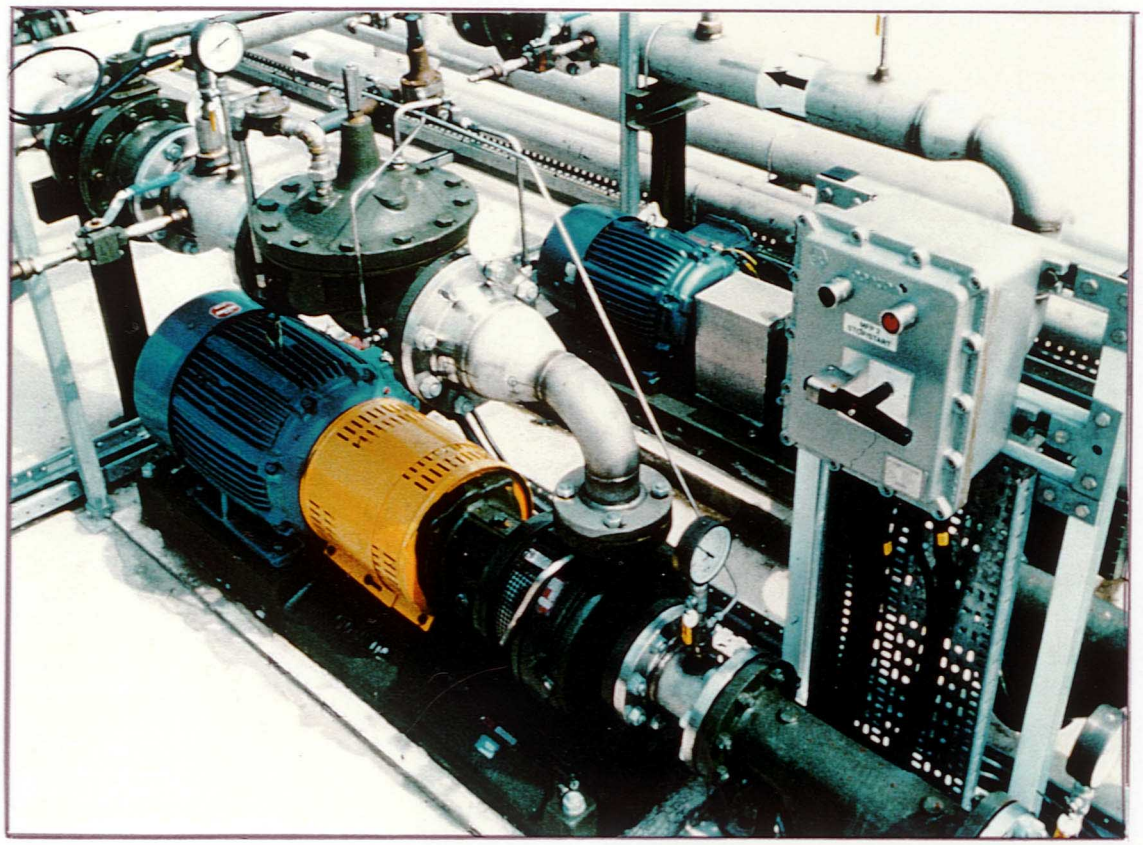
Specification 043

Pumps for bulk fuel installations



DEFENCE ESTATE ORGANISATION
MINISTRY OF DEFENCE

Specification 043

Pumps for bulk fuel installations

AIRFIELDS AND BULK FUELS GROUP (ABFG)
DEFENCE ESTATE ORGANISATION
MINISTRY OF DEFENCE

Foreword

This Specification was prepared under the patronage of the Defence Fuels and Lubricants Distribution Committee.

The selection of the appropriate pump to the product transfer task has safety, operational and environmental consequences.

The product transfer operations to which this Specification applies are detailed in Section 1.1.

This document provides guidance to Works Services Managers (WSMs) and Project Managers on operating conditions that are prevalent on bulk fuel installations and methods of achieving a cost effective and efficient pumping regime. It should be noted that there are no national or international standards that can be readily applied to attain an economic design.

This document is for the use of Top Level Budget Holders (TLBHs) for application by the Project Sponsors, Property Managers (PROMs), Establishment Works Consultants (EWCs), Works Services Managers and other parties involved in the design and construction of new and refurbishment of existing bulk fuel installations on the MOD Estate.

The principal users of the document are expected to be Project Sponsors to influence the preparation of the Statement of Requirements; WSM specifiers, designers, installers and maintainers for works which fall within the property services remit; and Project Managers, designers and installers for projects.

This Specification replaces:

Standard Specification (M&E) No. 35 Pumps for Bulk Fuel Installations, DOE/PSA.

Amendments to this Specification will be advised by Defence Estate Organisation (DEO) Technical Bulletin, issued to PROM and TLBH Works staff. It is the responsibility of the user to check with the PROM or Project Sponsor if amendments have been issued. There is a feedback sheet at Annex C, for suggested changes or developments to the document.

Technical advice and assistance can be obtained from the DEO. Approaches may be through local DEO offices or directly to the Focal Point:

Head of Bulk Petroleum Installations
Airfields and Bulk Fuels Group
Defence Estate Organisation
Blakemore Drive
SUTTON COLDFIELD
West Midlands
B75 7RL

Notwithstanding that this document sets out the specification for pumps for bulk fuel and is the MOD preferred solution, its use does not absolve a Project Manager or WSM from any responsibility for the design, neither does its existence constrain him from using alternatives, provided such alternatives can be demonstrated to provide a result of equal safety, quality and cost effectiveness.

This Specification has been devised for the use of the Crown and its Contractors in the execution of contracts for the Crown. The Crown hereby excludes all liability (other than liability for death or personal injury) whatsoever and howsoever arising (including, but without limitation, negligence on the part of the Crown, its servants or agents) for any loss or damage however caused where the Specification is used for any other purpose.

Compliance with a DEO Specification will not of itself confer immunity from legal obligations.

Abbreviations

BFI	Bulk Fuel Installation
BHN	Brinell Hardness Number
BS	British Standard
DEO	Defence Estate Organisation
EWC	Establishment Works Consultant
IP	Index of Protection
MOD	Ministry of Defence
NPSH	Net Positive Suction Head
PROM	Property Manager
TLBH	Top Level Budget Holder
WSM	Works Services Manager

Contents

1 Introduction

1.1 APPLICATION

This document has been produced to guide the selection of the appropriate pump to the product transfer task at bulk fuel installations. It is equally relevant to both new projects and maintenance/refurbishment works.

This Specification is intended for use in the UK and overseas.

The type of pumps covered by this Specification are:

- vehicle off-load and dispense pumps within aviation fuel installations
- cross-base aviation fuel transfer pumps
- hydrant pumps for aviation fuel
- sump pumps
- slops pumps
- diesel transfer pumps
- petroleum transfer pumps.

This Specification does not cover:

- additive injection pumps
- oil circulating and transfer pumps for domestic heating systems for which reference should be made to Spec 036 Heating, Hot and Cold Water, Steam and Gas Installations for Buildings, DEO
- diesel and petroleum dispensing pumps for mechanical transport fuelling installations for which reference should be made to DMG 14 Mechanical Transport Fuelling Installations, DEO.

This document refers to the Specification of equipment only, it is not intended to cover installation, commissioning or preventive maintenance.

1.2 ARRANGEMENT

This document is arranged to provide discrete information on all facets of pump design together with the requirements for motor compatibility, inspection and testing.

Annex A contains the data sheet which should be initiated by the designer or specifier selecting the pump and completed by the pump manufacturer.

Annex B provides guidance on the requirements for specific duty applications.

Annex C contains the Change Suggestion Form.

1.3 SCOPE OF SUPPLY

The pump manufacturer's scope of supply shall include, but not be limited to, the following for each pump:

- pump
- electric motor
- gearbox and transmission system (if required by the pump design)
- baseplate (if required by the pump design)
- couplings and coupling guards
- lubrication system
- cooling medium system (if required by the pump design)
- shaft sealing system
- all auxiliary pipework and fittings
- instrumentation (if specified on the data sheet)
- inspection and testing
- painting and preservation
- documentation
- special tools and spare parts.

The following items are excluded from the pump manufacturer's scope of supply:

- motor starting equipment
- baseplate foundation bolts and shims
- site installation and testing.

1.4 DESIGN PEDIGREE

Only standard designs in current production with a proven history of reliable operation in hydrocarbon service should be offered.

1.5 ENVIRONMENTAL CONDITIONS AND UTILITIES

Pumps shall be suitable for operation in the atmospheric conditions detailed in the data sheets, which also specify all available utilities.

1.6 DOCUMENTATION REQUIREMENTS

Proposal requirements:

- general arrangement drawing showing overall dimensions, weights, location, type and size of all termination points and foundation requirements
- performance curves showing capacity, differential head, efficiency, NPSH(Required) and power consumption
- completed data sheets
- details of self-priming devices (if required by the application)
- diagram indicating allowable forces and moments on the suction and discharge connections.

'As-installed' requirements:

- all of the documentation submitted at the time of the proposal but revised to indicate a true record of the equipment supplied
- cross-sectional drawings of the pump, seal, self-primer, gearbox and motor with itemised parts list referenced for materials and spares identification
- lubrication schedule

- certification for all electrical equipment and instrumentation
- relief valve certification
- painting procedures
- certified performance data for the pump and motor
- hydrostatic test certification
- installation and commissioning procedures
- operation and maintenance manual.

2 Design requirements

2.1 GENERAL

2.1.1 Centrifugal pumps

Pumps shall have a stable operating characteristic with a shut-off head between 110% and 120% of rated head. Where pumps operate in parallel the total head difference between the two pumps shall be less than 5% between 80% and 110% of rated flow.

Pumps shall be designed to operate satisfactorily between minimum flow and 125% of rated flow.

2.1.2 Positive displacement pumps

Pumps shall be rated for continuous operation against the relief valve setting without overloading the motor.

Pumps shall provide a pulsation free delivery flow.

2.2 PRESSURE CASINGS

Pressure casings shall be of steel or alloy steel, cast iron is not permissible.

The casing design shall be such that the pump shaft, mechanical seal and bearings can be removed without disconnecting the suction/discharge pipework. (This clause does not apply to submersible pumps).

2.3 NOZZLES AND PRESSURE CASING CONNECTIONS

Pumps which are not self-venting shall be provided with a valved and flanged casing vent connection.

Pump casings shall be provided with a valved and flanged casing drain connection

Suction flanges shall be designed for the same pressure as discharge flanges in order that testing can be undertaken to the full test pressure.

Steel flanges shall be in accordance with BS 1560 Part 3 Section 3.1 Specification for Steel Flanges Class 150 unless otherwise stated on the data sheet. Bolt holes shall straddle centrelines.

All tapped holes which are not connected to piping supplied by the pump manufacturer shall be provided with threaded bar stock plugs.

2.4 IMPELLERS

Impellers shall be of corrosion resistant material. Each impeller shall be free from blowholes and other defects and designed to be in dynamic balance at all speeds up to 10% above normal operating speed. Impellers may be of the single or double entry type according to the pump design and shall not be greater than 94% of the largest impeller diameter the casing is designed for.

2.5 SCREWS

Screws shall be of corrosion resistant material. Screw type positive displacement pumps shall have match marked driver and driven screws.

Screw pumps shall have external steady bearings and shall be of stiff shaft construction. The screws shall be in dynamic balance at all speeds up to 10% above normal operating speed and arranged to eliminate end thrust at all speeds.

When timing gears are employed they shall be totally enclosed in an oil bath and arranged such that contamination of the product being pumped cannot occur.

2.6 WEAR RINGS

If wear rings are offered they shall be removable and the hardness difference between static and rotating rings shall be at least 50 BHN.

2.7 PUMP SHAFTS

The shaft material shall be stainless steel, of adequate diameter to withstand all imposed loading and have a critical speed, when assembled with its impeller, at least 10% above normal operating speed.

2.8 MECHANICAL SHAFT SEALS

The pump manufacturer shall be responsible for the provision of a suitable mechanical sealing system for the pump service.

Pumps operating at sub-atmospheric suction pressures shall be designed to ensure that the mechanical seal fitted, will operate with the seal faces above atmospheric pressure to prevent leakage of air into the pump. Seal design shall be adequate to assure sealing against atmospheric pressures when pumps are not operating.

2.9 BEARINGS AND LUBRICATION

All bearings shall be of the anti-friction type with provision for lubrication without dismantling.

Submersible pumps shall utilise the pumped product as the lubricant.

2.10 COUPLINGS AND GUARDS

Couplings shall be of the flexible spacer type. The spacer length shall permit withdrawal of the pump internals without disturbing the pump suction and discharge pipework.

Coupling halves shall be match marked.

Guards covering couplings and exposed shafts shall conform to the requirements of BS 5304 Code of Practice for the Safety of Machinery, except that aluminium guards are not

acceptable. Guards shall be rigid and non-sparking.

2.11 AUXILIARY PIPING

Auxiliary piping shall be in accordance with FS 05 Specialist Works on Petroleum Installations - Mechanical, DWS.

2.12 SELF-PRIMERS

Where required by the process conditions a self primer shall be included as an integral part of the pump. The self primer shall comply with the following:

- It shall be of the positive displacement vane type, mounted on the pump, and shall be driven directly from the pump rotor shaft.

- It shall engage the drive and operate only when the suction line of the pump requires priming. The instrumentation, controls and linkages required to operate the primer under this constraint shall be provided by the pump manufacturer as part of the pump package. The self primer shall be entirely automatic in its operation.

- It shall be capable of priming the pump suction line which is initially devoid of product and only contains a mixture of air and vapour. The entrance to the suction line will be immersed in product. The level of the product and the volume of the suction line is as defined on the data sheet.

- The self primer and any of its associated pipework, controls and equipment shall not provide a leak path for product from the pump and its suction and discharge pipework to the venting system of the primer.

- The venting system shall be suitable for incorporation into a closed pipework system leading to a slops tank for product recovery. The vent pipework diameter and length and the back pressure in the slops tank are as defined on the data sheet.

2.13 MATERIALS OF CONSTRUCTION

Materials in contact with the product shall not be affected by the product, by water, or by water containing soluble fuel additives nor shall the materials have any effect upon the product. Metals and alloys that are product wetted shall be corrosion resistant or protected by a coating system in accordance with Spec 032 Internal Coating of Aviation Fuel Tanks, DEO. Dissimilar metals that will initiate and promote corrosion if in contact shall not be allowed. Copper, copper alloys, light metal alloys containing more than 4% copper, zinc or zinc alloys, cadmium, lead and lead alloys shall not be used in components exposed to the product.

2.14 MOTORS

Motors shall be of the totally enclosed squirrel cage induction type complying with the relevant parts of BS 4999 General Requirements for Rotating Electrical Machines and BS 5000 Rotating Electrical Machines of Particular Types or for Particular Applications. They shall be certified for the hazardous area classification, gas grouping and environmental protection as defined on the data sheet. They shall have characteristics to suit the electricity supply and the required power output and shall be continuously rated. They shall be fitted with grease lubricated ball or roller bearings, including a thrust bearing if required. Lubrication of bearings shall be possible without the need for any dismantling.

The motor shall have a rating not less than 115% of the pump power required at the duty point. In the case of a positive displacement pump the motor shall have a rating of 115% of the power required at the relief valve set pressure.

Motor condensation heaters shall be provided with connections which shall be brought out to a separate terminal box.

2.15 PUMP INSTRUMENTATION

2.15.1 Relief valves

To protect any positive displacement pump and piping when discharge is restricted or shut off, a pressure relief valve shall be provided in accordance with the requirements of FS 05 Specialist Works on Petroleum Installations - Mechanical.

The set pressure shall be not more than the maximum allowable working pressure of the casing but not less than 110% of the rated discharge pressure. The relief valve shall be able to handle the pump rated flow rate when fully open, at a pressure not more than 10% above the set point.

2.15.2 Pressure indication

When specified on the pump data sheet as a requirement the pump manufacturer shall supply and install suction and discharge pressure gauges. Pressure gauges shall comply with the requirements of FS 05 Specialist Works on Petroleum Installations - Mechanical, DWS.

2.16 TESTING

2.16.1 General

All pressure containing parts shall be hydrostatically tested at 150% of the maximum allowable working pressure. The test shall be considered satisfactory when no leaks are observed for a minimum of 30 minutes.

2.16.2 Centrifugal pumps

Each pump is to be assembled with its motor and tested in the pump manufacturer's works.

Performance curves from end of curve to shut-off head are to be produced by the pump manufacturer indicating:

- head versus flow
- power versus flow
- efficiency versus flow.

Where specified as a requirement on the pump data sheet, an NPSH test shall be undertaken and the results plotted as NPSH(Required) versus flow.

The test head-capacity curve shall not deviate from the proposal curve by more that -0% to +4% of the head at any point.

2.16.3 Positive displacement pumps

Each pump is to be assembled with its motor and performance curves produced for the following:

- discharge pressure versus flow
- power versus flow
- efficiency versus flow.

The test capacity shall not deviate from the proposal capacity at the rated pressure by more than -0% or +3%.

2.16.4 Self-primers

Demonstrate that the self priming mechanism, where provided, operates correctly.

2.16.5 Motors

Motors shall be tested at the motor manufacturer's works in accordance with the 'Routine Check Tests', as detailed in BS 4999 Part 143 General Requirements for Rotating Electrical Machines: Specification for Tests.

2.17 PAINTING

The pump manufacturer shall paint all external carbon steel surfaces to his standard paint system suitable for an exposed saline environment. The paint system shall also be resistant to all of the pumped products.

2.18 PRESERVATION

Each pump and motor shall be prepared for despatch to site as follows:

- all openings to atmosphere shall be closed by means of flanges or plugs securely bolted or screwed in place
- all bright metal surfaces shall be given a protective coating against rusting or other form of corrosion
- oil filled compartments or equipment shall be emptied and a rust inhibitor applied.

Any special requirements for the removal of preservative shall be clearly indicated on the pump and repeated in the commissioning instructions.

2.19 SPECIAL TOOLS AND SPARE PARTS

The pump manufacturer shall provide one set of commissioning spares and special tools with each pump together with a list of recommended operating spares for a two year period.

Annex A Data sheets

The designer, or specifier, of the pumping system shall consider the implications of extended closed discharge valve operations on the temperature of the product within the pump casing. If it is considered (or calculated) that product temperatures may rise to an unacceptable level (eg. 50°C for a Class II product) then the system shall be designed to stop the pump. This may be accomplished by means of a thermal cut-out device inserted into the pump casing or by the inclusion of a low flow switch on the discharge pipework from the pump. The low flow switch shall be overridden by a variable timer which shall be set at commissioning.

To be completed by the designer or specifier	
Equipment title and no.:	Pump type:
Location:	Liquid:
Suction pressure (bar g): min rated max	Discharge pressure (bar g): min rated max
Temperature (°C): min rated max	Specific gravity: min rated max
Vapour pressure (bar): min rated max	Viscosity (cP): min rated max
Shut-off head (m):	NPSH(Available) (m):
Ambient temperature (°C): min max	Relative humidity (%):
Hazardous area classification:	Electrical supply voltage (V):
Gas group:	Electrical supply frequency (Hz):
Environmental protection (IP):	Electrical phase:
Suction flange size (mm) and class (#):	Discharge flange size (mm) and class (#):
Thermal cut-out on casing: Reqd/Not reqd	Pressure gauges: Reqd/Not reqd
Self-primer: Reqd/Not reqd	Volume of suction line to be primed (m^3):
Self-primer vent pipework diameter (mm):	Self-primer vent pipework length (m):
Slops tank back pressure (bar g):	NPSH test: Reqd/Not reqd
Type of motor cable entry:	Maximum motor starting current (%FLC):
Finish paint colour:	
Notes:	
1. For submersible pumps a sketch is required to indicate respective min/max liquid levels	
To be completed by the pump manufacturer	
Manufacturer's name:	Pump model type and number:
Centrifugal Pumps	
Casing split:	Impeller diameter (mm): min rated max
Rotation viewed from coupling:	Lubrication medium:
Coupling manufacturer:	Coupling type:
Seal manufacturer:	Seal type:
Casing material:	Impeller material:
Wear ring material:	Shaft material:
Shaft sleeve material:	Guard material:
Pump speed (rpm):	Minimum continuous flow (m^3/hr)
Pump power at rated duty (kw):	Efficiency at rated duty:
NPSH(Required) (m):	Casing maximum allowable working pressure (bar):
Bearing lubrication:	
Positive Displacement (Rotary) Pumps	
Casing type:	
Rotation viewed from coupling:	Lubrication medium:
Coupling manufacturer:	Coupling type:
Seal manufacturer:	Seal type:
Casing material:	Screw material:
Guard material:	Pump speed (rpm):
Relief valve manufacturer:	Relief valve model no.:
Relief valve set pressure:	Pump power at rated duty (kw):
Pump power at relief valve set pressure (kw):	Efficiency at rated duty;
NPSH(Required) (m):	Casing maximum allowable working pressure (bar):
Bearing lubrication:	Timing gear lubrication:

Motor Driver	
Manufacturer:	Frame size;
Rating (kw):	Speed (rpm):
Mounting: Horizontal/Vertical	Voltage (V):
Frequency (Hz):	Phase:
Enclosure classification:	Minimum starting voltage (V):
Temperature rise (°C):	Full load current (A):
Locked rotor current (A):	Insulation rating:
Starting method:	Bearing type:
Bearing lubrication:	Thrust bearing capacity (N):

Annex B Specific requirements for certain duties

Road Tanker Offloading Pumps

Offloading pumps shall be of the positive displacement type utilising a rotary vane or meshed screws. Refer also to the following section on Bulk Fuel Installation Dispensing Pumps.

The pump's inlet centreline will be at a lower elevation than the lowest level of the fuel in the road tanker. Flow will normally be via 100 mm diameter reinforced rubber hoses into a suction manifold. The hoses which will have screwed end connections will require total drainage into the system so it is essential that the pump continues to operate until all fuel is removed from the tanker. This may require the operator to flex the hoses to ensure that the fuel is "tipped" towards the pump manifold.

The pump shall, therefore, be capable of handling the entrained air/fuel vapour drawn into the system at the end of the offloading operation.

On start-up of the next road offloading operation, the pump shall be capable of handling any trapped air/fuel vapour in the suction line until the fuel from the road tanker has run into the pipework and full flow is established.

Flow rate, head and NPSH(Available) characteristics are as defined on the data sheet.

Bulk Fuel Installation Dispensing Pumps

Dispensing pumps shall be of the vertical in-line or horizontal end suction centrifugal type.

When the pump inlet centreline is at a higher elevation than the lowest level of the fuel in the source tank the pump shall be fitted with a self-priming system as detailed in Section 2. For applications where the pump suction is always flooded the self-primer will not be required.

There may be an operational requirement for one of the dispensing pumps to act as a standby Road Tanker Offloading Pump. In such cases a back pressure control valve will need to be installed on the pump discharge pipework.

Flow rate, head and NPSH(Available) characteristics are as defined on the data sheet.

Tank to Tank Transfer Pumps

Transfer pumps shall be of the vertical in-line or horizontal end suction centrifugal type.

When the pump inlet centreline is at a higher elevation than the lowest level of the fuel in the source tank the pump shall be fitted with a self-priming system as detailed in

Section 2. For applications where the pump suction is always flooded the self-primer will not be required.

Transfer pumps may be used for "remote transfer" (from one Bulk Fuel Installation [BFI], across the base to another BFI) or "local transfer" (from one tank in a BFI to an adjacent tank in the same BFI). In the latter case the frictional resistance of the pipework will be greatly reduced so the flow will be directed into the "local" tank via a throttling section sized to impose the appropriate resistance on the pump.

The transfer pump shall, therefore, be capable of starting against a low head, and continuing operation under this condition until such time as the full flow through the throttle section is established and the full resistive head is matched.

Flow rate, head and NPSH(Available) characteristics are as defined on the data sheet.

Hydrant Feed Pumps

Hydrant feed pumps shall be of the vertical in-line or horizontal end suction centrifugal type.

When the pump inlet centreline is at a higher elevation than the lowest level of the fuel in the source tank the pump shall be fitted with a self-priming system as detailed in Section 2. For applications where the pump suction is always flooded the self-primer will not be required.

Flow rate, head and NPSH(Available) characteristics are as defined on the data sheet.

Multi-purpose Pumps

Multi-purpose pumps shall be of the vertical in-line or horizontal end suction centrifugal type.

When the pump inlet centreline is at a higher elevation than the lowest level of the fuel in the source tank the pump shall be fitted with a self-priming system as detailed in Section 2. For applications where the pump suction is always flooded the self-primer will not be required.

Where pumps are used for more than one process operation the flow rate, head and NPSH(Available) characteristics as defined on the data sheet are for the primary process. Secondary processes will not adversely affect the conditions under which the pump will operate providing the correctly selected pressure and/or flow control devices are installed within the pipework system.

Slops Pumps

Slops pumps shall be either of the horizontal self priming positive displacement or submersible type. The pump may be required to perform any, or all, of the following duties:

- transfer of settled water within the drain tank to the oil/water interceptor
- reinjection of clean fuel into storage tanks via a filter water separator
- transfer of sludge or dirty fuel to a road tanker.

Annex C Change suggestion form

	Defence Estate Organisation **Airfields and Bulk Fuels Group** **Blakemore Drive** **Sutton Coldfield** **B75 7RL**	**Spec 043** **Pumps for bulk fuel installations** **Change suggestion form**
Originator:		**Date:**
		Reference:
Change Suggestion		
Section		**Page:**
Change Detail: **Continuation Sheet included? Y☐ N☐**		
Reason: **Continuation Sheet included? Y☐ N☐**		
DEO Review		
Action:		**Reference:**
		Action Date:
		Approved:
		Actioned:

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