

Technical Specifications – Liquid Fuel Forwarding

Drawings and Schematics

P&ID: AGM-02-0204-PLA-P-0035

Mechanical Outline Drawing: AGM-02-0204-PLA-M-0034

Electrical Outline Drawing: AGM-02-0204-PLA-M-0036

Process Specifications:

Fluid – Distillate Fuel (see GE specification GEI-41047)

Fluid Specification:

	Skid Inlet		Skid Outlet	
	Maximum	Minimum	Maximum	Minimum
Pressure (psig)	25.0	0.5	150.0	55.0
Temperature (deg F)	150.0	40.0	150.0	40.0
Flow (gpm)	150.0	15.0	150.0	15.0

Electrical Control Center

480VAC, 3 phase, 60Hz	Pump Motors
125 VDC	Instrument Switches
24 VDC	4-20 ma Flow and Pressure Transmitters

Piping Specification

Manufactured to B31.1

Pump & Motor Specification

Two redundant (100%) ANSI pumps

Continuous Duty Motor

Other

- Open Skid
- Electrical NEMA 4 rated
- Non-hazardous rated
- Recirculation back to the tank via backpressure regulating valve

Calculations for Pump / Motor Specifications:

$$hL = f \times L/D \times V^2$$

Where:

hL = Head loss (ft)

L = Length (ft)

D = Diameter

F = Friction Factor

V = Average Velocity (fps)

g = Acceleration of gravity (ft/sec²)

$$NR = (VD\rho)/\mu$$

Where:

NR = Reynolds Number

ρ = Density (lb / ft³)

μ = Dynamic Viscosity (lb-sec/ft²)

$$RR = D/\varepsilon$$

Where:

RR = Relative Roughness

ε = Roughness

$$h_{fl} = K * V^2/2g$$

K = Friction coefficient

$$NPSHA = h_{atmo} + h_{ele} - h_f - h_{vap}$$

h_{atmo} = atmospheric head

h_{ele} = head due to elevation

h_f = friction losses

h_{vap} = vapor pressure of fluid

$$Q = AV$$

Where:

Q = Flow rate (ft^3/sec)

A = Average cross sectional area (ft^2)

Calculation of velocity in 4" suction assuming maximum flow rate: 150 gpm

$$(150 \text{ gpm} / 7.48 \text{ ft}^3/\text{gpm}) = [\pi \times (4.03/12)^2] / 4 \times V$$

$$V = 226.35 \text{ ft} / \text{min} \text{ or } 3.77 \text{ ft} / \text{sec}$$

$$2.436 \text{ cp} = 2.0895 \times 10^{-5} [\text{lb-sec}/\text{ft}^2/\text{cp}] \quad \mu = 5.088 \times 10^{-5} \text{ lb-sec}/\text{ft}^2$$

$$0.87 \times 8.33 \text{ lb} / \text{gal} \times 7.48 \text{ gal}/\text{ft}^3 = 54.208 \text{ lb}/\text{ft}^3 \text{ OR } 1.6848 \text{ slugs}/\text{ft}^3$$

Assuming liquid fuel specific gravity = 0.87

Reynolds Number Calculation:

$$NR = [3.77 \text{ ft} / \text{sec} \times 4 \text{ in}/12 \times 1.6848 \text{ Slugs}/\text{ft}^3] / 5.088 \times 10^{-5} \text{ lb-sec}/\text{ft}^2$$

$$NR = 24,274$$

$$RR = (4/12) / 1.5 \times 10^{-4} = 2,222 \rightarrow \text{Moody's Diagram}$$

Head Loss Calculation:

Moody's friction factor for 4" schedule 40 carbon steel pipe $f = 0.023$

$$h_{Lf} = 0.023 \times [100 \text{ ft} / (4/12)] \times [(3.8 \text{ ft}/\text{sec})^2 / (2 \times 32.2 \text{ ft} / \text{sec}^2)]$$

$$h_{Lf} = 1.547 \text{ ft diesel} / 100 \text{ ft} \rightarrow 1.346 \text{ ft H}_2\text{O}$$

Approximate pipe run = 260 feet

$$h_{Lf} = 260 \text{ ft} / 100 \text{ ft} \times 1.346 \text{ ft H}_2\text{O} / 100 \text{ ft} = \mathbf{3.5 \text{ ft H}_2\text{O}}$$

Losses in Fittings

		K
(2)	4" Ball Valve	0.06 ea
(4)	4" reg 90 ell	0.225 ea
(1)	4" nozzle at tank	0.5 ea

$$\text{Total K} = 1.52$$

$$h_{fL} = 1.52 \times 3.83^2 \text{ ft/s} / (2 \times 32.2 \text{ ft/s}^2)$$

$$\mathbf{h_{fL} = 0.346 \text{ ft Diesel} \rightarrow 0.301 \text{ ft H}_2\text{O}}$$

$$h_L = h_{Lf} + h_{fL}$$

$$h_L = 3.5 \text{ ft H}_2\text{O} + 0.301 \text{ ft H}_2\text{O}$$

$$h_L = 3.8 \text{ ft H}_2\text{O}$$

Liquid Fuel Forwarding – Skid Suction Losses

		<u>K</u>
(1)	4" tee branch flow	0.7
(1)	4" butterfly valve	1.5
(1)	4" 90 ell	0.3
(1)	3" butterfly valve	1.5
(1)	4"x3" reducer	0.25
(1)	basket strainer	1.1

$$K = 5.35$$

$$h_{Ll \text{ skid}} = 5.35 * 3.83^2 \text{ feet/sec} / (2 * 32.2 \text{ ft/s}^2)$$

$$h_{Ll \text{ skid}} = 1.22 \text{ ft Diesel} \rightarrow 1.06 \text{ ft H}_2\text{O}$$

NPSHA

$$\text{Skid Elevation} - 5.05\text{m} + \text{Inlet elevation} - 0.25\text{m} = 5.3\text{m}$$

$$\text{Tank Elevation} - 7.22\text{m}$$

$$\text{Head due to elevation} - 7.22\text{m} - 5.3\text{m} = 1.92\text{m} \rightarrow 6.297 \text{ ft diesel} \rightarrow 5.48 \text{ ft H}_2\text{O}$$

$$\text{NPSHA} = 14.1 \text{ psia} / .433\text{psi/ft} + 5.48 \text{ ft H}_2\text{O} - 4.86 \text{ ft H}_2\text{O} - 0.01\text{psia} / .433\text{psi/ft}$$

$$\text{NPSHA} = 33.16 \text{ ft H}_2\text{O}$$

Calculation of velocity in 3" discharge assuming maximum flow rate: 150 gpm

$$(150 \text{ gpm} / 7.48 \text{ ft}^3/\text{gpm}) = [\pi \times (3/12)^2] / 4 \times V$$

$$V = 397.34 \text{ ft / min} \text{ or } 6.62 \text{ ft / sec}$$

$$2.436\text{cp} = 2.0895 \times 10^{-5} [\text{lb-sec/ft}^2/\text{cp}] \quad \mu = 5.088 \times 10^{-5} \text{ lb-sec/ft}^2$$

$$0.87 \times 8.33 \text{ lb / gal} \times 7.48 \text{ gal/ft}^3 = 54.208 \text{ lb/ft}^3 \text{ OR } 1.6848 \text{ slugs/ft}^3$$

$$\text{Assuming liquid fuel specific gravity} = 0.87$$

Reynolds Number Calculation:

$$\text{NR} = [6.62\text{ft / sec} \times 3 \text{ in}/12 \times 1.6848 \text{ Slugs/ft}^3] / 5.088 \times 10^{-5} \text{ lb-sec/ft}^2$$

$$\text{NR} = 55,569$$

$$\text{RR} = (3/12) / 1.5 \times 10^{-4} = 1690 \rightarrow \text{Moody's Diagram}$$

Head Loss Calculation:

$$\text{Moody's friction factor for 3" schedule 40 carbon steel pipe } f = 0.023$$

$$h_{Lf} = 0.023 \times [100 \text{ ft}/(3/12)] \times [(6.62 \text{ ft/sec})^2 / (2 \times 32.2 \text{ ft / sec}^2)]$$

$$h_{Lf} = 6.26 \text{ ft diesel} / 100 \text{ ft} \rightarrow 5.45 \text{ ft H}_2\text{O}$$

Approximate pipe run = 1260 feet

$$h_{Lf} = 260 \text{ ft} / 100 \text{ ft} \times 5.45 \text{ ft H}_2\text{O} / 100 \text{ ft} = \mathbf{68.67 \text{ ft H}_2\text{O}}$$

Losses in Fittings

		K
(2)	3" Ball Valve	0.07 ea
(12)	3" reg 90 ell	0.35 ea
(1)	2" check valve	2 ea
(1)	3" butterfly	3 ea
(2)	reducers	.05 ea

Total K = 9.44

$$h_{fL} = 9.44 \times 6.62^2 \text{ ft/s} / (2 \times 32.2 \text{ ft/s}^2)$$

$$\mathbf{h_{fL} = 0.642 \text{ ft Diesel} \rightarrow 0.585 \text{ ft H}_2\text{O}}$$

$$h_L = h_{Lf} + h_{fL}$$

$$h_L = 68.67 \text{ ft H}_2\text{O} + 5.85 \text{ ft H}_2\text{O}$$

$$\mathbf{h_L = 74.25 \text{ ft H}_2\text{O}}$$

Calculation for total losses:

Turbine Elevation: 7.44M + .25m

Liquid Fuel Elevation: 5.3M

$$\text{Difference in Elevation: } 2.39\text{M} \rightarrow 7.839 \text{ ft diesel} \rightarrow 6.82 \text{ ft H}_2\text{O}$$

Pressure required at Unit: 70 psi

+ 161.66 ft H₂O – Pressure at unit

+ 6.82 ft H₂O - Elevation

+74.25 ft H₂O – Friction losses

-33.16 ft H₂O – NPSHA

Required differential – 209.57 ft H₂O → 90.74psi

Design Pressure: 80.8 x 1.125 = 91 psi

Documentation from Pump / Motor Supplier

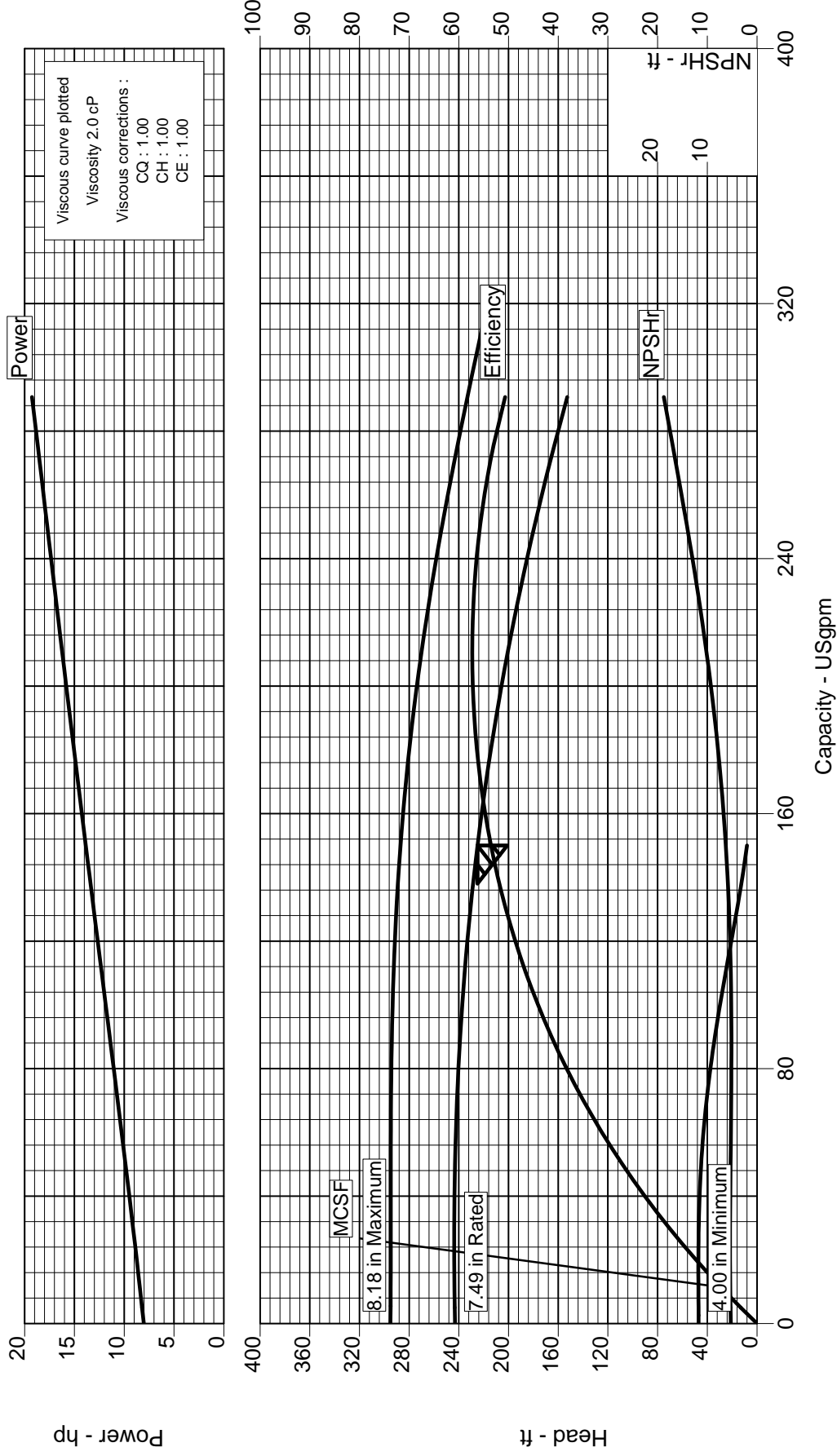


Customer : PRO ENERGY
Item number : DIESEL FUEL
Service :
Vendor reference : 4459-10006
Date : January 12, 2011

Capacity : 150.0 USgpm
Head : 225.00 ft
Specific gravity : 0.870
Pump speed : 3500 rpm

Pump size & type : 1K3x1.5-82RV M3 ST
Based on curve no. : MIII7140V
Number of stages : 1

CURVES ARE APPROXIMATE, PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS, CAPACITY, HEAD, AND EFFICIENCY.
MCSF PROVIDES MECHANICAL PROTECTION ONLY. MINIMUM THERMAL FLOW MUST BE CALCULATED FOR THE SPECIFIC FLUID AND OPERATING CONDITIONS.



Customer	: PRO ENERGY	Pump / Stages	: 1K3x1.5-82RV M3 ST	/ 1
Customer reference	: P203A & B	Based on curve no.	: MIII7140V	
Item number	: DIESEL FUEL	Vendor reference	: 4459-10006	
Service	:	Date	: January 12, 2011	

Operating Conditions		Materials / Specification	
Capacity	: 150.0 USgpm	Material column code	: D/C
Water Capacity (CQ=1.00)	: 150.0 USgpm	Pump specification	: ANSI B73.1
Normal capacity	: -	Other Requirements	
Total Developed Head	: 225.00 ft	Hydraulic selection : No specification	
Water head (CH=1.00)	: 225.00 ft	Construction : No specification	
NPSH available (NPSHa)	: Ample	Test tolerance : Hydraulic Institute Level A	
NPSHa less NPSH margin	: -	Driver Sizing : Max Power (SO to EOC) w/o SF	
Maximum suction pressure	: 7.1 psig	Seal configuration : Single Seal	
Liquid			
Liquid type	: Hydrocarbon		
Temperature / SG	: 90 °F / 0.870		
Solid Size - Actual / Limit	: - / 0.00 in		
Viscosity / Vapor pressure	: 2.0 cP / -		

Performance			
Hydraulic power	: 7.41 hp	Impeller diameter	
Pump speed	: 3500 rpm	Rated	: 7.49 in
Efficiency (CE=1.00)	: 54.2 %	Maximum	: 8.18 in
		Minimum	: 4.00 in
NPSH required (NPSHr)	: 6.3 ft	Suction specific speed	: 7810 US units
Rated power	: 13.68 hp	Minimum continuous flow	: 23.2 USgpm
Maximum power	: 19.2 hp	Maximum head @ rated dia	: 243.1 ft
Driver power	: 20.0 hp / 14.91 kW	Flow at BEP	: 210.7 USgpm
Casing working pressure	: 98.7 psig	Flow as % of BEP	: 71.2 %
(based on shut off @ cut dia)		Efficiency at normal flow	: -
Maximum allowable	: 250.0 psig	Impeller dia ratio (rated/max)	: 91.6 %
Hydrostatic test pressure	: 375.0 psig	Head rise to shut off	: 8.0 %
Est. rated seal chamb. press.	: -	Total head ratio (rated/max)	: 78.4 %

Power - hp

Head - ft

Capacity - USgpm

Efficiency

NPSHr - ft

Viscous curve plotted
Viscosity 2.0 cP
Viscous corrections :
CQ : 1.00
CH : 1.00
CE : 1.00

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8.18 in Maximum
7.49 in Rated
4.00 in Minimum
NPSHr

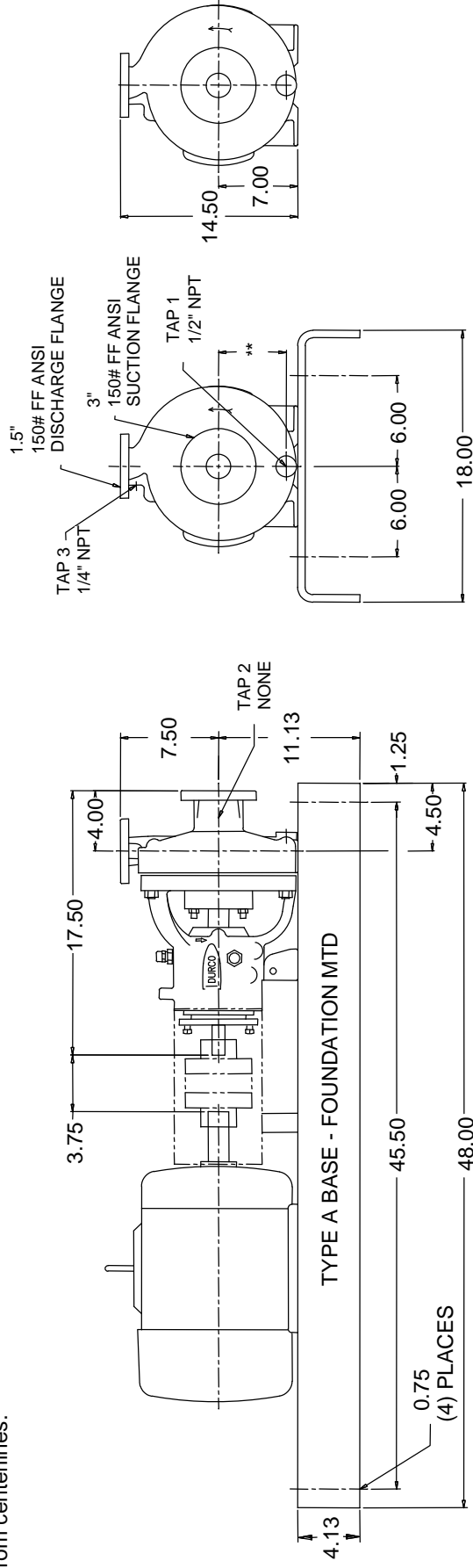
Customer : PRO ENERGY					Pump / Stages : 1K3x1.5-82RV M3 ST / 1				
Customer reference : P203A & B					Based on curve no. : MIII7140V				
Item number : DIESEL FUEL					Vendor reference : 4459-10006				
Service :					Date : January 12, 2011				
Construction					Driver Information				
Nozzles	Size	Rating	Face	Pos'n	Manufacturer : Flowserve Choice				
Suction	3.00	150#	FF	End	Power : 20.0 hp / 14.91 kW				
Discharge	1.50	150#	FF	Top	Service factor (req'st / act) : 1.00 / 1.25				
Casing mounting : Foot					Speed : 3600 rpm				
Casing split : Radial					Orientation / Mounting : Horizontal / Foot				
Impeller type : Reverse Vane					Driver Type : NEMA				
Bearing type (radial) : Sgl Row					Frame-size / material : 256T / Aluminum				
Bearing number (radial) : 6207-C3					Enclosure : TEFC				
Bearing type (thrust) : Dbl Row					Hazardous area class : -				
Bearing number (thrust) : 5306-AC3					Explosion 'T' rating : -				
Bearing lubrication : Flood					Volts / Phase / Hz : 230/460 / 3 / 60				
Rotation (view from cplg) : CW per Hyd. Institute					Amps-full load/locked rotor : 24.05 / 157.00				
Materials					Motor starting : Direct on line (DOL)				
Casing : Duct.Cast Iron (DCI)					Insulation : F				
Impeller : CD4M/CD-4MCu					Temperature rise : -				
Seal chamber : FML Box / (DCI)					Bearings : Ball				
Shaft : 316 SS					Lubrication : Grease				
Sleeve : No Sleeve					Motor mounted by : Flowserve				
Baseplate, Coupling and Guard					Sound Pressure (dBA @ 1.0 m)				
Baseplate type : Type A Founda					Driver, expected : 86.1				
Baseplate material : Steel					Pump & driver, estimated : -				
Baseplate size : 148 Baseplate					Seal Information				
Coupling manufacturer : T.B. Woods					Arrangement : Sgl Int O-Ring				
Coupling size : Sureflex S					Size : 1.375				
Coupling / Shaft guard : Steel					Manufacturer / Type : Flowserve / ISC Pusher				
Shaft / seal guard : None Supplied					Material code (Man'f/API) : CSCPX----ECXV- / BSTFN				
Weights (Approx.)					Internal neck bushing : Not Available				
Bareshaft pump(nett) : 124.0 lb					Gland				
Baseplate(nett) : 163.0 lb					Gland material : 316SS				
Driver(nett) : 210.1 lb					Flush : .375" NPT				
Shipping gross weight/vol. : 571.7 lb / 10.25 cu.ft					Vent : .375" NPT				
Testing					Drain : .375" NPT				
Hydrostatic test : Non witnessed					Auxiliary seal device : Carbon Bushing				
Performance test : None					Piping				
NPSH test : None					Seal flush plan : Plan 12				
Paint and Package					Seal flush construction : Tubing				
Pump paint : Std.Polyurethane					Seal flush material : Carbon steel				
Base grout surface prep : Standard					Aux seal flush plan : None				
Shipment type : Domestic					Aux seal flush construction : -				
					Aux seal flush material : -				
Notes									
Mark 3A w/Watchdog oiler									
Casing w/1/2" Plugged Drain (NPT)									

Dimensions certified for construction
when properly endorsed below.
Refer to factory for any "xxx" dimensions.
DO NOT SCALE DRAWING

NOTES:

1. Consult pump I.O.M. before installing the pump.
2. Installation dimensions are +/- .13" (3mm), unless otherwise noted.
3. Foundation bolts and piping should not be set rigidly before receipt of equipment.
4. Allow a minimum of .75" (19mm) under baseplate for adjustment and grouting.
5. All holes in flanges are offset from centerlines.

6. Piping, foundations, and systems are the responsibility of others. Flowserve Pump Division data and comments are offered as an aid, but Flowserve Pump Division cannot assume responsibility for the system design or operation. It is recommended that a specialist skilled in this area be consulted to ensure a successful installation.
7. Dimension shown from bottom of base to centerline of pump includes any blocks under pump, as necessary.



All dimensions are in inches unless otherwise specified

Customer	: PRO ENERGY	Pump size & type Pump speed / Stages Flow / Head Driver power / Frame Volts / Phase / Hz	: 1K3x1.5-82RV M3 ST : 3500 rpm / 1 : 150.0 USgpm / 225.00 ft : 20.0 hp / 14.91 kW / 256T : 230/460 / 3 / 60	Drawing number	
Item number	: DIESEL FUEL			Date	: January 12, 2011
Service	:			Certified by / Date :	
Customer PO #	:			Seal type	: ISC Pusher
Vendor reference /	: 4459-10006 Rev. A			Seal flush plan	: Plan 12



Pricing Sheet / Scope of supply

Customer: PRO ENERGY
Cust / Proj Ref: P203A & B
Item Number: DIESEL FUEL
Service:

Pump / Stg: 1K3x1.5-82RV M3 ST / 1
Curve Number: MIII7140V
FPD Reference: 4459-10006
Date: Jan 12, 2011

Qty	Description	Average Unit Price	Extended Price
1	1K3x1.5-82RV M3 ST FPD - D/C Pump - Standard Duty Packaging by Chesapeake Safe(non explosive) atmosphere Alloy Surcharge / Chesapeake Flowserve Single Cartridge Seal Flowserve ISC2 Pusher w/o Pumping Ring SilCar Rotary vs. Carbon Seat Atlas Elastomers 316SS Metal Parts 316SS Large Bore Gland No Seal Price Adder Required Cover - FML Gland Provided By Seal Manufacturer ANSI Plan 7312 Seal Flush 1/4" .035 Wall Tube Tube Fittings FPD Choice Carbon Steel - Seal Flush Material Casing - Ductile Cast Iron (DCI) Cover - Ductile Cast Iron (DCI) Cover Gasket - TM Impeller - CD4M/CD-4MCu Impeller Gasket - TFR No O-ring required Bearing Housing - DCI2 No Bearing Housing Adapter Required Bearing Housing Foot - CI Shaft - Standard Shaft - 316 Stainless Stud B7 / Nut SR2H (Steel) Casing - Standard 150# FF ANSI Drilling 1/2" NPT Casing Drain Tap (Plugged) No Suction Tap 1/4" NPT Discharge Tap (Tap 3) Plastic Flange Covers		

** - additional pricing to follow

Feature quantities match pump quantity unless otherwise noted.

1 of 3

Prices may be subject to exchange rate fluctuations.
Proposal is valid for 30 days.

Customer: PRO ENERGY
 Cust / Proj Ref: P203A & B
 Item Number: DIESEL FUEL
 Service:

Pump / Stg: 1K3x1.5-82RV M3 ST / 1
 Curve Number: MIII7140V
 FPD Reference: 4459-10006
 Date: Jan 12, 2011

ISO 1940 G6.3 Impeller Balance Power End - Mark 3A Oil Lubricated Bearings Watchdog Trico Oiler Oiler/Sight on Rgt Side-Viewed From Cplg Oil Seals - TSSR 3.5" Coupling Spacer Woods Coupling Sureflex Type SC7 EPDM Spacer Type A - Foundation Baseplate Baseplate Drip Rim - (Pump End Only) 148 Baseplate Steel - Baseplate Polybloc - Driver Mounting Steel - Fasteners Baseplate - Drip Rim (Pump end only) Std. Steel Cplg Guard (Safety Yellow) Paint - Plant Standard Paint - Entire Pump & Baseplate Paint Over Standard Flowserve Primer One Coat of Paint (4-6 mils DFT) No Customer Inspection No PMI Testing No 2.1 Certificate of Compliance No 2.2 Cert of Compliance No 3.1 CMTRs No Radiography / X-Ray No Dye Penetrant of 100% Machined Surf. No Dye Penetrant of Gasketed Surfaces Standard Domestic Packaging (6 Months) No Documentation Required Nameplate w/US Customary Units Driver Driver Mounted to Base by Factory NEMA Motor Flowserve Choice TEFC [20.0 hp 3600 RPM 256T] 230/460 Volts No Space Heaters		
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** - additional pricing to follow

Feature quantities match pump quantity unless otherwise noted.

2 of 3

Prices may be subject to exchange rate fluctuations.
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