditions of Contract.

Contract Review Procedures

A formal post project evaluation meeting will take place after completion of the project.

The Contract will be continuously monitored against the KPIs as detailed in the tender documents and the arrangements outlined in the monitoring schedule.

The pattern of review above should be in line with any applicable Monitoring Schedule.

Dispute Resolution and Escalation Procedures

If any dispute arises between the parties under or in relation to the Contract, it should be managed in accordance with the relevant Clauses within the Conditions of Contract. DfI Roads and Rivers PB should be notified immediately of any such disputes.

Procedures for Contract Variation

Any variation to the contract must be carried out in accordance with the relevant Clauses of the Conditions of Contract.

Any such variations must be recorded using the Contract Variation Form at Annex A.

DfI Roads and Rivers PB should be consulted PRIOR to any contract variations.

Sustainability

The Terms and Conditions included the following sustainability clauses as standard **Prompt payment**, **Payment of sub-contractors on** "no less favourable terms" than those contained in the prime contractor's contract. **Equality of Opportunity** and **Health and Safety.**

Annex A

VARIATION TO CONTRACT FORM

CONTRACT TITLE: .....

FOR THE PROVISION OF: .....

CONTRACT REF: ..... VARIATION NO: ..... DATE: / /

BETWEEN:

1. The Contract is varied as follows:

2. Words and expressions in this Variation shall have the meaning/s given to them in the Contract.

3. The Contract, including any previous Variation(s), shall remain effective and unaltered except as amended by this Variation.

SIGNED:

For: The Client	For: The Contractor
Signature:	Signature: .....
Full Name:	Full Name: .....
Grade:	Grade: .....
Date: .....….	Date: .....….

CfT:3370640 DFI Roads and Rivers –Strangford Lough Ferry Service – Design, Supply and Installation of a Diesel Particulate Filtration System for MV Strangford II

SCHEDULE 2 - PRICING SCHEDULE

Tenderers must **fully** complete the Pricing Schedule for each field highlighted in yellow. All costs will then be added together to give an Overall Total Cost. This figure will be used for evaluation purposes. All prices submitted must be in £ sterling and exclude VAT.

The prices below must include **all costs** associated with the work carried out for this project as detailed in the Specification including, but not limited to, the following:

(a) All costs associated with the specification, design and manufacture of the four DPF units and associated systems for MV Strangford II.
(b) All costs associated with the installation of the four DPF units and associated systems within MV Strangford II with the vessel alongside in Strangford, NI.
(c) All costs associated with the commissioning, testing and acceptance of the installation within MV Strangford II within Strangford Lough, NI.
(d) All costs associated with the project management of the project.
(e) All the economic operator's travel and accommodation costs associated with the project.
(f) Establishment charges, Overheads and Profits.
(g) Insurance as per the contract.

	Unit	Quantity	Price	TOTAL £	Notes
Specification, design and approval from Lloyds / MCA.	item	1	[redacted]	[redacted]	
Manufacture and delivery to 1 The Slip Strangford.	item	1	[redacted]	[redacted]	
Installation, commissioning, sea trials and testing.	item	1	[redacted]	[redacted]	
Crew training. This is to include, but not be limited to, provision of hard and soft copy manuals, on-site training in the operation and maintenance of the system and health and safety procedures such as removal of filters for deep cleaning.	item	1	[redacted]	[redacted]	
Annual operating cost of the complete installation including the cost of additional fuel/electric power for regeneration of the four DPF units.	item	1	[redacted]	[redacted]	[redacted]
The cost of deep cleaning of all the filter elements including an estimate for shipping costs from ferry to manufacturers site and return.	item	1	[redacted]	[redacted]	[redacted]
The cost of any parts and/or consumables required to operate and maintain the installation for a 12 month period.	item	1	[redacted]	[redacted]	
The cost of sufficient spare filter elements to allow complete replacement of those within one main engine DPF and one generator DPF.	item	1	[redacted]	[redacted]	

Overall Total tendered cost (Contract Price) to be used for evaluation purpose	[redacted]

Estimated Fuel Costs for DPF	Running Hours/Day	Running Hours/Year	Qty of Regens / day (Regen approx every 8 hours)	Fuel Consumption L / Regen.	Daily Fuel Consumption (Litres)	Annual Consumption
Fwd Main Engine	16	5840	2	5	10	
Aft Main Engine	16	5840	2	5	10	
Fwd Genset	16	5840	2	2	4	
Aft Genset	16	5840	2	2	4	
			Totals	**14**	**28**	**10220**
			Fuel Cost £/Litre	£0.70		**£7,154**